EXHIBIT 1

May 13, 2013

Via Electronic Mail

Ms. Cindy Bladey
Chief, Rules, Announcements, and Directives Branch
Office of Administration
Mail Stop: TWB-05-B01M
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

RE: NRDC Comments on *Draft Supplemental Environmental Impact Statement* for the Ross ISR Project in Crook County, Wyoming, Docket ID NRC-2011-0148.

Dear Ms. Bladey:

The Natural Resources Defense Council (NRDC) writes today to comment on the Nuclear Regulatory Commission's (NRC) *Environmental Impact Statement for the Ross ISR Project in Crook County, Wyoming; Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities; Draft Report for Comment* (hereinafter "Draft SEIS" or "DSEIS"). *See* 78 Fed. Reg. 19330 (March 29, 2013). NRDC respectfully urges NRC to withdraw the Draft SEIS as the agency's actions fail to meet the requirements of the National Environmental Policy Act (NEPA) 42 U.S.C. § 4321 *et seq.*, and further direct the applicant for this NRC's materials license to re-submit an Environmental Report that adequately addresses the scope and extent of the proposed major federal action.

Summary of Comments

The Draft SEIS is a deficient presentation that fails a federal agency's basic duties to both define the scope of a major federal action and take a "hard look" at the significant environmental impacts associated with that action. These requirements—properly defining the scope of the major federal action, and taking a searching look at the associated environmental impacts of "in-situ leach" (ISL) mining and reasonable alternatives to avoid or mitigate those impacts–comprise the heart of a federal agency's NEPA obligations.[1] Indeed, NEPA is clear in its well-established

[1] NEPA directs that DOE take a "hard look" at the environmental impacts of its proposed program and compare them to alternative means of fulfilling the same purpose and need for agency action that may avoid or mitigate environmental harms or risks posed by the Proposed Program. "What constitutes a 'hard look' cannot be outlined with rule-like precision, but it at least encompasses a thorough investigation into the environmental impacts of an agency's action and a candid acknowledgement of the risks that those impacts entail." *Nat'l Audubon Soc. V. Dept of the Navy*, 422 F.3d 174, 185 (4th Cir. 2005).

mandates. NEPA characterizes environmental impacts broadly to include not only ecological effects, such as physical, chemical, radiological and biological effects, but also aesthetic, historic, cultural, economic, and social effects. 40 CFR § 1508.8. NEPA requires an agency to consider both the direct effects caused by an action and any indirect effects which are reasonably foreseeable. Effects include direct effects caused by the action and occurring at the same time and place and indirect effects caused by the action, but later in time or farther removed in distance, but still reasonably foreseeable. 40 CFR § 1508.8.

Rather than comply with these well-established NEPA requirements, the Draft SEIS submits a set of quantitatively baseless environmental conclusions (that impacts will largely be "SMALL" and in a few specific instances "MODERATE") concerning an arbitrarily truncated segment of a project that is quite obviously the first step in a much larger plan for mining uranium in eastern Wyoming. Our detailed comments follow a brief explanatory background that ensures a full agency record.

Background

As NRC is aware, we are currently admitted parties in this matter in an Atomic Energy Act hearing before the Atomic Safety & Licensing Board ("ASLB" or the "Board"). On October 27, 2011 and pursuant to 10 C.F.R. § 2.309 and NRC's Federal Register notice published at 76 Fed. Reg. 41,308 (July 13, 2011), NRDC and the Powder River Basin Resources Council (PRBRC) submitted a Petition to Intervene and Request for a Hearing in the Strata licensing matter. Petitioners articulated five contentions in their Petition. These contentions address various deficiencies in Strata Energy, Inc.'s (Strata) source materials license application, for the proposed Ross In Situ Recovery (ISR) Uranium Project in Crook County, Wyoming, that have now carried over into the Staff's DSEIS.

Following briefing on standing and the admissibility of each contention, the Board conducted a day-long hearing on these matters on December 20, 2011. On February 10, 2012, the Board issued LBP-12-3, "Memorandum and Order, Ruling on Standing and Contention Admissibility." This 53-page opinion held that Petitioners had established standing and admitted two of their five contentions in whole while admitting the remaining three in part. *See* LBP-12-3 at 1–2, 18–25, 28, 32, 36, 37, and 39–40. On February 21, 2012, both Strata and NRC Staff filed appeals of LBP-12-3 and argued Joint Petitioners had not demonstrated standing to challenge Strata's application for a license for an in situ uranium recovery project in Crook County, Wyoming. Strata also asked the Commission to eliminate two contentions from the proceeding, should it decline to reverse the Board's standing determination. NRDC and PRBRC opposed both appeals. On May 11, 2012 the Commissioners issued CLI-12-12 and affirmed the Board's standing determination and declined to consider Strata's remaining claims. See CLI-12-12 at 1-2.

On March 21, 2013, Staff issued the Draft SEIS for the Ross ISR Project. Amended or new contentions on the DSEIS were due on May 6th, 2013 and today we attach those pleadings and the two supporting declarations for consideration as part of our comments on the DSEIS. The

legal pleading before the ASLB and the two supporting technical declarations from Dr. Richard Abitz and Christopher E. Paine speak for themselves, but NRC staff should be aware that the documents identify numerous NEPA deficiencies specifically related to the four admitted contentions and with respect to the new contention – NRC's failure to consider the environmental impacts of, and appropriate alternatives to, the applicant's actual proposed project, and instead to improperly segment the project by framing the Proposed Action under review as only a small part of the Applicant's planned and scheduled In Situ Recovery (ISR) activities in the Lance District.

However, the previous timely filed pleadings appended as part of our comments today comments are only that – they are intended to complement and enlarge upon the deficiencies noted herein on the Draft SEIS. With the obligation to file our new and amended contentions on May 6th, we were only able to develop this larger set of comments on the DSEIS in a short timeframe, but we suggest the document is so deficient the agency should withdraw it and direct the applicant to resubmit an ER of proper scope. During that interim, we also suggest NRC invest in developing an EIS process that provides a quantitative basis for analysis, consistent with its own regulations. *See* 10 C.F.R. § 51.71(d) (The analysis for all draft environmental impact statements will, to the fullest extent practicable, quantify the various factors considered. To the extent that there are important qualitative considerations or factors that cannot be quantified, these considerations or factors will be discussed in qualitative terms.).

Specific Comments

Executive Summary

1. P. xviii, line 6. "The purpose and need for this proposed action is to provide an option that allows the Applicant to recover uranium and produce yellowcake at the Ross Project area."

> **NRDC Comment**:
> This odd wording, evidently adopted to enable a vague scope for the project that facilitates future expansion with minimal or no further environmental analysis, potentially via FONSI's covering future license amendments to permit additional well-fields. The Ross Project will also allow, and it is Strata's declared intention, to recover and produce significant quantities of vanadium, but this activity is not mentioned in the statement of purpose and need.
>
> More importantly, this statement seems an oddly vague and amorphous description for an NRC-proposed major federal action that triggers the need for this SEIS, which action is the exercise of federal authority to grant or deny a license to construct, operate, and decommission a uranium recovery facility and restore the site and mined aquifer in accordance with its statutory mandate under the AEA to ensure "adequate protection of the public health and safety" from the hazards posed by such activities, and to ensure that these activities are not inimical to the "common defense and security." Thus one might logically expect the statement of purpose and need to say something like this:

> "The purpose and need for the proposed action -- the granting of an NRC license to recover uranium from [name well-field areas] and process it at [name Central Processing Facility} for [x years] -- is to ensure, through a rigorous nuclear safety and NEPA review process prior to licensing, that the uranium recovery activities and associated environment, safety, and health risks and environmental impacts described in the license application and applicant's Environmental Report, faithfully represent the full range of activities, risks, and impacts that will arise as a result of the licensed activity, and that all these activities will be conducted in a manner that: (1) ensures adequate protection of public health and safety and the common defense and security; (2) identifies and seeks to avoid or minimize all reasonably foreseeable environmental impacts, while mitigating any unavoidable adverse environmental impacts.

2. P. xviii, lines 20 -25. "Strata's Proposed Action, the Ross Project, would occupy 697 ha [1,721 acres] in the north half of the approximately 90-km2 [56-mi2] Lance District, where the Applicant is actively exploring for additional uranium reserves. Strata has also identified four other uranium-bearing areas that would extend the area of uranium recovery to the north with the Ross Amendment Area 1 and to the south of the Lance District with the Kendrick, Richards, and Barber satellite facilities. *These areas are not a component of the Proposed Action in this SEIS* (emphasis added)."

> Lines 42 – 47: "The Proposed Action includes the option of the Applicant operating the Ross Project Facility beyond the life of the Project's wellfields. The facility could be used to process uranium-loaded resins from satellite projects within the Lance District operated by the Applicant, or from other offsite uranium recovery projects not operated by the Applicant (i.e. "toll milling), or from offsite water-treatment operations. With that option, the life of the facility would be extended to 14 years or more."
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> **NRDC Comment:**
> This additional processing at the "Ross Project Facility" is described as an "option" within the scope of the Proposed Action, but analysis of the environmental impacts of the additional wellfields and facilities needed to produce feedstock for this processing are not "a component of the Proposed Action in this SEIS." Later in the document we learn that the presently proposed Central Processing Plant (CPP) facility is being sized to accommodate the additional processing expected from "other offsite uranium recovery projects" or "offsite water-treatment operations." Note also that the term of this additional processing, and any connected environmental impacts associated with producing the uranium-loaded resins that are expected to be shipped to this enlarged facility, is given as "14 years *or more*," and thus is essentially open-ended with respect to the connected environmental impacts of the additional well-field operations that produce these uranium-loaded resins.
>
> However, meaningful consideration of impacts in the SEIS is limited to the Ross Project well-fields only, even though the capacity of the proposed CPP has been sized to accommodate a throughput four times greater than that required by the Ross Project alone, and will thus enable the simultaneous ISL mining of additional areas. If the ISL

mining were to occur sequentially over many years, as "reasonably foreseeable" future mining areas are developed in series, there would be no need to build the facility with four times the capacity need for the Ross Project alone.

This already planned mining, coincident with the Ross Project, is a clear and obvious consequence of the NRC's proposed licensing action that must be analyzed in detail in an original ER and in a Draft SEIS. In reality, the Proposed Action effectively encompasses this additional ISR activity, which vastly exceeds the scope of the "Ross Project" itself, because it is planned to be carried out through the establishment of multiple "satellite" ISR operations via multiple Ross Project license amendment amendments that would most likely invoke "No Significant Hazards Consideration," and thus potentially be granted without a contested hearing opportunity, and be supported by multiple NEPA "Findings of No Significant Impact" (FONSIs) for each additional satellite operation. See also, Paine Declaration, filed May 6 in this proceeding.

Further, the Paine declaration substantiates our claim that both the near-term and ultimate size and geographic extent of the uranium mineralization that Peninsula is intent on recovering from the Lance District deposits are much larger than what is analyzed in the DSEIS, and thus the scale of environmental impacts will be proportionately larger, nearer in time than hitherto described, longer lasting, and potentially more damaging to the environment than assessed in the DSEIS.

3. P. xix. "The ore zone is that portion of the aquifer that has been permanently exempted by the U.S. Environmental Protection Agency (EPA) from requirements as an underground source of drinking water under the Safe Drinking Water Act."

NRDC Comment:
The geographic extent and boundaries of the "ore zone" that has been "permanently exempted" and subject to water quality degradation is not given with any precision in the SEIS. We understand separately from EPA that the current extent of the application for permanent exemption extends only to the smaller Ross Project. Are there separate filings NRC is aware of where the SDWA exemption proposed or granted for the aquifer to be mined by the Ross Project already cover some or all of the additional "satellite areas?" What is the basis for the applicant's confidence to build a CPP facility that is four times the size of that needed for the Ross Project and twice the size of the facility analyzed in the GEIS?

4. P. xix. "Once uranium recovery is complete, the ore-zone's ground water is restored to NRC-approved ground-water protection standards, which are protective of the surrounding ground waters."

NRDC Comment:
Neither the specific restoration standards that will be applied to the ore zone's ground water, nor any analysis demonstrating that such "restoration" will be "protective of the surrounding ground waters," is provided in this DSEIS. On the contrary, the penetration

of the mined and surrounding aquifers in the Ross Project Area by some "3000 drill-holes and wells" at an average density of "1.7 wells per acre" [p. xxvi] suggests the potential for substantial fluid migration and degradation of water quality beyond the ore zone.

5. P. xx. "The significance of potential environmental impacts is categorized as follows: "Small: …Moderate:…Large:…."

NRDC Comment:
While the NRC's taxonomy (small, moderate, or large impacts) for classifying and characterizing environment impacts has been established for some time, the way it has evolved in its use is inadequate and the DSEIS illustrates these problems. Specifically, such terms are no longer tied to any consistent set of quantitative or otherwise objectively ascertainable metrics for assessing and comparing the impacts of ISL activities on groundwater or any other environmental resource, or on human health.

For example, what is the difference, in terms of measurable impacts on human health and the environment, between "altering noticeably" and "destabilizing important attributes of" the resource considered? If construction and operation of one ISL-related activity (one well-field "module," for example) is assessed as having a "small" environmental impact on "land use" and "geology and soils" because it represents only a small fraction of "disturbed" land within a given area, does it necessarily follow that 5000 such wells, and the piping and roads that connect them, will likewise have only a "small" impact? If the impacts of one well field penetrating a "shallow aquifer" are assessed as "small," does that mean that the impacts of scores of such well fields penetrating the same aquifer are also "small"? If all the impacts to each of the affected resources (Land, soils, groundwater, ecology, air quality, noise, etc. are assessed individually as being "small," does it follow that the aggregate and cumulative impact of all these "small" changes on a given area is likewise "small?" The NRC's methodology leads ineluctably to such "conclusions" based on no quantitative data.

6. P. xxiv, line 5. "Construction: Impacts would be SMALL. A total of 113 ha [280 acres] of land, which represents 16 percent of the Ross Project Area, would be disturbed during the construction of a CPP, surface impoundments, and other auxiliary structures such as storage areas and parking lots. The well-fields would be sequentially developed over the Ross Project lifecycle. All disturbed areas would be fenced, and thus, somewhat limit grazing by livestock, access by wildlife, and recreational opportunities. Operation: Impacts would be SMALL….Areas where Ross project uranium production activities would take place would remain fenced, somewhat limiting grazing and crop production."

NRDC Comment:
The total land area, including wellfields, which would remain fenced and limit access by wildlife, and its percentage of the total project area, are not given. Thus there is no basis for the conclusion that the impact on wildlife, crop production, and livestock grazing would be "Small."

7. P. xxiv, line 19: "No new facilities would be constructed that would result in additional land disturbance during operation, although well drilling would continue as the wellfields would be sequentially developed."

NRDC Comment:
This is a misleading statement. Figure 2.6 on page 2-8 shows "facility construction" occurring during "facility operation," but more to the point, continuing well-field development involves continuing construction of "module buildings" and "valve manholes" and continuing trench excavation for burying the extensive pipeline network that carries lixiviant to potentially thousands of injection well and retrieves it from thousands of recovery wells. Also, up to five deep disposal wells are permitted over the life of the project. Each one of these is an industrial installation mounted on a 250 x 250 ft. asphalt or gravel pad with storage tanks, pumps, filtration systems, I &C systems, and injection equipment for process chemicals. In other words, construction activity will be almost continuous throughout the first eight years of the project, according to Figure 2.6-16.

8. P. xxvii, line 40: "Operation: The impact [on groundwater] would range from SMALL to MODERATE (depending upon whether excursions occur)."

NRDC Comment:
No empirical evidence or reference is provided for this conclusion, and thus the statement is meaningless. If a major excursion occurs and remains undetected for an extended period, for example, why would the impact not be "LARGE?" Again, this NRC methodology for assessing and comparing impacts has evolved to a degree where it is baseless.

9. P. xxvii, line 49: "The Applicant's implementation of BMPs during Ross Project operation would reduce the likelihood and magnitude of spills or leaks [getting into shallow aquifers] and facilitate expeditious cleanup."

NRDC Comment:
The SEIS is examining only the best case. What if the price of uranium drops and the Applicant does not follow "Best Management Practices" in order to save money and maintain profit margins? What if the operation leaks like a sieve and plant personnel cover up the leaks, or never bother to investigate them? What damage could be done then to shallow aquifers?

10. p. 1-9, line 25:

NRDC Comment:
Please provide in these SEIS the USFWS recommendations "for protective measures for threatened and endangered species" and "recommendations concerning migratory birds." Which of these measures and recommendations will be incorporated as binding conditions of the proposed license?

11. p. 1-9, line 35: "Impact mitigation measures were discussed" [with Wyoming Game and Fish Department (WGFD)] regarding "invasive species and impacts to wildlife due to power lines, evaporation ponds, and increased traffic."

NRDC Comment:
Please provide in the SEIS a discussion of what specific mitigation measures were recommended by WGFD staff to protect big game animals, raptors, migratory birds, and small mammals, and which of these measures have been incorporated as binding conditions of the proposed Ross Project license?

12. p. 2-13, line 50: "[the CPP]…would be designed to process approximately 1.4 million kg/yr. (3 million lb./yr. of yellowcake (Strata, 2011b), which is about four times the capacity necessary to recovery (sic) uranium from the Ross Project. The excess capacity in the yellowcake production circuit would allow processing of loaded IX resins brought to the Ross Project from other ISR or water treatment facilities."

NRDC Comment:
This statement provides incomplete and misleading information. The loaded resins "brought to the Ross Project" would be brought there, in the first instance, by Strata Energy Inc., itself, from its own satellite operations, and not from "other ISR or water treatment facilities." Moreover, the excess capacity is likely to be applied first to additional uranium bearing lixiviant arriving by pipeline at the CPP from contiguous Strata well-field operations. NRC Staff should provide straightforward clarity with respect to Strata's near term expansion plans.

13. p. 2-16, line 9: "The Applicant notes that the final areal extent of the constructed wellfields is expected to be greater as additional ore-zone delineation occurs (Strata, 2011b)."

NRDC Comment:
How much greater? And please provide specifics. This is not a minor matter, as it would increase environmental impacts for almost every project phase and affected resource.

14. p. 2-21, line 33: "In the event that recovery, injection, and/or monitoring wells must be located within a floodplain…."?

NRDC Comment:
How many, and what percentage of the total wells are planned and/or likely to be located "within a floodplain?"

15. p. 2-21, line 45: "The Applicant expects that the water produced during well development would meet Wyoming's temporary Wyoming Pollution Discharge Elimination System (WYPDES) discharge standards, which would allow this water to be discharged directly to the ground surface (WDEQ/WQD, 2007).

NRDC Comment:
(a) Please provide the empirical basis for the Applicant's "expectation," and do the NRC and EPA agree with it? (b) Are WYPDES discharge standards sufficiently protective that the produced water will not cause any harm to wildlife, surface water quality, or shallow aquifers if discharged directly to the ground surface?
(c) What is the NRC's licensing requirement in the event that the water produced during well development does not meet WYPDES discharge standards? (d) Please describe any contingency plans and capabilities required under the proposed license for safely disposing of the produced water from well development if the Applicant's "expectation" proves to be incorrect.

16. p. 2-22, line 8: "After initial testing by the Applicant, the well would be retested at five year intervals."

NRDC Comment:
What reassurance is to be derived from the 5-year retesting interval, given that the operating life of the average ISL injection or recovery well is considerably less than five years? Please provide data on how many wells, as a percentage of the total licensed and operated for ISL injection or recovery in the NSDWUMR region, or in Wyoming, have been retested for well casing integrity prior to well plugging and abandonment.

17. p. 2-23, line 14: "The applicant would test for leaks with fresh water on the pipelines prior to their burials, in order to ensure the pipelines' mechanical integrity."

NRDC Comment:
(a) Please describe the specific standards, approved test protocols, and inspections that the NRC (a) generally requires and (b) specifically intends to apply to the "Ross Project," and to further already planned "Lance District Development" that will be undertaken pursuant to the License for the "Ross Project," to ensure the mechanical integrity of buried ISL pipelines;
(b) What kind of leak detection/warning systems will the NRC require to ensure that the Applicant reacts promptly to any leaks?

(c) How will the NRC Staff verify the licensee's compliance with buried pipeline integrity requirements?

18. p. 2-24, line 14: "Prior to the submittal by an Applicant of its license application to the NRC, an Applicant performs site-characterization environmental monitoring efforts for at least a year…the values measured by Strata prior to its submitting its license application are called 'pre-licensing baseline values' in this SEIS."

NRDC Comment:
(a) Please provide in the SEIS a map showing the name, location and targeted aquifers of all pre-existing wells and purpose-drilled monitoring wells that contributed pre-licensing baseline ground-water-quality data to the Applicant's site characterization of the Ross Project area.
(b) Please describe the specific regulatory function of these "pre-licensing baseline" measurements of water quality in NRC's regulatory scheme to guard against aquifer degradation.
(c) Are they the standard by which lixiviant "excursions" outside the ore zone and/or aquifer restoration to pre-mining conditions are to be judged under the Proposed License? If not, why not?

19. p. 2-24, line 14: "Prior to commencing ISR operations, these [monitoring] wells [around the perimeter of each wellfield] would allow sampling and analysis of ground water and, in this SEIS, this type of monitoring is called 'post-licensing, pre-operational.' The resulting…data would be used to determine concentration-based levels that would permit identification of any excursions from the respective wellfields; these would be called the Ross Project's upper control limits (UCLs). These post-licensing, pre-operational baseline values would be established for each separate wellfield (and they would be codified in the Applicant's license)" [emphasis added].

NRDC Comment:
From the description in the SEIS, it is apparent that monitoring to set these UCLs would be undertaken only when a given wellfield's construction is complete and a perimeter ring of monitoring wells has been established around the wellfield. This methodology raises a number of important issues that are not discussed in the SEIS.
(a) What is the scientific and technical rationale for using "post-licensing, pre-operational," rather than "pre-licensing baseline" measurements, to establish baseline water quality data to detect excursions?
(b) Since the construction of multiple individual wellfields is a sequential operation taking place over several years, how will NRC and the applicant avoid the obvious potential problem of each operational wellfield degrading the "post-licensing, pre-operational" baseline water quality of subsequent down gradient monitoring wells targeting the same aquifers, creating a potentially cascading deterioration of baseline water quality standards from wellfield to wellfield in the course of building-out the "Ross Project" and already scheduled "Lance District Development?

(c) For any given wellfield, how will NRC/Applicant prevent the "post-licensing, pre-operational baseline" water quality measurements from being contaminated by the effects of drilling, casing and testing the injection and recovery wells, and from the effects of previous and ongoing exploratory drilling?

20. p. 2-24, line 41: "Later, prior to actual uranium-recovery wellfield operation, but after the initial NRC license is issued for wellfield construction, the ground water in each wellfield would be analyzed for the post-licensing, pre-operational baseline concentrations of constituents specified by the NRC (NRC, 2003a)."

NRDC Comment:
Comment 20 and its many parts, directed at the above sentence in particular, focuses on establishing baseline water quality prior to licensing and as an important component of NEPA review.
(a) Are the "post-licensing, pre-operational baseline concentrations of constituents" referenced in the above excerpt from the SEIS the same as the "Ross Project's upper control limits (UCLs)" described in the preceding paragraph? If not, why and how would they differ?
(b) When and how would the NRC employ these "post-licensing pre-operational baseline concentrations" to measure and mitigate adverse impacts on groundwater from (1) "the Ross Project;" (b) the "Lance District Development" shown in Figure 2.6.
(c) Please provide a map showing the sequence, timing and locations of the "pre-operational baseline" measurements for each well field proposed or planned for development under (1) the Ross Project; (2) the "Lance District Development" shown in Figure 2.6
(d) The baseline concentration of monitored constituents in Ross Project aquifers of interest as given in Table 3.7 on page 3-41 is frequently given as a range, rather than a single value:

(1) Please describe in detail the scientifically valid techniques the NRC will employ to translate such range bound data into a single value for the purpose of establishing UCL's and "pre-operational baseline concentrations of constituents " in the Proposed License for groundwater monitoring purposes.
(2) When and how will the NRC select the constituents to monitor for (i) "the Ross Project, and (ii) "Lance District Development."
(3) When in the ISL uranium recovery licensing process, and how will NRC employ the values that are established for each constituent, to control excursions and establish target restoration values for aquifer restoration?
(4) For the purpose of ensuring that this SEIS complies with NEPA, how does the NRC evaluate and compare the environmentally protective efficacy of prospective UCLs and "post-licensing pre-operational baseline concentrations" that it has not yet established?

(i) If these UCLs and post-licensing baseline concentrations are to be established "prior to commencing ISR operations….for each separate wellfield" as described on page 2-24, and there are "15-25 wellfield areas" in the "Ross Project" alone, as described on page xix, how can all these

multiple well-field limits simultaneously be "codified in the *Applicant's* NRC license," when the "Applicant" must logically become the "Licensee" upon commencing operation of the first well-field?
(ii) Legally speaking, is a "Licensee" at one and the same time also a perpetual "Applicant" when it comes to the licensing of subsequent well-fields? If so, please cite one or more specific instances in which the NRC has revoked or suspended an initial ISR materials license for a Licensee's failure to agree to environmentally protective UCLs and TRVs for subsequent wellfields developed under the license that was granted for operation of the first well-field?

(e) Please state the case why the public should repose any confidence whatsoever in the environmental protection afforded by this "bass-ackwards" regulatory scheme?

(f) The ER (p. 6-11) contains a reference to "Target Restoration Values (TRVs)," a term that does not appear to be used in the SEIS. The Draft SEIS does not include this acronym in its "List of Abbreviations" on p. xxxix. Please provide an adequate response in the Final SEIS to the following requests for relevant environmental information:

(1) What is the definition of a "TRV," exactly how does it relate to the term "post-licensing pre-operational baseline concentration" used in the Draft SEIS, and why was use of the term "TRV" not employed in the draft SEIS?;
(2) Who within NRC establishes a TRV?
(3) What, if any, peer-reviewed and widely accepted scientific and technical methodologies are used to establish it?
(4) Can TRV's for different constituents be established at different times, or are they all determined at the same time?
(5) Please describe in detail the process that ensues when Licensee does not achieve the "Target Restoration Values" specified for each wellfield in its license.
(6) Please provide a schedule showing when during the licensing process for the "Ross Project" and subsequent planned "Lance District Development" TRVs were/will be established, and how does the timing and technical methods of this procedure compare to those used in previously -licensed ISL operations;
(7) Was a comparative analysis of the technical feasibility and environmental benefits and costs of setting and achieving various alternative TRVs for the "Ross Project" performed in connection with this Draft SEIS?
(8) Is an analysis like the one described in (vii) above germane to NRC's NEPA evaluation of the comparative environmental impacts involved in granting, denying, or modifying the terms of the proposed license for the "Ross Project?" If not, why not? Please provide detailed information in the Final SEIS documenting any methodologies used and results obtained in such an analysis.
(9) Please explain how the "post-licensing" determination of "upper control limits"(UCL's) and Target Restoration Vales (TRVs) for the "Ross Project" and "Lance District Development" would inform the NRC's required pre-licensing NEPA analysis of reasonable alternatives, including mitigation alternatives for limiting unavoidable adverse impacts, that by law must precede and inform an NRC materials licensing decision?

(10) (i) Is a "wellfield" the same as a "wellfield area"? If not, what is the distinction? How does the term "wellfield module" relate to the aforementioned terms?

(ii) How many distinct "well-field modules," "well-fields," and "wellfield areas" are contained in Figure 2.4 ("Proposed Ross Project Facility and Wellfields") on page 2-6 of the SEIS?

(iii) Are the shaded areas marked "Wellfield Perimeter Accounting for Future Drilling" in Figure 2.4 included in the SEIS detailed analysis of environmental impacts from the proposed "Ross Project"? If not, why not?

(iv) Are the shaded areas described in the preceding paragraph included in the analysis of "cumulative impacts" from reasonably foreseeable drilling activity ostensibly contained in Section 5 of the Draft SEIS? If so, please provide the page and line number reference.

(g) Please explain why it is (1) scientifically indicated for "baseline" pre-mining water-quality monitoring purposes , and (2) advantageous for a NEPA-informed licensing decision, for the NRC to establish UCL's after well-field licensing and construction, rather than before, given the availability of both existing "pre-licensing baseline" measurements, and the obvious ability to establish additional environmental sampling wells over relevant portions of the site prior to the construction of the first complete well field.

21. p. 2-25, line 31:

NRDC Comment:

Figure 2.4 on page 2-6 of the SEIS shows the location of 5 "proposed deep disposal wells" within the "Ross Project Area" alone.

(a) Please provide a map(s) showing the number, locations and required capacities of all Class 1 deep disposal wells and target aquifer(s) associated with disposal of wastes from the scheduled "Lance District Development" shown in Figure 2.6, including any currently planned and reasonably foreseeable ISR operations in the Lance District that are not reflected in Figure 2.6. (Please consult the attached "Declaration of Christopher E. Paine" for the names and approximate locations of future Lance District ISL projects planned by the Applicant, according to its Australian parent company, Peninsula Energy, Ltd.)

(b) Please provide a map(s) showing the number, proposed locations and required capacities of all Class 1 deep disposal wells and target aquifers that would dispose of wastes from full utilization of the currently proposed CPP capacity (4x greater than required by the "Ross Project" alone) over its "reasonably foreseeable" full operating lifetime.

(c) Please provide a scientifically and technically adequate discussion of the cumulative environmental impacts of such a vastly increased volume of uranium mining waste disposed via deep well injection, including a cumulative impact assessment that includes the adverse impacts of other deep well injection activities in the same NEPA region of interest.

(d) Please provide all the information related to Applicant's UIC Permit No. 10-263, dated April 4, 2011, that was requested in the EPA's Region 8 Scoping Comments letter to the Commission of 12/29/2011, including:

(i) Discharge zones, well locations, groundwater classifications;
(ii) Monitoring requirements, plugging and abandonment procedures;
(iii) The permitted injection formation, and descriptions of any underground sources of drinking water (USDWs) that may occur above or below the permitted injections zones;
(iv) Relevant information on existing aquifer exemptions in the vicinity that have been approved by the permitting agency;

(e) A full and adequate discussion of the process by which UIC permits are issued and the environmental and safety factors are considered in their approval;
(f) A full and adequate discussion of design features and/or mitigation measures required under the permit to prevent potential adverse impacts to groundwater resources from deep disposal well operations.

22. p. 2-25, line 31:

NRDC Comment:
Figure 2.4 on page 2-6 of the SEIS shows the location of a large number of overlapping "wellfield perimeters" representing potentially thousands of UIC Class 3 Mining Wells within the "Ross Project Area" alone.
(a) Please provide tables and map(s) showing the number and locations of all prospective UIC Class 3 mining wells (or "wellfield modules' and/or "well-fields" if specific well locations are not yet known) and the targeted aquifer(s) that would be part of the impending "Lance District Development" shown in Figure 2.6, and classify them as one of the following:

(1) Part of the Applicant's current schedule and business plan for near-term development (defined as initiation of well-field construction within 10 years of "Ross Project" licensing) of proven and/or indicated uranium resource areas within the Lance District utilizing the processing capacity of the "Ross Project" CPP;
(2) Targeted for future development based on the Applicant's currently inferred uranium resource estimates in the Lance District and utilization/expansion of the planned processing capacity of the Ross Project CPP;
(3) Any other reasonably foreseeable ISR projects in the Lance District.

(b) Please provide a map(s) showing the additional number and proposed locations of all UIC Class 1 Mining Wells (or "wellfield modules" and/or "wellfields") and target aquifers that could potentially be drilled premised on the availability of the proposed Ross project CPP capacity (4 x greater than required by the "Ross Project" alone) over its "reasonably foreseeable" full operating lifetime.
(c) Please provide a scientifically and technically adequate discussion of the cumulative full life cycle environmental impacts that this number of UIC Mining Wells for uranium extraction could have on the NEPA-defined region of interest surrounding the Ross Project, including the adverse impacts of all other reasonably foreseeable UIC Class III

Mining Wells and UIC Class I Disposal Well activities in the same NEPA region of interest.

23. Page 2-26, line 14: "The Applicant proposes that each [disposal well] location would consist of a 76 m x 76 m [250 ft. x 250 ft.] pad [asphalt or gravel] with a storage tank (Strata 2011b; Strata 2012b). Surface equipment for the deep-disposal wells would include storage tanks, pumps, filtration systems, instrumentation and control systems, and equipment for injection of process chemicals (Strata, 2011b).

NRDC Comment:
A gravel or asphalt pad measuring 250 ft. x 250 ft. is equivalent to an area of 1.43 acres, and the UIC permit for the Ross Project reportedly allows for five such deep-well waste injection sites. So, more than 7 acres (not including associated service roads and pipelines) of the Ross Project area could be industrialized via the construction and operation of such deep disposal sites.
(a) Are the land use-impacts of these, and any planned and reasonably foreseeable disposal wells required for the "Ross Project" and "Lance District Development," included in the SEIS estimate of land area disturbed by ISR mining? Please provide the page and line numbers where these impacts are included.
(b) How and when will the concrete or gravel pads surrounding the deep disposal wells be reclaimed?
(c) What is the licensed disposal capacity of liquid wastes for each UIC-permitted well, and what is the total licensed disposal capacity of the five permitted wells mentioned in the SEIS for the "Ross Project?"
(d) If five such deep-disposal sites have been permitted for waste disposal from operation of the CPP in connection with the Ross Project, how many additional deep disposal wells, with what disposal capacities, targeting which formations, are required in connection with processing of pregnant lixiviant and/or loaded resins from the following planned "satellite projects" that would utilize the CPP: Ross "Amendment Area 1;" Kendrick Satellite Area; Richards Satellite Area; Barber Satellite Area.
(e) Please provide a table showing the above information, and when construction, operation, and abandonment of each disposal well is planned, or could reasonably be expected to occur.
(f) Please provide a map showing the planned or reasonably foreseeable locations of the disposal wells described in (d) and (e) above.
(g) How many additional deep-disposal wells, targeting which formations, at which locations, would be required to dispose of the wastes from processing loaded resins from the following potential ISR facilities within 50 miles of the Ross Project's CPP: Aladdin ISR Project, 41 miles from the CPP, under consideration by Powertech; Elkhorn ISR Project, 16 miles from the CPP, under evaluation by NCA Nuclear, a wholly owned subsidiary of Bayswater Uranium Corp; Hauber ISR Project, 14 miles from the Ross project, also owned by NCA Nuclear, in a joint venture with Ur-Energy Inc; Alzada Project, 39 miles from the Ross Project, also owned and operated by NCA Nuclear?

24. Page 2-26, line 39: "As shown by the proposed schedule in Figure 2.6, uranium recovery during the proposed Ross Project would follow a 'phased,' where one group of well modules could be in operation, while preceding well modules are being engaged in aquifer restoration (Strata, 2011b). During the operation phase, three major phases would occur involving the wellfields: an operation-only phase, a concurrent operation- and aquifer-restoration phase, and an aquifer-restoration-only phase."

NRDC Comment:

(a) The referenced Figure 2.6 contains no reference to a proposed "Ross Project," but rather its title states that it describes a "Schedule for Potential Lance District Development."

(1) Please explain this discrepancy.

(2) Is the current title for Figure 2.6 in error, or is it the figure itself that is erroneous?

(b) Figure 2.6 shows an "aquifer-restoration only phase" being attained about 11.75 years after regulatory approval.

(1) If the figure actually refers to the "Ross Project," as mistakenly claimed above, is this a correct estimate for the "Ross Project?"

(2) If the figure refers to "Lance District Development," as currently stated, is 11.75 years a correct estimate for the currently planned and reasonably foreseeable "Lance District Development"?

(3) (i) What fraction of the Applicant's "reasonably foreseeable" mining activities in Wyoming involve development of the "Lance District," and

(ii) What fraction of these Lance District activities are already planned and included in the business plan of the Applicant for this area?

(4) Would construction of the CPP be economically viable if its feedstock were limited to the "Ross Project" as currently defined in the SEIS? If not, why is the scope of the "Proposed Action" in this SEIS limited to the "Ross Project"?

(5) What fraction of the potential production areas that the Licensee has identified in the "Lance District" must be developed to ensure economic viability of the Licensee's investment in the CPP, and hence a financial capacity to comply with all environmental mitigation, monitoring, and restoration undertakings undertaken in connection with the "Ross Project" license?

(c) Why did the NRC limit the scope of its detailed environmental analysis in the SEIS to the "Ross Project," when the proposed licensed capacity for the CPP is clearly designed to process uranium recovered from a much wider area than the Ross Project?

(1) Please provide the most recently updated schedule(s) for "Lance District Development" planned by this or any other Applicant for an NRC license.

(2) Please provide a detailed map showing the cumulative extent of the planned and contemplated "well-field areas" to be mined and enclosed by fences in the course of "Lance District Development" that would utilize the proposed CPP to be licensed pursuant to the "Ross Project."

(3) Which specific geographic areas will be mined when, and to what extent does this schedule overlap that of the "Ross Project"?

25. Page 2-27, line 22: "…Table 2.4.1 of the GEIS shows consistency between the Ross project and the GEIS, except for higher concentrations of uranium and vanadium that could be present in the pregnant lixiviant at the Ross Project (Strata 2011b); NRC, 2009)."

NRDC Comment:
(a) What accounts for these "higher concentrations of uranium and vanadium" (than were analyzed in the GEIS), and what are they?
(b) Are they a function of the particular ISR process to be employed, or are they also present in the ore body to be mined pursuant to (1) the "Ross Project;" (2) "Lance District Development"?
(c) Please provide an adequate NEPA discussion of the adverse environmental impact these "higher concentrations" could have on (1) post-mining concentrations of key constituents of groundwater quality in the mined aquifer? (2) Radiation exposure to site workers; (3) waste disposal.

26. Page 2-27, line 30: "The excess water, referred to as 'production bleed,' is a radioactive byproduct material that must be properly managed and disposed (NRC 2009). For the Ross Project, the Applicant proposes production-bleed range from 0.5 percent to 2 percent, and averaging 1.25 percent of the injection volume (Strata, 2011b).

NRDC Comment:
Please provide a NEPA-compliant quantification and sensitivity analysis of environmental consequences in the event that:
(a) The required bleed range to prevent excursions exceeds that "proposed" by the Applicant by technically plausible margins; and/or
(b) The average bleed rate exceeds 1.25 percent of the injection volume;
(c) What is the maximum observed peak bleed rate and maximum bleed volume for an ISR well-field to date in the Nebraska-South Dakota-Wyoming Uranium Milling Region?
(d) What is the maximum observed average bleed rate and total bleed volume for an ISR wellfield in this region?
(e) Please provide the proposed and/or estimated total "injection volume" for the Ross Project, and the technically supported range of uncertainty that surrounds this number?
(f) What is the proposed or estimated total "injection volume" for the full "Lance District Development "referenced in Figure 2.6, and a technically-supported range of uncertainty that surrounds this number?
(g) What is the relationship between, on the one hand, expected versus actual well-field bleed rates, and:
(1) The maximum safe capacity of the RO circuit in the CPP;
(2) Higher than expected excess permeate and the capacity of planned surface impoundments;
(3) Higher than expected brine production and the capacity of planned storage impoundments prior to deep well injection;
(4) The licensed capacities of deep injection wells.

(h) (1) At what bleed rates and injection volumes would the inbound capacity of the CPP-RO circuit be exceeded, and where would this excess bleed be stored until it could be processed in the CPP?

(2) What types of temporary waste storage capacity, if any, are contemplated to deal with higher-than-expected "bleed" production?

27. Page 2-27, line 43: (a) "The Applicant proposes a maximum injection pressure … less than the pressure rating for operation of the pipes and other equipment (Strata, 2011b).''

NRDC Comment:
(a)What is the pressure rating for operations of the pipes and other equipment to be used in the injection and recovery circuits of the "Ross Project" and the scheduled "Lance District Development" described in Figure 2.6.
(b) "…pressure requirements within a specific wellfield generally tend to increase with time." Please provide a discussion of wellfield injection pressure requirements over time, including the range of expected and maximum plausible values for minimum, maximum, and average wellfield injection pressure over the life of the wellfield.
(c) What is the relationship, if any, between injection pressure, wellfield pressure, wellfield balance, and the likelihood of excursions?
(d) Does the likelihood of excursions increase with increasing with increasing injection pressure?
(e) Does the available regulatory record of ISR excursions show any correlation between injection pressure and the likelihood of excursions?

28. Page 2-27, line 48. "The Applicant suggests that, in order to maintain flow rates and wellfield balance, some wellfields would require flexibility in their allowable injection pressure."

NRDC Comment:
(a) What does the phrase "flexibility in their allowable injection pressure" mean in practice?
(b) How would this "flexibility" be administered?
(c) Would this flexibility encompass exceeding the Applicant's proposed "maximum injection pressure" of 140 pounds-per-sq.-in.?
(d) If so, by how much, and for how long?
(e) What specific purpose is served by allowing this "flexibility" under the License?
(f) Does operating at such elevated injection pressures increase the likelihood and/or potential severity of leaks?

29. Page 2-28, line 1: "To specifically avoid the injection restriction problems that plagued the Nubeth operation, the Applicant has proposed several improvements to well-design, well development, and filtration (Strata 2011a; Strata, 2011b)."

NRDC Comment:
(a) Please describe the "injection restriction" problems that plagued the Nubeth operation.

(b) Please describe the specific primary purpose and function of each improvement to well-design, well-development, and filtration proposed by the Applicant.
(c) Which improvements are directed primarily or exclusively at increasing production efficiency, and which are directed primarily or exclusively to improving safety and reducing the risk of environmental contamination?
(d) For the purposes of preparing this SEIS, which improvements, if any, did NRC assume as being accepted and incorporated in the license?
(e) How do these "improvements," taken individually and together, affect the risk of environmental contamination from the "Ross Project" and scheduled "Lance District Development?"

30. Page 2-28, line 40: "The monitoring of water levels that would be performed would serve to avert a potential excursion."

NRDC Comment:
Please explain further:
(a) Which specific "water levels" would be monitored, how would they be monitored, where would they be monitored, in order to "avert" a "potential" excursion?
(b) How does NRC infer scientifically from "water levels" alone than an excursion is about to occur, as opposed to detecting one already in progress?
(c) What has been the record in ISR operations of using such water level measurements to "avert" (i.e. prevent) excursions from occurring.
(d) How many of the excursions that were later confirmed to have occurred via exceeding UCLs, were correctly forecast by such water level measurements, and why did such water level measurements fail to avert them?

31. Page 2-28, line 41: "Water quality indictors in the ground water from monitoring wells that would be established after wellfield installation (i.e. post-licensing, pre-operational baseline concentrations defined as excursion indicators) would also be used to detect whether an excursion has occurred."

NRDC Comment:
Please clarify the meaning of this inherently ambiguous sentence.
(a) Is it the "water quality indicators," or the "monitoring wells," or both that would be "established after wellfield installation?" Are not "monitoring wells" an inherent part of "wellfield installation? Why would they be established "after wellfield installation?"
(b) If the water quality indicators are in fact established after wellfield installation but prior to "operation," what prevents the prior drilling, construction, and pressure testing of hundreds or potentially thousands of previously constructed injection and recovery wells from polluting the baseline measurement of the "water-quality indicators" to be used as "excursion indicators?"
(c) If these "water-quality indicators" are "also used to detect" whether an excursion has occurred, what is the other method implied by the use of the word "also" in this context, given that "water level measurements" have been previously described as "averting a potential excursion," as opposed to "detecting" one that has already occurred?

32. Page 2-30, line 10: "If a vertical excursion occurs, then the Applicant's injection of lixiviant would cease, and for any excursion, corrective action would be initiated."

NRDC Comment:
Why would NRC Ross Project license conditions require cessation of lixiviant injection only in the case of a "vertical excursion," rather than all excursions?

33. Page 2-30, line 20: "If an excursion cannot be recovered within 60 days of confirmation (measured by a concentration of more than 20 percent of any excursion indicator)…."

NRDC Comment:
(a) Is "confirmation" of an excursion the same as initially "detecting" it?
(b) What constitutes "confirmation" of an excursion for the purpose of triggering the Licensee's 24 hour notice requirement to the NRC?
(c) How soon after "confirmation" of a vertical excursion would lixiviant injection be required to cease?
(d) How soon following the 60 day period for "retrieving" horizontal excursions does the Licensee have to decide whether to "terminate lixiviant injection within the wellfield" or "increase the surety for the ISR project by an amount sufficient to cover the full-third party cost of correcting and remediating the excursion?"

NRDC Comment 33a:
Figure 2.4 shows many contiguous and overlapping "Ross Project" wellfields that appear to share common boundaries at the ground surface.
(a) If a horizontal "excursion" occurs into a neighboring well-field that is under construction or into an area designated for future uranium well-field development, does this count as an "excursion"?
(b) Can a hydrologic "cone of depression" to prevent excursions encompass multiple contiguous wellfields, so that horizontal excursions are deemed to occur only along a more restricted azimuth along the conjoined external boundaries of the contiguous well-fields, as shown in Figure 2-6?

34. Page 2-31, line 26: "The off gases generated during the drying cycle would be filtered and scrubbed to remove entrained particulates."

NRDC Comment:
Are these off-gases then released to the open air through a stack? What are the radioactive and/or other potentially hazardous constituents of these off –gases, if any, and would prolonged exposure to them over the lifetime of the CPP pose an incremental health risk to plant workers or nearby residents?

35. Page 2-32, line 5: "The Applicant estimates that 0.1 – 2 kg of V_20_5 would be produced for every 1 kg. of U_3O_8.

NRDC Comment:
What accounts for the extreme variability in the estimated yield of co-produced vanadium?

36. Page 2-32, line 18: "The purpose of aquifer restoration is to restore the respective aquifer to its baseline conditions, as defined by post-licensing, pre-operational constituent concentrations…so as to ensure public health and safety."

NRDC Comment:
Please point to the specific pages and lines of the Draft SEIS – because we have been unable to locate them – wherein it is demonstrated (or in the alternative provide in the FSEIS an adequate NEPA-complaint analysis showing) that—
(a) Yet-to-be-defined "post-licensing, pre-operational constituent concentrations" in groundwater will fairly represent the baseline water quality of the target aquifer before wellfield development activities commence under the "Ross Project" and scheduled "Lance District Development;"
(b) Irrespective of any avowed "purpose" of "aquifer restoration," it would actually restore the small segment of the mined aquifer within each wellfield to the NRC's *ex-post facto* determination of "baseline conditions," much less any scientifically credible representation of pre-ISR water quality;
(c) The integrated summation of all these hundreds of individually variable wellfield target restoration values, even if achieved in practice, would actually restore the overall pre-mining water quality over the entire extent of the aquifer that has been mined and adversely affected by mining;
(d) There is reason to conclude from the record of previous NRC-regulated mining operations that the Target Restoration Values (TGVs), established *seriatim* in a private post-licensing consultative process between the NRC and the Licensee as wellfield expansion proceeds, will be achieved in practice prior to wellfield abandonment, and will ensure that the License by its terms protects "public health and safety," as the NRC is mandated to do by the Atomic Energy Act.
(e) That any fallback standards (e.g., "Maximum Concentration Limits," "Alternative Concentration Limits") subsequently employed in an amended License to terminate aquifer restoration efforts short of achieving TGVs will nonetheless ensure adequate

protection of the "public health and safety," as the NRC is mandated to do under the Atomic Energy Act, and avoid, minimize, or mitigate other adverse environmental impacts, as required under NEPA

37. Page 2-33, line 11: "The Applicant proposes that concurrent ISR operations and aquifer restoration would occur when several of the first well modules have been depleted and are ready for restoration activities (Strata, 2011b). As aquifer restoration occurs in depleted well modules, ISR operations would be ongoing in subsequent well modules."

NRDC Comment:

(a) (1) Please clarify the difference between a "well module" and a "well-field" for the purposes of establishing accountable units for implementing and assessing aquifer restoration.

(2) How many lixiviant injection and uranium recovery wells will comprise a typical Ross Project "well module," and how many such "well modules" will comprise a "wellfield," and how many wellfields will ultimately be deployed pursuant to the granting of a license to the "Ross Project?"

(b) Will the "post-licensing, [i.e. post-drilling, post-construction, post-testing] pre-operational constituent concentrations" found in perimeter groundwater monitoring wells and so-called "baseline recovery wells" [ER, p. 6-11] be applied—for the purpose of determining the Target Restoration Values (TRVs) obliquely referenced on page 6-11 of the Applicant's ER—to individual "well modules," or to a group of "several well modules," or to a "well-field?" Please be specific in your answer.

(c) What has been the NRC's established practice to date in regard to the question posed in (b) above, prior to the proposed licensing of the "Ross Project?"

(d) How many discrete environmental accountancy areas – i.e. groups of location-specific UCLs and TRVs—will be established within (1) the Ross Project, and (2) within the scheduled "Lance District Development" that is directly tied to the use of the Ross Project CPP—to detect and control excursions and set standards for aquifer restoration?

(e) Who is responsible for establishing and maintaining this large and complex data set of water quality measurements, and where will it be maintained?

(f) Who initially formulates and proposes module -specific UCLs and TRVs based on these measurements—the Licensee or NRC?

(g) How will the relevant UCLs and TRVs applicable to each specific module be communicated to the field personnel responsible for detecting and preventing excursions and assessing aquifer restoration at particular sites.

(h) With a small workforce covering so many individual environmental compliance units that must monitored and assessed, how will the Applicant and NRC avoid the confusion or misapplication of standards between units?

(i) Please provide a full and NEPA compliant description of the NRC's process for reviewing and validating the environmentally protective character of UCLs and TRVs proposed for inclusion in the Ross project license over time;

(j) If there are differences in view between NRC and the Applicant on the establishment or revision of UCLs and TRVs, how will these differences be adjudicated and resolved? Who within NRC holds the final decision authority on such matters?

(k) How will NRC verify the authenticity of the large number of site-specific data sets required under the module-by-module standard-setting approach?

(l) Please identify prior NRC-licensed uranium ISR operations that

(1) Have conducted "aquifer restoration" activities in the manner described in the Draft SEIS: i.e. "as…restoration occurs in depleted well modules, ISR operations would be ongoing in subsequent well modules." (SEIS, 2-33, line 13).

(2) Please provide a detailed discussion of historical evidence, if any, showing that such parallel production and aquifer restoration efforts pursued at the "well module" level, with TRVs tailored to each well module or "wellfield," have been successful at restoring groundwater to pre-mining baseline values over the full extent of the mined aquifer.

(m) Please provide a map showing the location and planned restoration sequence of the Ross Project "well modules" that would undergo restoration, relative to those modules in which "ISR operations would be ongoing" at the same time.

(n) Please provide detailed topographic and stratigraphic maps showing the location, relative to the "Ross Project," of all "subsequent well modules" in contiguous areas currently scheduled for "Lance District Development" in which "ISR operations would be ongoing" while "Ross Project" well modules are undergoing "aquifer restoration."

(o) Which subsequent ongoing ISR operations, if any, would be hydrologically up-gradient of well modules undergoing simultaneous "aquifer restoration?"

(p) Would all "well modules" undergoing restoration be hydrologically up-gradient of well modules in which ISR operations would be ongoing?

(q) (1) Please define and describe a "baseline recovery well," as the term is used in the Applicant's ER.

(2) Is the use of "baseline recovery wells" included in the "post-licensing, pre-operational" scheme (for characterizing baseline water quality and establishing UCLs and TGVs for each "well module" or "wellfield") that is partially and inadequately described in the SEIS?

(r) If so, please provide a detailed description of how and when data from these "baseline recovery wells" will be acquired and used in concert with other data sources to establish TRVs for each "Ross Project" well module or wellfield, provide the number of such recovery wells that will be used for baseline sampling in each discrete baseline monitoring and excursion control area, and where these wells would be located in an actual Ross project well module or wellfield design, relative to the perimeter monitoring wells.

38. Page 2-33, line 31: "The pumping rates used would depend on the hydrologic conditions at the Ross Project, and the duration of the aquifer sweep and the volume of water removed would depend on the volume of the aquifer affected by the ISR process."

NRDC Comment:
(a) Please provide an explanation of the specific existing, planned or expected "hydrologic conditions" at the Ross Project that will affect the pumping rates, duration, and volume of water removed during "aquifer sweep."
(b) Please explain why these particular hydrologic conditions have not already been ascertained or modeled based on the results of pre-licensing site investigations;
(c) How do these hydrologic uncertainties affect the forecast efficacy of the NRC's efforts to ensure environmentally protective "aquifer restoration;"
(d) Please provide a detailed and adequate NEPA discussion that relates the prevailing uncertainties in hydrologic knowledge of the "Ross Project" and "Lance District Development" areas to the Licensee's ability to achieve, and the NRC's ability to enforce, Target Restoration Values (TRVs) that will be sequentially established "post-licensing" and added incrementally to the terms of Applicant's NRC License.
(e) What is the range of potential environmental outcomes, in terms of the restoration of the relevant baseline water quality concentrations, arising from uncertainties in "hydrologic knowledge" of (1) the "Ross Project" area and (2) the wider area encompassed by scheduled "Lance District Development" (see Figure 2.6)?
(f) Based on the record of previous and ongoing uranium ISR operations in (1) this GEIS "Milling Region," and (2) within the state of Wyoming, please compare and weight the likelihood of achieving representative alternative sets of post-mining water quality concentrations for the relevant constituents that must be monitored and controlled to ensure public health and safety and minimize harmful environmental impacts and the irretrievable commitment of natural resources.

39. Page 2-33, line 36: "The Applicant's aquifer restoration plan calls for removing up to 0.5 pore volumes of water during ground-water sweep (Strata, 2011b). Additional pumping would occur in select areas that would be identified during facility operation. The pumping rate is estimated at 284 L/min [75 gal/min] from well modules in the ground-water sweep stage."

NRDC Comment:
This paragraph discloses almost nothing about the likely range of environmental impacts from aquifer restoration activities.
(a) If an Applicant's aquifer restoration plan "calls for" the removal of "up to" 0.5 pore volumes during ground-water sweep, does this mean that this number represents a hard and fast regulatory limit on the amount of water that will actually be removed during ground-water sweep?
(b) Please provide a table showing the actual pore volumes removed from prior and still ongoing ISR operations in:
(1) This GEIS Milling region; and
(2) Within the State of Wyoming; that have undergone "aquifer restoration."

(c) Please provide a table showing "expected" and "maximum allowable" pore volumes per "well module" (or other applicable unit for aquifer restoration) that would be removed in the course of aquifer restoration activities for the "Ross Project," translate these values into total gallons of water removed per well-module, per well-field, and for the "Ross Project" as a whole, and estimate the time required for the full extent of the Ross Project's mined aquifer to recover to its natural background or pre-mining pore volume, based on this range of requirements for "groundwater sweep."

(d) Please provide a discussion --

(1) Comparing the environmental risks and benefits from high levels of pore volume removal from the mined aquifer with the environmental risks and benefits of failing to attain License-specified TRVs (or lesser fallback standards) for aquifer restoration.

(2) Please describe the methodology the NRC and/or the Applicant will employ to evaluate environmental restoration decisions regarding this tradeoff, and the point at which concerns regarding the consumptive use of groundwater may trump the achievement of particular Target Restoration Values.

(e) To enable an adequate NEPA assessment of water quantity impacts, please provide the same pore volume and gallons withdrawn estimates as in (b) above for the projected numbers of "restored" well-field modules falling into the following two categories,

(1) included in the contiguous (to the Ross Project) and already scheduled "Lance District Development;" (see Figure 2.6)

(2) Other "reasonably foreseeable" "Lance District Development" that would likewise utilize the "Ross Project" CPP; and provide an explanation of the methodology used in producing these estimates.

40. Page 2-33, line 40: "The Applicant proposes to use ground-water sweep selectively (for example, around the perimeter of the wellfield) rather than throughout the entire well module to minimize the consumptive use of groundwater."

NRDC Comment:
This statement again gives rise to ambiguity regarding what the environmental baseline accounting unit for aquifer restoration will be: a "wellfield," an "entire well module," as stated above, or a group of several "well-modules" as suggested in lines 11-14. Please clarify the ambiguity.

41. Page 2-34, line 41: "The need for aquifer stabilization would be determined on a case-by-case basis and would depend upon how effectively the sweep and recirculation processes restore the affected aquifer to the license required standards."

NRDC Comment:
What are the NRC's "license required standards" for the "Ross Project," and for the scheduled "Lance District Development" shown in Figure 2.6 on page 2-8 of the Draft SEIS? I cannot find these "standards" listed anywhere in the SEIS.

42. Page 2-34, line 43: "Following aquifer restoration, the Applicant would monitor the ground water by quarterly sampling to demonstrate that the approved standard for each constituent has been met, and that any adjacent nonexempt aquifers are unaffected."

NRDC Comment:
(a) What is the "approved standard for each constituent" that will be subjected to monitoring "to demonstrate that the approved standard…has been met" for aquifer restoration?"
(b) Please provide the specific water quality standards that will be used "to demonstrate…that any adjacent nonexempt aquifers are unaffected?"
(c) What happens if "quarterly sampling" demonstrates that one or more "adjacent nonexempted aquifers" are affected?
(d) Who would conduct this quarterly sampling, and if it is the Licensee, how would the NRC obtain independent verification of the results?
(e) What do the mutually agreed terms of the proposed NRC license for the "Ross Project," issued to the Applicant in late 2012, require the Licensee to do in the event "adjacent non-exempted aquifers" are adversely affected by ISL mining or aquifer restoration efforts?

43. Page 34, line 32: "If the oxidized (i.e. the more soluble) state is allowed to persist after uranium recovery is complete, metals and other constituents such as arsenic, selenium, molybdenum, uranium and vanadium could continue to leach and remain at elevated levels. To stabilize these constituent concentrations, the pre-operational oxidation state in the ore zone must be reestablished as much as is possible."

NRDC Comment:
(a) For the purposes of this SEIS analysis, what has the NRC deemed to be "elevated levels" for the above-named constituents?
(b) Please provide the range of historically- and geotechnically-indicated minimum, maximum, and most-likely (expected) "elevated levels" for each of the above named constituents that could result from the NRC's decision to grant the "Ross Project" license, and discuss the scientific and technical basis for the information provided?
(c) What is the "pre-operational oxidation state" in the proposed ore zones of the "Ross Project" and scheduled "Lance District Development" shown in SEIS Figure 2.6?
(d) Would the "pre-operational oxidation state" of these ore zones differ from their baseline "pre-licensing state?"
(e) If so, please identify the known and likely factors contributing to this difference? If not, why does the NRC not employ the measured "prelicensing" baseline oxidation state of the ore zone as the value to be "reestablished as much as possible?"
(f) How much is "as much as possible?" What are metrics that the Applicant will employ, and/or the NRC will enforce, to establish that "the pre-operational oxidation state in the ore zone" has been "reestablished as much as is possible?"
(g) Would "as much as possible" be less that the TRVs specified in the Applicant's NRC license? If so, what elevated concentrations of the "dissolved metals" enumerated on page 2-34, line 33-34 of the SEIS would be deemed acceptable for terminating the

"aquifer stabilization" phase of aquifer restoration under the proposed Ross Project license?

44. Page 2-34, line 45: "The Applicant would reinitiate the entire aquifer restoration phase if stabilization monitoring determines it is necessary. Both WDEQ and the NRC must review and approve all monitoring results before aquifer restoration would be considered to be complete."

NRDC Comment:
This vague statement leaves many obvious and important environmental questions unaddressed—
(a) What are the specific environmental monitoring benchmarks that will determine whether it is "necessary" to "reinitiate the entire aquifer restoration phase" for the "Ross Project" and scheduled follow-on "Lance District Development" efforts;
(b) Please provide a list or table showing any and all historical instances in which the NRC has directed the recipient of an ISL license to "reinitiate the entire aquifer restoration phase" following a failure of the first aquifer restoration phase to achieve the TRVs specified in the license, and the resulting improvements in measured environmental benchmarks obtained thereby.
(c) The SEIS states that the NRC "must review and approve all monitoring results." How will the NRC go about independently confirming or otherwise verifying the authenticity, accuracy, and completeness of the "monitoring results" that it will "review and approve" for the "Ross Project" and other scheduled "Lance District Development?
(d) Please provide a complete list of the water quality standards and criteria that the NRC will apply when it makes a determination on whether "Ross Project" aquifer restoration "would be considered to be complete." Which of these standards or criteria are considered binding on the Agency and the applicant, and which can be abandoned or modified at will using the agency's enforcement discretion?
(e) Which official or officials within NRC are entrusted with the responsibility and authority to approve monitoring results and declare aquifer restoration "to be complete?"
(f) What does "aquifer restoration" really mean if uranium ISR wellfield construction and testing and ISR operations are ongoing in adjacent portions of the same hydrologically connected formation, and neither the starting nor finish lines for assessing groundwater degradation and restoration have been established in advance as being both environmentally protective and legally binding on the Applicant and the NRC.
(g) For how long will the proposed license require the Applicant "to monitor the groundwater by quarterly sampling to demonstrate that the approved standard for each constituent has been met and that any adjacent nonexempt aquifers are unaffected?"
(h) Please provide the "approved standard for each constituent" that will be used to conduct this quarterly monitoring, and the standards for determining that "any adjacent nonexempt aquifers are unaffected."
(i) What does "adjacent" mean in this context?

45. Page 2-35, line 9: "Prior to the Ross Project's facility decontamination, dismantling, and decommissioning…"

NRDC Comment:
(a) Please provide the earliest and latest dates at which this facility D & D could reasonably be expected to occur based on the current mining plans of the Applicant in the Lance District?
(b) Is the "Ross Project facility" named above the same as the "Lance Projects Central Processing Plant (CPP)" described by Applicant Strata Energy's parent company, Peninsula Energy, Ltd., in releases to the global investing community?
(c) If so, why is it referred to in this DSEIS by a different name?

46. Page 2-35, line 10: "…appropriate cleanup criteria for surfaces would need to be established in concert with NRC requirements."

NRDC Comment:
(a) What are the current NRC requirements, if any, for "appropriate cleanup criteria for surfaces" of ISL plants in the D&D phase?
(b) When and how would the criteria required for cleanup of surfaces at the "Ross Project facility" be determined?
(c) Please provide a table showing the expected levels of radioactive and chemical contamination before and after decontamination of a typical ISL facility similar in size to the Ross CPP.
(d) If the data requested in (c) is time dependent, please present showing how the contamination levels pre- and –post decontamination may vary with the plants operating history.

47. Page 2-35, line 12: "…a Ross Project-specific decommissioning plan (DP) would need to be accepted by the NRC. The Applicant has committed to satisfying these NRC requirements for decontamination and decommissioning."

NRDC Comment:
(a) When would a "Ross Project-specific decommissioning plan DP)…need to be proposed by the Applicant?
(b) When would it "need to accepted by the NRC?"

48. Page 2-35, line 17: "…to identify those areas at the Ross Project that would need decontamination to meet applicable cleanup criteria or those that cannot economically meet the criteria (Strata, 2011b)."

NRDC Comment:
(a) Please describe the difference between "cleanup criteria" and "applicable cleanup criteria." When would cleanup criteria in the DP not be "applicable?"
(b) What happens when a contaminated area "cannot economically meet the criteria" established in the DP?

49. Page 2-35, line 21: "The onsite excavated pits, or "mud pits," used for disposal of drilling fluids and muds (or "cuttings" during the installation of wells, would be included in the survey to ensure no long-term radiological impacts (Strata, 2011a)."

NRDC Comment:

(a) Please estimate the total number, land area, and approximate locations of all mud pits that will be created in the complete cradle-to-grave life cycle of drilling for the following: the "Ross Permit Area;" "Ross Amendment Area # 1;" "Kendrick Production Unit (Amendment Area #2);" Richards Production Unit (Amendment Area # 3); Barber Production Unit (Amendment Area # 4); all "Lance District Development," including the preceding named areas and units, plus "the Warren Project," the "Richards Project," the "Osborne Project," the "Chatterton Project," the "Brooks Project," the "Carey Project," the "Houx Project," the "Clark Project," the "Lucas Project," and the "Emerson Project; " all of the preceding, plus ISL mining-to-depletion of the entire "Lance District" uranium resource under the control of the Applicant?

(b) What about any long-term chemical as well as radiological impacts of these drilling "mud-pits?" Please describe the specific chemical as well as radiological constituents of the "Ross Project" and "Lance Projects" drilling muds, and any potential short and long-term hazards they may present to the human and natural environment, including crops, livestock, and wildlife, from leaving them in place.

(c) Are these radiological and chemical constituents of drilling muds expected to be consistent across all uranium-ore bearing areas of the "Lance District," or could they vary significantly depending on local drilling conditions and the specific characteristics of the ore-bearing formations?

(d) Please provide expected ranges for the concentrations and activity levels for all constituents of these drilling muds, including radioactive decay products over time, for every area planned to be mined under the Proposed License and any planned amendments thereto.

(e) Which constituents present the highest risk of mobilization in the event of (i) erosion and flooding; (ii) dessication and wind- blown dispersion?

(f) Which constituents present the greatest risk of uptake in the food chain?

(g) Are these mud-pits subject to the "applicable cleanup criteria" in the Applicant's NRC-approved "Ross-Project-specific" decommissioning plan (DP)?

(h) What standards would be applied to these mud pits in the Applicant's decommissioning plan to determine whether they present "no long-term radiological (and chemical) impacts" if left in place?

(i) If the "radiation survey" referenced in lines 16 – 25 documents the existence of a long-term radiological or chemical hazard at some or all of these "mud-pits," what will the Applicant's NRC-approved DP require in the way of cleanup?

(h) Could some or all of these mud pits qualify for a determination that they "cannot economically meet the criteria" for cleanup?

(i) If a survey documents that some or all mud-pits will have long-term adverse environmental impacts, and some or all of these mud pits qualify for a determination that they "cannot economically meet the criteria" for cleanup, what steps will be taken, if any, to mitigate their environmental risks?

(j) Please briefly summarize and provide detailed citations to technical literature demonstrating that the cumulative impacts of many thousands of such contaminated mudpits in an area of 90-120 km2 does not present an elevated risk of environmental harm.

50. Page 2-36, line 6: "However, at the Ross Project, complete decontamination...and decommissioning…could occur years after the wellfields begins to be decommissioned and the aquifer begins to be restored."

NRDC Comment:
(a) Could occur or would occur? Why the use of the conditional tense? Don't the economic rationale for the "Ross Project" CPP and the Applicant's licensing strategy both depend on bringing numerous additional wellfields into production beyond the initial Ross Permit area considered in this SEIS?
(b) How long would the CPP remain in operation after the first "Ross Project" wellfield "begins to be decommissioned" if the Applicant's business plan for mining the entire Lance District region is realized?

51. Page 2-36, line 32: "All wastes and the equipment associated with surface impoundments….disposed of appropriately or released for unrestricted use…The soil beneath the surface impoundments would be analyzed for radioactive contamination, and any areas that exceed the cleanup criteria for unrestricted release would be excavated and disposed of at a licensed radioactive waste disposal facility."

NRDC Comment:
(a) Would the "soil beneath the surface impoundments" be examined for chemical contamination?
(b) How wide an area around and down gradient from the mudpits will be examined for contamination that may have migrated through seepage, leaching and erosion?
(c)What are the specific criteria that would be applied to determine the choice between "disposed of appropriately" and "released for unrestricted use?"
(d) With 750 to 1000 individual wells estimated for the Ross Project, how many total acres of: (1) "excavated mudpits;"and (2) surrounding land; will be examined for radioactive and/or chemical contamination?
(e) Please provide the data requested in (d) for all planned "amendment area" expansion wellfields (including all disposal and monitoring wells) with output that would be processed in the "Ross CPP" (aka the "Lance Projects Central Processing Plant") with the next 10, 15, 20, 25, 50, and 70 years.
(f) Would these mudpit zones be subject to the same radiation survey and evaluation process mentioned on page 2-35, line 18, which could result in a determination that some or all of them requiring cleanup "cannot economically meet cleanup criteria?"
(g) Would mudpit areas that meet cleanup criteria be suitable for reseeding and livestock grazing? If not, how will they be identified to prevent same?
(h) If mudpit areas that do not meet cleanup criteria are left in place because they "cannot economically meet cleanup criteria," do they present any future contamination threat to

the livestock or wildlife food chains, or to surface or shallow groundwater resources? Please characterize the chemical and radiological nature of this threat?

52. Page 2-38, lines 8 – 41, Airborne Emissions:

NRDC Comment:
(a) Please provide the full lifecycle CO2 –equivalent emissions per-pound-of-yellowcake to be produced from the "Ross Project, including in this calculation all on-site and off-site sources of electricity and fossil-fueled thermal combustion required for all phases of the Ross Project, including aquifer and site restoration. Please make all components of this calculation transparent.
(b) What is the estimated lifetime output, measured in pounds of yellowcake, of the "Lance Projects Central Processing Plant," (aka the "Ross Project" CPP)?

53. Page 2-39, line 10: "The Applicant has committed that these [radon] discharges would meet all local, State, and Federal requirements related to air quality as well as occupational health and safety (Strata, 2012b)."

NRDC Comment:
(a) Please describe how the NRC, or if not the NRC, other government agencies will monitor and confirm the Applicant's compliance with these requirements?
(b) Please describe any and all historical instances in which the NRC or another agency has cited or fined an ISR facility for failure to comply with radon-monitoring, -ventilation, or -personnel protection requirements.

54. Page 2-39, line 39: "The composition and quantities of liquid waste from Ross Project processes related to uranium recovery are similar to those ranges provided in Table 2.7-3 of the GEIS (NRC, 2009);"

NRDC Comment:
Attempting to quantify the output of liquid wastes from the "Ross Project" by saying that it is "similar to a range" provided in some other document conveys no useful information and fails to comply with NEPA, which requires that important environmental parameters be quantified wherever possible.
(a) Please provide estimates of the total quantity and composition of liquid waste requiring deep well disposal from:
(1) The "Ross Project,"
(2) All future "Lance Projects" that would utilize the CPP;
(3) All "satellite IX facilities" planned by the Applicant in connection with future use of the CPP.
(b) Please provide the number, planned locations, target aquifers, and required capacities of all deep disposal wells that would be created by executing:
(1) The Applicant's current plan to solution-mine the Ross, Kendrick, and Barber "amendment areas;"
(2) the Applicant's future plans to mine all the projects identified in its corporate parent's long range business plan for "Lance District Development," including

> "the Warren Project," the "Richards Project," the "Osborne Project," the "Chatterton Project," the "Brooks Project," the "Carey Project," the "Houx Project," the "Clark Project," the "Lucas Project," and the "Emerson Project; " (3) All of the preceding, plus ISL mining-to-depletion of the entire "Lance District" uranium resource under the control of the Applicant?

55. Page 2-40, line 36: "The applicant expects the capacity of each of the five Class 1 wells to range between…" You have expressed the "capacity" of a disposal well as a flow-rate, not as a limit on the total amount of liquid wastes injected.

> **NRDC Comment:**
> (a) What determines the actual amount of liquid waste that each deep injection well can accommodate, and how is this limit expressed?
> (b) Is there a limitation imposed on the maximum injection pressure, or on the resulting water pressure in the deep formation that is receiving the waste, and what is (are) this limit(s) for the Ross Project and for subsequent "Lance Projects"?
> (c) Would all deep disposal wells associated with uranium yellowcake produced pursuant to the proposed license be targeted in the same formations (Deadwood and Flathead) as targeted by the five deep disposal wells permitted for the "Ross Project."?

56. Page 2-40, line 41: "Net annual evaporation of brine in the surface impoundments would be 5.3 L/min-ac [1.4 gal/min-ac] which would reduce the volume of brine injected in the disposal wells (Strata, 2011b)."

> **NRDC Comment:**
> (a) Please provide the total quantity and percentage of total produced brine that would be disposed via evaporation.
> (b) Please quantify the amounts of radon or other hazardous gases that might be released via evaporation from the "surface impoundments."

57. Page 2-41, line 27: "The Applicant estimates that a volume of 22,000 L (6,000 gallons) of water and 12 m3 [15 yd3] of drilling muds would be produced per well."

NRDC Comment:
Please explain the derivation of these numbers.
(a) Do they represent an average value of "produced water" and drilling muds per well sunk into the ore zone only, or do they include the deep wells, which one would expect to be about 16 times greater, based on a ratio of their respective depths.
(b) Please provide separately the values for produced water and drilling muds from the drilling of deep disposal wells into the Deadwood and Flathead formations.

58. Page 2-41, line 30: "The Applicant expects the production of ground water during operations and decommissioning of wells completed outside of the aquifer exempted for uranium recovery (Strata, 2011a). This ground water would be discharged under a temporary WYPDES Permit."

NRDC Comment:
(a) How many wells, of what type, into which formations, are covered now under the terms of this "temporary permit?"
(b) How many wells will be drilled and covered by this permit in the future;
(c) How long is the term of the renewed permit?
(d) Where and how is the groundwater "discharged" under the terms of this permit?

59. Page 2-43, 44, lines 39-9 "Financial Surety."

NRDC Comment:
With a history of failures in efforts to adequately restore contaminated aquifers at ISL uranium mining sites, the subject of financial surety is of concern. Please provide:
(a) A full (and comparative) accounting of each and every original financial surety required by NRC or relevant state agencies for ISL uranium mines, including the type of surety arrangement (e.g., bonds, cash deposits, certificates of deposit, parent company guarantees, etc.).
(b) What was the basis for the initial surety requirement?
(c) Were there license conditions requiring each of these surety arrangements?
(d) Were the surety estimates for funding the entirety of groundwater restoration and decommissioning the facility adequate in each instance? If not, why not?
(e) How often were updates required of each surety at each ISL mining site?
(f) If at any point a surety was not adequate to meet the costs of restoration and decommissioning, what entity provided funding for continuing restoration?

60. Page 2-44: "As of October 2010, the applicant has located 759 of the 1682 holes thought to exist from Nubeth exploration activities and has plugged 55 of them (Strata, 2011b)."

NRDC Comment:
(a) Based on historical records, how many previous drill holes from all sources (e.g. oil, gas, uranium, water exploration and extraction) are believed or known to exist on (1) the Ross Project site; (2) the area encompassed by future planned "Lance District Development?" Please provide a map showing the boundaries of this wider area.
(b) How many of the preceding holes described in (a) have been located, and how many have been plugged?
(c) Does the total of 1682 holes from "Nubeth exploration activities" include the wells that were drilled for Nubeth's abortive production operation? How many of the latter are there?
(d) (1) Of the known subset of holes associated with Nubeth exploration activities, how many has Strata located to date (May 9, 2013);
(2) How many of these have been plugged?
(3) How many of these have been correctly plugged or replugged to modern well abandonment standards?
(e) Of the larger number of drillholes from all sources, how many of these has Strata located, and how many of these have been correctly plugged to ensure that no vertical or horizontal migration of lixiviant occurs, or any migration of otherwise altered water outside the permitted area of the mined aquifer?

61. Page 2-44, line 2: "Alternative 3: North Ross Project."

NRDC Comment:
The ER and DSEIS contains no evidence that other CPP location alternatives were screened for their environmental advantages and disadvantages prior to selecting the "North Ross Project" for detailed NEPA analysis.
(a) Please explain why this alternative, and not others, was deemed more reasonable than other potential CPP location alternatives, and provide evidence that an environmentally-based screening process was used to identify environmentally preferred sites;
(b) What environmental or other criteria elevated the North site and the chosen Ross site above other alternative sites?
(c) Please provide a detailed discussion of why the selected Ross Site is the environmentally preferred site within the Lance District areas acquired, optioned, or leased by Peninsula Energy Ltd/Strata Inc., for ISR of uranium.
(d) Strata's Australian parent company, Peninsula Energy, Ltd., has proposed ["Lance-Development Model," March 21 presentation 2013 Hong Kong Mines and Money conference] that a satellite ion exchange facility will be part of the planned "Barber Production Unit" in the southern part of the Lance District. A location in this area, closer to the towns (Gillette and Moorcroft) where the plant workers are likely to live, would appear to offer environmental advantages in terms of minimizing dust and transport emissions during construction, operations, product shipments, workforce commuting and decommissioning. What consideration, if any, was given to locating the CPP here, much nearer to paved roads and the main I90 east-west transportation corridor?

(e) Please describe the comparative environmental and other factors, relative to other candidate CPP sites considered, that led to the selection of the (south) Ross project site as the preferred site for building the CPP and the first wellfields to be constructed under the proposed licensing action.

62. Page 2-46, line 35:

NRDC Comment:
In discussing the alternative (eliminated from detailed analysis) of possibly employing conventional mining and milling to extract the Lance District resource, the DSEIS states that "the uranium ore in the Lance District is low-grade…" and located at "nearly the maximum depth for surface mining to practically recover uranium from an open pit."
(a) Please give the definition of "low-grade" uranium ore used here.
(b) Is uranium mineralization of 4 to 5 feet at 1000-1300 parts per million (ppm) considered "low grade?"
(c) If the Ross Project uranium is indeed "low-grade," please provide a NEPA analysis showing that on balance, developing this Lance District resource, at the cost of incurring some measure of unavoidable adverse environmental impacts, particularly on groundwater, is worth the socio-economic benefits that would flow from this decision in light of available alternatives to the proposed licensing action.
(d) For example, if Canadian uranium imports from the Athabasca Basin can be tunnel-mined from an ore body that is on the order of 200 times richer than the Lance District's (concentration of 0.1% versus 20% at MacArthur River) thus in principle incurring significantly fewer environmental impacts per ton of U308 product extracted, and this rich mining district is located in a remote area that is literally saturated with vast surface and groundwater resources, why then does it make environmental sense to impair relatively scarce groundwater resources to mine uranium in a semi-arid region of eastern Wyoming, water that would otherwise be available to support livestock, crop irrigation, and human consumption (the city of Gillette even today, much less at some parched time in the future, taps the Fox Hills/Lance aquifers for water that is blended Madison formation water with lower TDS values to yield potable water, and thus the aquifers to be degraded by the licensed mining comprise a source of human drinking water.)?
(e) Could the extended mining contemplated by Applicant in the planned southern "Barber Production Unit" of the Lance District, under so-called "amendments" to this proposed License, threaten future use of the above-mentioned municipal, and other actual and potential wells in the area, as a source of drinking water via blending? A planned "Warren Project" at the far southern end of the Lance District [avg. 10 ft. of mineralization @ 700 ppm eU308] would apparently come even closer to the town of Moorcroft. Please provide a technical justification for your answer.
(e) Please provide a detailed map showing the location of the Moorcroft and Gillette wells tapping the Fox Hills/Lance formations and or nearby aquifers in relation to the planned southern "Amendment Areas" that could be added to the proposed "Ross Project" license.

63. Page 2-50, line 46: "The Applicant has estimated that the 2.5 ha [6.3 ac] available for evaporation in the Proposed Action would provide 33.3L/min [8.8 gal/min] of average annual

evaporation. Linear extrapolation suggests that 65 ha [160 ac] is the minimum surface area required for evaporation of all brine and other byproduct waste generated at the CPP."

NRDC Comment:
How was the proposed surface area of 6.3 acres for the CPP surface impoundments arrived at? Why was not a larger or smaller acreage proposed? What were the environmental and operational factors considered?

64. Page 2-52, line 18: "During operations there would be a MODERATE impact to ore-zone aquifer water quality due to excursions…"

NRDC Comment:
(a) What is the technical basis for the apparent view expressed here that a "moderate" degradation of mined aquifer water quality would be "due to excursions," rather than to the real time effects of mobilizing uranium and other constituents of the ore-bearing sandstones (like radium and selenium) known to be harmful to human and animal health?
(b) Expressed quantitatively, as a deviation from the pre-licensing site-characterized baseline levels, what does a "MODERATE" impact on mined aquifer water quality mean in this context?

65. Page 2-52, line 20: "…however, with measures in place to detect and resolve excursions, the impacts would be reduced."

NRDC Comment:
(a) Please quantify the meaning of "reduced" in this context – from what to what?
(b)With the ability in place to "detect and resolve excursions," does this mean that the impacts on the mined aquifer would be no longer "MODERATE," and therefore "SMALL"? What does "SMALL" mean quantitatively in this context, expressed as a deviation from pre-licensing site-characterized baseline levels?
(c) Does anyone in NRC have the intestinal fortitude to acknowledge the utterly circular and syllogistic nature of this ludicrous mode of fact-free environmental analysis?
(d) "During aquifer restoration there would be a MODERATE impact to ore-zone aquifer water quantity to short-term drawdown..." Please define the possible range of time that NRC associates with "short-term" drawdown of an aquifer, and explain why this length of time would impose only a "moderate" environmental impact on current and potential future users of the aquifer. If a "restored" aquifer fails to recharge fully after thirty years, is this a "moderate" impact?
(e) What about impacts to ore-zone aquifer water quality during and after "restoration?" The NRC staff's conclusions stated on page 2-52 include water quality impacts during operations, but say nothing about these impacts during and after "restoration?" Are we to presume that there are no water quality impacts arising from and/or enduring past the restoration phase of the Ross Project?
(f) Since it is well known that there are such lasting impacts, expressed as prolonged deviations from pre-mining baseline levels for key constituents whose concentrations determine the relative human potability and other uses of groundwater, please describe the

deviations from baseline water quality values expected in the Ross Project, and subsequent Lance Projects."

66. Page 2-53, line 1-6: "Regarding groundwater, the portion of the aquifer(s) designated for uranium recovery must be exempted as underground sources of drinking water before ISR operations begin."

NRDC Comment:
(a) Why is this exemption necessary if, as claimed in the same paragraph, "Strata would also be required to restore groundwater parameters affected by the ISR operations to levels that are protective of human health and safety?"
(b) In other words, if Strata must restore groundwater parameters affected by ISR operations to levels that are "protective of human health and safety," why is it necessary to exempt the aquifer in the future from serving as a potential source of drinking water? Please explain this apparent contradiction.
(c) What are the levels for key constituents of the "restored" mined-out aquifer that the NRC deems "protective of human health and safety?" If these levels are truly protective of human health and safety, why can't the restored aquifer serve as a source of drinking water? If it can't serve this function, is it reasonable or legitimate to say that the aquifer has been "restored" to a level that is "protective of human health and safety," including future uses that humans depend on, such as watering livestock and crop irrigation?
(d) The only way to decipher and make sense of this apparent contradiction, which arises from purposefully vague writing, is to interpret the phrase "restore groundwater parameters affected by ISR operations" as excluding the mined aquifer itself. Then the problematic phrase reduces to, "Strata will protect human health and safety as it relates to current and future uses of aquifers beyond the ore zone." Although no quantitative demonstration is provided showing Strata's pathway to achieving even this more limited goal, at least read this way the assertions in this problematic paragraph begin to make logical sense! Please clarify that this is what the paragraph at the top of page 2-53 is intended to convey, even though it is drafted to leave an impression of a more robust groundwater restoration capability.

Section 3: Affected Environment

67. Page 3-1, line 38: "The Ross Project area encompasses approximately 697 ha [1,721 ac] as described in the SEIS Section 2.1.1."

NRDC Comment:
(a) Please provide (and show on a map) the total land area encompassed and affected by Applicant Strata Energy's proposed "Lance District Development" (referenced in Figure 2.6) and "The Lance Projects," given by sources other than this deficient DSEIS as the following: the "Ross Permit Area;" "Ross Amendment Area # 1;" "Kendrick Production Unit (Amendment Area #2);" Richards Production Unit (Amendment Area # 3); Barber Production Unit (Amendment Area # 4); "the Warren Project," the "Richards Project," the "Osborne Project," the "Chatterton Project," the "Brooks Project," the "Carey Project," the "Houx Project," the "Clark Project," the "Lucas Project," and the "Emerson Project."

(b) Please provide the total land area and show on a map the boundaries of the area that would be affected by mining the entire "Lance District" to depletion, and discuss all the existing human settlements and existing land uses that would be affected within this wider area designated by the Applicant for uranium development.
(c) Please revise this entire section (Sec. 3) on the "Affected Environment" to encompass a description of all the important environmental attributes of the wider area that could be solution-mined as a direct or foreseeable consequence of the NRC's proposed licensing action.

68. Page 3-4, line 24:

NRDC Comment:
Include in this paragraph all of the "potential projects" planned for the Lance District by Strata Energy's corporate parent, Peninsula Energy, Ltd.

69. Page 3-9, line 15 -18:

NRDC Comment:
Please provide the JORC-compliant uranium resource estimates for "recoverable uranium" in the area encompassed by future planned "Lance District Development."

70. Page 3-38, subsection on existing Groundwater Quality:

NRDC Comment:
The data and discussion in this section is vague, disconnected, and entirely inadequate. It never forthrightly discusses historical and current water quality data from a representative sample of existing wells completed in the Lance and Fox Hills aquifers outside of the previous Nubeth exploration and mining zone, and the sparse data from such existing wells appears to have been dropped from Tables 3.6 and 3.7, which includes only "Nubeth Data" and "Ross Project Monitoring Well Data."

71. Page 3-43, lines 19 -22:

NRDC Comment:
(a) Please provide a map showing the locations and current uses of the "identified 29 currently operable water-supply wells within the Ross Project area and the surrounding 2-km (1.2 mi) area."
(b) Provide a similar map for the wider area proposed for uranium ISR by the Applicant, as described earlier in these comments.

72. Page 3-43, line 32 -34: "Domestic wells are generally deeper than stock wells, ranging from 46-180 m [150 – 600 feet] The limited information available on these wells precluded a determination of which aquifer was supplying water to the domestic wells."

NRDC Comment:

This data gap seems a little too convenient. The referenced depth range of these domestic wells could easily include the Lance/Fox Hills formations. Please provide more information on the supply aquifers and water quality of these domestic wells.

73. Page 3-43, line 37 -38: "The results of the water –quality analyses are provided in the Applicant's ER…"

NRDC Comment:
Please provide and discuss these results in this SEIS. The public does not read the Applicant's ER, and it is not a NEPA document.

74. Page 3-43, line 41: "As described below for each type of well, these analyses showed that the local water supply's contaminants *generally exceeded* EPA's drinking water standards and *often exceeded* Wyoming's less stringent quality standards for agricultural use."

NRDC Comment:
(a) These are tendentious and unsubstantiated conclusions based on the data provided. Sulfate exceeded the standards in 54% of the wells sampled – given inherent measurement and sampling errors, and the small size of the sample, this is hardly a basis for concluding that these wells "generally exceeded EPA's drinking water standards." Gross alpha was exceeded in only "4 of the 13 domestic wells," or 31 % of the wells, again hardly the basis for a conclusion that these wells "generally exceeded" EPA or WDEQ standards.
(b) Likewise, the conclusion for the stock wells that "the water quality of stock wells is variable" does not substantiate the conclusion that water from these wells "often exceeded Wyoming's less stringent quality standards for agricultural use." The results summary on page 3-44, line 19, states that "gross alpha exceeded both the Class II standard and the MCL in 7 of the 15 stock wells," or only 45% of the wells. In other words, more than half the time, they complied with this standard. Selenium exceeded these standards in only 1 of 15 (7%) of wells, which hardly comports with the descriptor "often exceeded."

75. Page 3-44, line 16: "TDS often ranged from 370 to 1,610 mg/L, often exceeding the EPA Secondary MCL standard…"

NRDC Comment:
Please describe what "often" means in this context. Provide a numerical value to substantiate the claim.

76. Page 3-44, line 16: "Sulfate, ranging from 28 to 679 mg/L, often exceeded …"

NRDC Comment:
Please describe what "often" means in this context, and provide a numerical value to substantiate the claim.

77. Page 3-103, line 27: "Twenty-nine *local drinking water wells* were also sampled quarterly, beginning in July 2009…"

NRDC Comment:
Please provide a map and tables showing the locations and results, respectively, from this quarterly sampling program of local drinking water wells. If this is an erroneous reference to the sampling of 29 *water supply wells* for all uses given at pages 3-43/44 of this section, then correct the error.

Sec. 4 Environmental Impacts and Mitigation Measures

78. Page 4-3, line 18: "The GEIS defined land-use impacts to be SMALL when they ranged from 50 -750 ha [120 – 1,880 ac]."

NRDC Comment:
This is an arbitrary, capricious, and frankly ridiculous statement. Without a detailed consideration of the environmental attributes of a land area, irrespective of its size, one cannot "define" land use impacts as being anything, much less "Small."

79. Page 4-3, Table 4.1:

NRDC Comment:
The implication of this misleading chart, that only 280 acres of the total Ross Project area will be "disturbed" by the Proposed Action, is palpable nonsense. Apparently the faulty environmental premise being utilized here is that the land disturbance impacts of the proposed action are limited to only those specific areas which are physically occupied by facilities, equipment, and roads associated with the project, rather than the denial or alteration of existing land uses imposed by the project as a whole. Even on the basis of the narrower phony premise, Table 4.1 fails, as it fails to include the direct land use impacts of mudpits, well-pads, and fenced-in areas. The area occupied by 5 permitted deep injection wells is given as 5 acres, but should be 7 acres based on the given wellpad area of 250 x 250. Compare Table 4.1 with the graphical depiction of the "Ross Project Facility and Wellfields" in Figure 2.4, showing the perimeters of the proposed wellfields occupying what looks to be at least 60% of the Ross permit area.

80. Page 4-6, Transportation:

NRDC Comment:
Reasonable alternatives for locating the CPP to diminish transportation impacts (e.g. dust, carbon emissions, and probability of vehicle accidents) are not examined.

81. Pages 4-11/12, beginning line 48 on page 4-11:

NRDC Comment:
The conclusion in this paragraph that upping the shipment of resins received at the CPP daily from one to four would not affect the risk of accidents is unsubstantiated, and the increased risk arising from shipping four times the yellowcake output obtainable from the Ross Project alone is not even evaluated.

Section 5 Cumulative Impacts

NRDC Comment:
In numerous locations throughout the cumulative impacts discussion the DSEIS foregoes attempts at quantitative analysis of cumulative environmental impacts, or even substantive discussions of qualitative factors. The document achieves this dubious distinction by relying on blanket assumptions that, for a given action or impact (*i.e.*, deep-well waste storage, geologic/soil impacts, etc.), the Applicant will adhere to relevant regulations and monitoring programs. The Staff then interprets this as yet to be demonstrated adherence – an adherence with no basis in historical practices at ISL mines[2] – as offering some guarantee that the cumulative impacts associated with this action will not rise to a significant level that merits detailed analysis in the EIS, by virtue of the regulation's or program's underlying intent to prevent impacts in the first place. It is obvious that the Applicant's intent to adhere to existing regulations and guidelines should be assumed during the life of the Ross Project; however, this assumed adherence should not serve as a substitute for thorough analysis of impacts and presentation of findings within the SEIS.

82. Page 5-2, line 20: Other Past, Present, and Reasonably Foreseeable Future Actions
NRDC Comment:

[2] *See*, NRDC's *Nuclear Fuel's Dirty Beginnings*, at 26-33, for historical treatment of ISL mining practices and associated environmental harms. For example, we noted "[e]xcursions and leaks have been serious ongoing problems for many ISL facilities. In issuing a 2007 Notice of Violation to the Cameco Corporation's Smith Ranch-Highland ISL mine, the state of Wyoming noted: '[O]ver the years there have been an inordinate number of spills, leaks and other releases at this operation. Some 80 spills have been reported, in addition to numerous pond leaks, well casing failures and excursions. *Unfortunately, it appears that such occurrences have become routine*. The LQD [Land Quality Division] currently has two large three-ring binders full of spill reports from the Smith Ranch- Highland operations.'" (citations omitted and emphasis added). *Found* online at http://www.nrdc.org/nuclear/files/uranium-mining-report.pdf , and please incorporate by reference the report as a whole.

The statement is that other industrial activities near Crook County could have environmental impacts that could be greater than the individual impacts of the Ross Project. Because these additional activities are stated to include similar uranium recovery projects, as well as other activities known to impact environmental systems (e.g. oil and gas recovery), it should be assumed that the proposed action is necessarily smaller than the sum of all impacts due to external activities, as opposed to ambiguously representing the proposed action as potentially inconsequential within the context of cumulative impacts analysis.

83. Page 5-4, lines 1-6:

NRDC Comment:
Is the Richards Satellite Area anticipated to serve as replacement capacity to retiring wells, as with the Ross Amendment Area 1, or is it expected to run concurrently, thereby increasing the production rate of the CPP?

84. Section 5.6 Geology and Soils, page 5-18, line 3:

NRDC Comment:
Where is the data presented, or referenced, that shows both the initial (baseline) and post-decommissioning conditions regarding geology and soil on the Ross Project site, thus allowing the conclusion that the geologic and soil conditions of the Nubeth area are no longer relevant in a cumulative impacts analysis for the proposed action?

85. Page 5-18, line 13:

NRDC Comment:
What is the basis for concluding that the geology/soil impacts would dissipate quickly once site restoration is complete? Please provide examples of geologic/soil "disturbances" that are expected in the Ross Project along with previously observed instances in similar projects and their observed recovery times. In light of this data, is a 5-year recovery buffer conservative?

86. Page 5-18, line 46:

NRDC Comment:
Is there not enough information presently available regarding future development of satellite areas and their operational characteristics to more accurately estimate the area of soil disturbance, in contrast to assuming all four sites are identical?

87. Page 5-19, line 3:

NRDC Comment:
To what extent does the cumulative geologic impacts analysis change when considering successive (or replacement) operational capacity versus concurrent operations in potential satellites areas? What justification is there to conclude there will be a SMALL impact as a result of drilling, plugging, and abandonment of holes for either of these operational scenarios, which were both recognized by the Applicant as foreseeable?

88. Section 5.7 Water Resources, page 5-19, line 39:

NRDC Comment:
(a) Does limiting the geographic area of study to the upper reaches of the Little Missouri River Basin preclude or unnecessarily limit the scope of study on impacts that could be experienced beyond this area of data collection and monitoring?
(b) What additional watersheds are implicated in the Applicant's plans for extended ISR operations in the Lance District, and what are the cumulative demands on water resources from those projects in conjunction with all other reasonably foreseeable sources of water consumption and/or water quality degradation in the same area?

89. Section 5.17 Waste Management, page 5-48, line 26:

NRDC Comment:
(a) What methodology was used to determine the 20-year timeframe for evaluating the cumulative impacts of deep-well injection of liquid wastes? Why not a longer timeframe?
(b) What analysis has been performed specific to the formations existing in the Ross Project area that studies the potential for migration of liquid wastes and the associated timelines for this migration and/or transformation into acceptable forms?

90. Page 5-50, lines 26-33:

NRDC Comment:
(a) Describe why only using the physical geographic footprint (approximately 0.4 km around each well) in relation to the overall project area is appropriate for assessing the cumulative impacts of 17 deep-injection wells within the Ross Project site and potential expansions, and concluding they are SMALL?
(b) What data are available on the failure rates and historical performance of deep-well waste storage, particularly in industrial activities similar to ISR? Does this data, when incorporated into the Ross Project cumulative impacts analysis over the entire lifecycle, still allow for the conclusion that these effects are SMALL?

EXHIBIT 2

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
STRATA ENERGY, INC.,	)	Docket No. 40-9091-MLA
	)	
(Ross In Situ Recovery Uranium Project)	)	

(Materials License Application)

DECLARATION OF ROBERT E. MORAN ON BEHALF OF THE NATURAL RESOURCES DEFENSE COUNCIL & POWDER RIVER BASIN RESOURCE COUNCIL

I, Robert E. Moran, declare that the following statements are true and correct to the best of my knowledge:

Introduction

1. I am a hydrogeologist/geochemist with more than 39 years of domestic and international experience in conducting and managing water quality, geochemical, and hydrogeologic work for private investors, industrial clients, tribal and citizens groups, NGO's, law firms, and governmental agencies at all levels. Much of this technical expertise involves the quality and geochemistry of natural and contaminated waters and sediments as related to mining, nuclear fuel cycle sites, industrial development, geothermal resources, hazardous wastes, and water supply development.
2. I have significant experience in the application of remote sensing to natural resource issues, development of resource policy, and litigation support. I have often taught courses to technical and general audiences, and have given expert testimony on numerous occasions. I have worked in numerous countries including Australia, Greece, Mali, Senegal, Guinea, Gambia, Ghana, South Africa, Iraqi Kurdistan, Oman, Pakistan, Kazakhstan, Kyrgyzstan,

Mongolia, Romania, Russia (Buryatia), Papua New Guinea, Argentina, Bolivia, Chile, Colombia, Guatemala, Honduras, Mexico, Peru, El Salvador, Belgium, Canada, Great Britain, and the United States. My CV is attached.

3. Much of my experience has involved uranium mining, processing, and related environmental impacts.
4. The Powder River Basin Resource Council has contracted my services to supply comments on the Strata Energy Ross In-Situ Recovery[1] NRC License Application.
5. In addition to my professional experience, the opinions and comments that follow are based on review of relevant portions of the application and documents listed in the References Cited section as well as a site visit to the proposed Ross Project area on June 7, 2011.

Summary of Comments

6. It is my opinion that Strata Energy misuses the term "Baseline." Baseline water quality results are, of course, a very important part of any uranium mining and milling license application because the baseline is what one measures impacts from and what one strives to restore to. The application fails to define pre-operational groundwater and surface water baseline water quality and aquifer water levels. As a consequence, it is likely the company will be able to avoid future liability for inadequate restoration.
7. It is my opinion that the application fails to adequately present the true extent of historical exploration drilling, borehole abandonment details, R&D testing, changes to groundwater water quality, and interconnections of geologic strata. These are cumulative impacts that should be disclosed and analyzed.

[1] In-situ recovery ("ISR") is also commonly referred to as in-situ leaching ("ISL"). For the purposes of this declaration, the two phrases are used interchangeably.

8. The Ross permit area is only one small part of Strata Energy's proposed Lance Project. However, the application does not fully discuss the scope of the larger planned Lance Project and in doing so disregards cumulative impacts. For instance, the application states that "it is likely that the proposed Ross CPP will serve as the central processing location for future Strata satellite facilities and, potentially, satellite facilities owned and/or operated by other uranium recovery companies or water treatment entities; however, for purposes of the current license application, Strata intends for the Ross CPP to service only ISR operations within the proposed Ross license boundary." ER pg. 1-20. Therefore, any reasonably foreseeable future cumulative impacts associated with using the Ross CPP facility for future Strata or other operator sites and the related cumulative impacts related to water and other resources from the ISL mining associated with those future Strata or other operator sites are not disclosed or analyzed in the application.
9. Although it is not tabulated anywhere in the application, by my count, Strata Energy's Technical Report (TR) plus Appendices consists of more than 3577 pages. The Environmental Report (ER) consists of 1206 pages over three volumes. This is a very long application and unfortunately it is disjointed, confusingly-organized and repetitive, with discussions artificially split between numerous sections, so that a coherent picture is lacking. In my professional opinion, the organization of the report makes it difficult to fully assess Strata's proposed operations and their corresponding impacts.
10. It is my opinion that the ultimate conclusions in the application are not technically independent of Strata's financial interests. The license application (composed of the ER & TR) is written in a way that represents the positions, interests, and business needs of the company, rather than being written to provide an independent technical approach with full

disclosure of unfavorable arguments and conclusions. I believe it is therefore important for the NRC and the public to serve as independent reviewers and fully scrutinize the application with independent data and conclusions.

11. In some places of the application, it is unclear who is the author of individual opinions and conclusions. It is therefore not clear whether the opinions are of individuals with sufficient credentials and expertise to issue the opinions. As a professional in my field, I believe it is crucial that all conclusions related to water resources be drawn by individuals with sufficient expertise and experience. Where opinions or conclusions are of a professional nature, the person making them should be clearly identified.
12. It is my opinion that the application also fails to address several subsidiary tasks and permits that should be evaluated prior to award of the NRC license (for instance, the wetlands determination).
13. In summary, I believe there are several main questions that need to be answered in a NRC license application, the answers to which are not included in Strata's application. Specifically, Strata needs to 1) statistically define pre-operational baseline water quality, both on-site and in the potentially-impacted perimeter; and 2) fully disclose and analyze impacts related to the amount of water that will be consumed by operations per year and over the lifetime of the Lance project; 3) fully disclose and analyze impacts related to the sources and causes of water and hydrogeologic interactions of water-bearing units in the long-term; 4) fully disclose and analyze impacts related to the aquifer restoration criteria; and 5) fully disclose and analyze impacts related to the cumulative impacts that will result from past, present, and reasonably foreseeable future actions. Without answering these questions it is my professional opinion that the NRC will not be able to determine whether approving the

Strata project will adequately protect public health, safety, and the environment pursuant to NRC obligations.

Specific Comments

[Note: all page numbers cited refer to the number on the printed page, not the counter on the electronic files.]

The Application Fails to Adequately Characterize Site Disturbance from Past Exploration and Test Activities—Historic and Recent

14. The Application states in numerous places that thousands of exploration boreholes were drilled on the Ross site and throughout the Lance area during the 1970s and other time periods and that a pilot plant conducted test leaching / extraction activities from 1978 to 1979 (ER, pg. 3-10).
15. It is required in ISL License Applications to include detailed tabulations on all historic boreholes, including locations, dates of drilling, depth drilled and abandonment details. NUREG 1569, pg. 2-5 states that the site characterization related to water should include a map of abandoned wells and "The locations of abandoned wells and drill holes, including the depth, type of use, condition of closing, plugging procedure used, and date of completion for each well or drill hole within the site area and within 0.4 km [.25 mi] of the well field boundary." While there is some discussion in the application disclosing exploration boreholes, the application is deficient in meeting the requirements to fully disclose the wells, their status, and their impacts.
16. Importantly, the application is deficient because it never discloses the precise number of boreholes drilled in pre-Strata times. There are various numbers presented in different parts

of the Application. For example, within a 0.5 mi. radius of the Ross site, the following numbers are given:

- ER, pg. 3-47 reports 1,115 surveyed drillholes and 962 unsurveyed drill holes. (It is unclear whether this includes both Strata and pre-Strata drillholes);
- TR Addendum 2.6-B, Table1 reports 1,483 Nubeth holes within the Permit Area and 199 Nubeth holes within the 0.5 mile "buffer" and 1,952 total holes within the Permit Area and 270 within the 0.5 mi. "buffer." (It is once again unclear whether these numbers include pre-Strata drillholes).

17. Meanwhile, Peninsula Energy's (Australian parent of Strata) website reports 5,036 drillholes constructed within the Lance project, which includes the Ross Project.[2] This is clearly more holes than were considered in Strata's license application.

18. In addition to confusion about the number of boreholes, several locations in the Application confusingly summarize the fate of the boreholes [i.e. TR Addendum 2.6-B, Table 1; and TR Addendum 2.6-E] and raise more questions than they answer.[3] Importantly, nowhere in the application is there a complete description of the status of the boreholes and information necessary for a regulator to determine that there were properly plugged and abandoned and thus will not create pathways for water contamination. TR Addendum 2.6-E, pg. 1, states that "Details on the Nubeth boreholes are tabulated in Appendix A of this Addendum. Documentation on the abandonment practices of the majority of the boreholes was not available." Appendix A is not included in any of the Application documents, as was confirmed after talking with the project manager for WWC, the main consultants to Strata. Two possibilities for this important data are (1) that it was included in previous drafts and

[2] http://www.pel.net.au/projects/lance_project__wyoming_usa.phtml
[3] For clarity these two addenda should have been combined—as is the case throughout the Application.

subsequently removed for some reason; or (2) the information simply no longer exists and Strata does not have the information to demonstrate that the boreholes were properly abandoned. Either way, Strata should be required to come back and discuss the location and status of the boreholes.

19. Strata's application downplays the significance of the boreholes without sufficient support. At ER, pg. 4-63, Strata states without sufficient basis that "Given the relatively small borehole diameter used for exploration and delineation, little water would be capable of migrating through one or more of these conduits." Such a statement is clearly without support and fails to consider the presence of thousands of potential pathways (open or ineffectively plugged boreholes) leaking over decades.
20. In my experience, the plugging and sealing materials used to abandoned boreholes and wells (bentonite, cement, gels) all begin to deteriorate many years after emplacement. It is also common that wells and boreholes are incorrectly or imperfectly abandoned in the first place (URS, 2006). In the present situation, we don't know the details, but we do know that at least hundreds and probably thousands of these Ross-Lance area boreholes have remained open for several decades, allowing mixing of waters between water-bearing units. Until these wells are located and shown to be sealed properly, they will continue to serve as a conduit for fluid migration and inter-mixing of the aquifers.
21. Given the operation of the ISL test plant in 1978-79, it seems inevitable that Nubeth leach solutions mobilized high concentrations of cations, anions, metals / metalloids and even some organic compounds between the ore zones and the proximate strata, both vertically and horizontally.

22. The significance of this is that the various geologic strata in the Ross / Lance region have been perforated by at least 5000 boreholes through the activities of Nubeth and Strata. It is unclear whether other companies also drilled in the area in pre-Strata times, possibly prior to the 1970s. Many of the historic boreholes have never been located by Strata and of those that have been located, many have not been correctly plugged and abandoned. Hence, the open boreholes provide potential pathways for the movement of ground water and solution fluids between the various water-bearing strata and the inter-fingering finer-grained sediments, both vertically and laterally. It is clear that original baseline ground water quality (pre-Nubeth operations) would have been negatively-impacted by the pilot ISL testing and the presence of the open boreholes, and that many of these impacts are present today. Thus there is much less certainty that Ross site ground waters and leach solutions can be as completely contained as is alleged throughout the Application.

The Ross water-bearing units are hydrogeologically interconnected with potential pathways for fluid migration

23. The Ross area sediments are composed of interfingering fluvial-deltaic sediments (Buswell, 1982), commonly referred to as facies rather than traditional geologic formations. (Fisher, et. al., 1969; Galloway, 1982). Such interfingering environments are the typical hosts for sedimentary uranium deposits. In many such settings, the water-bearing units are hydraulically interconnected, as has been demonstrated by long-term aquifer testing combined with water quality solute and isotope testing. (i.e. Galloway, 1982; Henry et. al., 1982; Moran, 1976).

24. The Ross Application repeatedly alleges that the site aquifers are hydraulically isolated from each other, meaning that vertical leakage and fluid migration will not occur, because of the presence of fine-grained sediments above and below these aquifers. Unfortunately, Strata fails to demonstrate such hydraulic isolation. Rather, the evidence presented in the Application demonstrates the reverse.

25. First, TR pages 2-151 and 152 report that three water supply wells (for oilfield water flood uses) on the Ross site have pumped continuously from the uranium ore zone (the OZ unit) since 1980 -- for more than 30 years. Thus we have the equivalent of a 30 year-aquifer test performed at relatively low pumping rates. TR pg 2-157 estimates the total yield from the three oilfield wells to be 30 gpm.

26. Interestingly, Strata estimates (based on computer simulations) that water levels in the OZ unit have declined roughly 150 feet in the area of the oilfield water supply wells as a result of the 30 years of pumping.[4] Similarly, Strata estimates that water levels in the SM unit have declined roughly 10 feet during this 30 year period. The most obvious explanation for these declines is that the confining strata between the OZ and SM units allow vertical leakage of ground water under such long-term pumping conditions. It is totally unreasonable to conclude that such water level declines would result from compression of the intervening sediments.

27. Several other lines of evidence indicate that these water-bearing units are hydraulically connected. 1) the lithology of the SM unit is discontinuous (TR, pg. 2-152) and it is likely that the detailed lithologies of several of the other units are also discontinuous; and 2) Strata

[4] Two of the oilfield water supply wells pumping from the OZ (ore zone) aquifer were originally Nubeth R & D wells. They had maximum estimated drawdowns of 176 feet and 158 feet (ER p. 4-64).

states that "….the SM unit does not behave as a single aquifer and vertical gradients are present." (TR pg. 2-152).

28. In my experience, almost all aquifers leak if pumped for extended periods of time (i.e. years) at high rates (i.e. Freeze and Cherry, 1979; Kruseman and DeRidder, 1979; Todd, 1976). On pg. 320, Freeze and Cherry state: "Even when production wells are screened only in a single aquifer, it is quite usual for the aquifer to receive a significant inflow from adjacent beds."
29. Strata conducted seven pumping tests, six of 24 hour duration and one of 72 hour duration (TR, Addendum 2.7-F), all having low pumping rates (between 2.3 and 14.9 gpm). Such testing is adequate for calculating theoretical hydraulic parameters, but these durations are far too short and the pumping rates far too low for evaluating whether leakage occurs between the water-bearing units. More importantly, if Strata actually wanted to answer the question of whether aquifers are hydrologically connected and can result in fluid leakage and migration, they should have collected water quality measurements and samples (*in-situ* field and laboratory solute and isotope samples) throughout the duration of the aquifer testing. (Moran, 1976; Mazor, 1991). Interpretation of such data allows one to identify leakage of flow and chemical constituents from one unit to another. No such combined pump testing / water quality evaluations were performed or presented in the Application.
30. The Application is unclear regarding the total volumes of ground water that will be extracted during the various operational and recovery periods (see later discussions). Nevertheless, it is clear that Strata plans to extract hundreds of gallons per minute of local ground water during the Ross Project, which will undoubtedly result in leakage between the water-bearing units.

31. Nevertheless, throughout the Application, Strata contends that no leakage occurs or will occur. Despite such promises, Strata appears to want to take both sides of the argument. On ER, p. 4-61 they state in somewhat tortured language: "Water quality impacts to the vertically adjacent SM and DM aquifers, though isolated from the ore zone by natural conditions, could potentially occur through a compromise of the confining intervals. The geologic modeling and hydrologic testing conducted to date indicate no natural conduits are available for vertical migration of uranium recovery fluids. However, an improperly abandoned borehole or an improperly sealed well could introduce injected lixiviant into a vertically adjacent non-exempt aquifer." As was described previously, thousands of exploration boreholes and wells have been drilled in the Ross area. Many were undoubtedly drilled through multiple zones interconnecting the various water-bearing units. Clearly, many of these boreholes / wells have never been located or correctly plugged and abandoned. These open boreholes provide more direct pathways between the water-bearing units, in addition to the other leakage routes.

Changes to Water Quality from Baseline Conditions Have Already Resulted from Exploration Drilling, ISL Test Operations and Associated Construction

32. My applied experience with exploration / well drilling and associated ground water quality monitoring, plus numerous technical studies I have reviewed clearly indicate that such activities alter the original, baseline ground water quality conditions. Exploration drilling alters the baseline chemical conditions via the following actions: 1) introduces oxygen and other atmospheric gases formerly lacking, or at low concentrations; 2) drilling grinds up and fractures the subsurface rock / sediments, increasing the surface area available for chemical reactions; 3) introduces numerous forms of bacteria which can change the rates of chemical

reactions in the borehole (i.e. iron-reducing / sulfate-reducing / nitrifying, etc.; 4) changes down-hole Eh-pH conditions; 5) alters the pressure conditions in these subsurface zones; and 6) creates interconnections of subsurface water bearing zones formerly separated.

33. All of the above factors alter the chemical reactions occurring in the borehole, both on the walls of the borehole and out to a radius of many feet outside the borehole. These changes generally increase the concentrations of dissolved and total (particulate) chemical constituents in the local ground waters.

34. I have reviewed over the years numerous literature sources that describe and support the sorts of biogeochemical changes to ground waters described above: Abitz (2003), Abitz and Darling (2010), Chapelle (1994), Freeze & Cherry (1979), Gotkowitz, et. al. (2004), Hem (1989), Leybourne et. al. (2009, 2010), Moran (1976), Ripley and others (1996), Rose, Hawkes & Webb (1979), Sass (2011).

35. At TR, pg. 4-7, Strata states that Non-AEA-regulated liquid wastes will include TENORM wastes (technologically enhanced naturally occurring radioactive materials). "TENORM liquid waste includes drilling fluid and 'native' groundwater generated during construction and development of monitor, recovery and injection wells…" However, as described above, the drilling of thousands of exploration boreholes plus the leaching and recovery activities related to the Nubeth pilot operations, have already altered the previously undisturbed, baseline ground water quality conditions. Thus, portions of the Ross site ground waters no longer have the chemical characteristics of "native" ground water; thus, they should not be considered as representative of baseline or TENORM.

The Application Fails to Adequately Define and Characterize Baseline Conditions

36. The word baseline is used hundreds of times throughout the Ross Application. Nevertheless, baseline conditions for water resources at the proposed Ross site are never adequately defined or characterized. It is clear that Strata prefers to be held to two general definitions of baseline conditions: 1) those conditions existing when field activities occurred in support of the Application preparation (roughly 2009-2010); and 2) conditions that will be defined after NRC license approval, construction and further monitoring.

37. For the reasons discussed below, the Ross Application discussions of "baseline" largely confuse and confound the categories of historic and recent baseline, and site-specific and regional baseline.

38. Strata's approach contradicts NRC guidance (NUREG-1569), which requires that pre-mining baseline conditions be defined before licensing (NRC, 2003, pg. 2-24). As discussed in the previous section, the Application makes clear that this site has already been significantly disturbed through the drilling of thousands of exploration boreholes and wells, construction and operation of a pilot ISL operation during 1978 and 1979, which involved injection of lixiviant into the ore zone, pumping of production and recovery of the various solutions, and related construction. All such historical (pre-Strata) baseline water quality and water level data should be provided as part of the NRC Application, including sampling locations that should be clearly shown on appropriate maps and data that should be summarized in tables and where appropriate (such as with water quality data) statistically summarized.

39. Importantly, the application is deficient because no detailed data (pre-Strata) are included or statistically summarized in either the TR or the TR Addenda.[5] Incidentally, the addendums to the TR contain information that could be used to describe and interpret pre-mining baseline water quality but it is not presented as doing that. TR Addenum 1.2-A contains correspondence between the State of Wyoming and NRC regulators and the Nubeth Venture partners regarding the Sundance Project (Nubeth). TR Addenum 1.2-A, pg. 12—16, is a Memo (June 9, 1983) to Docket File No. 40-8663 from Ted Johnson, Project Manager, Uranium Recovery Field Office. This memo discusses the existence of baseline data for several wells, and that in a 1980 Nubeth report reviewed by NRC, additional restoration was needed "…because levels of arsenic, molybdenum, selenium, vanadium, and uranium exceeded baseline values." Hence, detailed pre-Strata baseline water quality data – both before and after the Nubeth project - obviously do exist, but have not been analyzed in the Ross Application.

40. In my experience with and interacting with numerous federal, state and international agencies on mining and other resource-related issues, baseline conditions represent conditions that act as a "yardstick" or criterion against which future conditions can be compared. Baseline water

[5] On TR pg. 2-171 and 172, the Application claims that data from 9 Nubeth wells are "summarized in TR Table 2.7-52. This table simply confirms that these 9 Nubeth wells were sampled from 4/1978 through 10/1981 (or 4/1980). No water quality data are presented. A following table, TR Table 2.7-53 reveals that the well waters were mostly of a sodium sulfate type, with one being dominantly sodium bicarbonate type. This table also presents concentrations for each well of Gross Alpha, Radium-226, and uranium; single values only for each well. No other Nubeth ground water quality data are presented here. Moreover, TR Table 2.7-23 identifies 80 wells (registered and unregistered) within 2 miles of the proposed project that have historically made use of local ground waters. However, on TR pg. 2-156, the application states that 14 monitor and industrial wells were permitted for the Nubeth operations. It seems likely that many of these wells and the neighboring private wells (those shown on TR Fig. 2.7-23) were previously sampled as part of the 1978-79 Nubeth efforts, but these historical data are not included in the Application---but should be.

The Nubeth test operations occurred in 1978-79, which was at the height of environmental reporting following the passage of the Clean Water Act in 1972. It is clear that the Nubeth partnership would have collected and maintained significant quantities of environmental data [water quality, water quantity (hydrogeology, pump tests, water levels) facility soil chemistry, etc.] as well as exploration data and reports. Detailed pre-Strata data are not presented in the Ross Application.

conditions are usually interpreted as conditions existing prior to the beginning of any significant industrial activities. If the NRC were to disregard the pre-Strata (Nubeth) baseline data, it would be equivalent to approving continued degradation of the earlier site water quality and to some extent quantity conditions. Therefore, the NRC should consider baseline for the purposes of determining restoration targets as pre-Nubeth conditions.

41. Moreover, it is likely that many of the recent wells (clusters) have water quality impacted by previous exploration and test activities and inadequate abandonment procedures. Hence, many of the conclusions presented in the Application are largely irrelevant without discussion of this past activity.

42. In addition to failing to consider pre-Strata water conditions, the Application also fails to properly characterize current water conditions. The Application claims that Baseline Groundwater Quality data are summarized in TR Addendum 2.7-I, but this table contains only data from Strata-collected samples (from industrial, stock and domestic wells) in 2009 and 2010. None of these Strata data are summarized in a meaningful statistical manner (i.e. showing for each constituent, by well: (n)—number of values; minimum, maximum, median, mean). Clearly, where the site (n) equals only two or three, the mean or median is essentially meaningless, statistically. The TR presents a table inadequately labeled "Table 2.7-29. Cluster Well Water Quality." It fails to tell the reader which wells were sampled, on what dates, and identify whether they were Strata wells or pre-Strata wells. The table also fails to identify the number (n) of samples used to construct the concentration ranges presented. One can only assume that the data summarized in Table 2.7-29 are the same Strata well data presented in TR Addendum 2.7-I, but it is unclear from the document.

43. In addition, only dissolved concentrations (filtered samples) are presented in Addendum 2.7-I for the majority of the minor constituents (except for iron and manganese). This totally misrepresents the water being used for domestic, stock and industrial purposes as humans don't consume water filtered through a 0.45- micrometer membrane filter. It simply presents a body of data having artificially low concentrations when compared to water actually used and consumed.

44. The application is also not clear in identifying how previously monitored wells will continue to be tested and monitored throughout the life of the project. TR Figure 2.7-14, TR, pg. 2-156, is titled "Regional Baseline Groundwater Monitoring Network." On the contrary, this map covers predominantly the *site-specific portions* of the proposed Ross project. The Application is not clear as to precisely which wells be monitored, both the on-site Strata wells and the buffer zone wells (within 2-miles of the project boundary). In order to be meaningful, future monitoring should include many of the wells previously monitored during both historic and Strata Application monitoring. Otherwise, Strata will be using different wells to determine post-mining water quality than they used to determine pre-mining water quality.

45. In my opinion, in order to have a technically sufficient application, Strata must collect and analyze unfiltered samples, as a minimum, for baseline ground water evaluation. These provide a more accurate and properly conservative characterization of the ground waters, because waters used in rural areas (human and livestock consumption from wells, other agricultural uses, irrigation, and fisheries) are not filtered. Furthermore, contaminants carried in particulate form are ingested by humans and other organisms when consuming unfiltered waters. These particles / colloids are dissolved by the extreme biochemical conditions found

in the guts of such organisms, mobilizing the contaminants into the blood and other tissues. In addition, many trace constituents are mobile in ground waters as colloidal particles (McCarthy, 1989; Ramsey, 2000, Slowey et. al., 2007, Crancon et. al, 2010), which would be removed by filtration, generating unreasonably-low concentrations.

46. The application is also deficient because a baseline spring and seep survey is not presented in the application. TR pg. 2-134 states that springs were identified near Oshoto Reservoir and several others were noted on the USGS quadrangle map, but these were more than 0.5 miles from the project area so their locations were not verified. The Application further states springs occur about 7 miles to the north of the site where the Lance and Fox Hills Formations outcrop. Thus these springs are potentially in direct hydrologic connection to the Ross ore zone. It is imperative that a detailed spring and seep survey within at least a 2-mile distance form the project boundary be performed which would: locate and map all spring locations, measure spring discharge, and collect and analyze samples from all springs. These activities should be performed at least quarterly for a year prior to permit approval.
47. Further, the application is deficient because soil contamination (radiation and metals / metalloids) from past mining and exploration data are not incorporated into determining baseline.
48. Strata has also inadequately defined the existing conditions of the soils and shallow ground waters within the proposed plant area. The Application presents no historical data (pre-Strata) on detailed soils or shallow ground water chemistry. On TR pg. 2-167 the application describes water quality samples taken from piezometers installed by Strata, but fail to mention the presence of actual monitoring wells in the plant area. Ground water (shallow) quality data from the plant area piezometers are presented in TR Table 2.7-43. These data are

not compared to the water quality data from the shallow aquifers. More importantly, Strata states that the total dissolved solids (TDS) in piezometer SA43-18-2 was between 4190 and 7280 mg/L (TR p.2-167) and also had high gross alpha concentrations. *These results (and others, such as elevated specific conductance (SC), chloride, sulfate, uranium, selenium, radium, etc.) suggest that these shallow ground waters below the plant area are already contaminated from past operations or recent activities. Such data should not be considered as representative of baseline conditions.*

49. Strata also needs to include water testing results from areas below and near proposed evaporation ponds that may leak and contaminate shallow aquifers.

50. The Application presents inconsistent approaches to defining the present use of local ground waters and thus determining baseline water quality. TR p. 2-156 says Strata evaluated ground water use in the project area and surrounding 2-mile (3.2 km) area. However, on TR p. 2-168, it says: …operable water supply wells were identified within a 2 km (1.2 mi) area.

51. TR Addend. 2.9-A, p. 26, states that Strata followed NRC Regulatory Guide 4.14 to monitor wells. Regulatory Guide 4.14. is available at http://pbadupws.nrc.gov/docs/ML0037/ML003739941.pdf. It is a 1980 document related to surface uranium mills and largely irrelevant to in-situ uranium mining and milling. In contrast, NUREG 1569 (US NRC, 2003), which is directly related to in-situ mining and clearly relevant to Strata's application, at pg. 2-4 states:

> "The staff should also review tables showing, for each of the 22½-degree sectors centered on each of the 16 compass points (i.e., north, north-northeast, etc.), the distances {to a distance of 3.3 km [2 mi]} from the center of the site to the nearest resident and to the nearest site boundary.
>
> The staff review should include the location, nature, and amounts of present and projected surface-and ground-water use (e.g., water supplies, irrigation, reservoirs, recreation, and transportation) within 3.3 km [2 mi] of the site boundary {0.8 km [0.5 mi]

for research and development operations} and the present and projected population associated with each use point.

The reviewer should determine whether the application provides sufficient information on the use of the lands and waters within a 3.3 km [2 mi] distance from the site boundary surrounding the proposed facilities {0.8 km [0.5 mi] for research and development operations} to assess the likely consequences of any impacts of in situ leach operations on adjacent properties.

The staff should determine that the application contains the location of residences, ground-water supply wells, surface-water reservoirs, and the estimated use of water in the lands surrounding the site of the proposed facility. Data sources should be referenced. This information should be evaluated to determine whether it is sufficient to delineate the likely impact(s) of the facility, under both normal operating conditions and accidents, on the ground water, surface water, and population (both human and animal) near the site. The reviewer should determine that within 3.3 km [2 mi] from the site boundary, the nature and extent of present and projected water and land use and any other trends or changes in population or industrial patterns have been reported. Any other nuclear fuel cycle facilities located or proposed within an 80-km [50-mi] radius of the site should be identified."

52. At pg. 2-5, NUREG -1569 further states: "A 3.3-km [2-mi] distance from the site boundary is an acceptable area for which land and water use data should be collected."

53. Given these NRC guidelines, Strata should have evaluated and sampled all wells within a distance of at least 2 miles from the site boundary, and should have included pre-Strata baseline data for all wells within such an area. The Application fails to present *detailed* water quality data for all **functioning private wells within the 2-mile buffer zone** (i.e. as shown on TR Fig. 2.7-26). These summaries should include **both recent Strata and pre-Strata data** including: detailed water quality, water levels and well yields. Where adequate data are available, the Application should present detailed maps portraying changes in the local water levels through time, using both historic and recent data.

54. Because the closest private well is only 0.12 mi. (TR, pg. 2-170) outside the Ross Project boundary, it is imperative that the long-term trends in detailed water quality and water level measurements for these private wells be available to the public and regulators. Clearly it is possible that the water quality of some of these wells may already have been impacted by the previous (pre-Strata and Strata) drilling and test activities.

55. Without detailed baseline data (based on both historic and recent Strata data) on ground water quality and well water levels, there will be no reliable criteria for determining whether changes have occurred in the future during and after the various Strata operations. Also, there would be no reliable method for stating what Strata actions caused such changes in the future. This missing critical information makes it impossible for the NRC to determine whether the public health and safety will be protected during the project.

56. In my opinion, without all of this information, Strata has been unable to adequately define the presence of high-quality ground waters within the Ross Project boundary and therefore does not have appropriate baseline measurements, both within the project boundary and outside, that can be approved in a license application.

Project Water Use: The Ross Project will Use Significant Volumes of Ground Water and Will Impact Water Levels and Availability

57. Despite assurances to the contrary stated in the application, the proposed Ross ISL project can, and likely will have negative impacts on ground waters surrounding the site. Potential impacts are mentioned in the ER, Section 4.4 and in the TR, Section 7.2. Potential declines in water levels in surrounding wells are summarized in ER Table 4.4-2. Such declines may or may not occur in these and other wells. There is a great deal of potential error in the use of

such computer models and their assumptions. In my experience, such predictions made in environmental permit documents are generally far too optimistic (see later discussion).

58. The Ross Application fails to clearly answer the following question: How much water will be used by all proposed Ross operations in the long-term? The Application presents differing volumes in different portions of the Application. These variations likely result from the great uncertainty in many of the operational details (see subsequent discussion) to be selected. Nevertheless, these differences should be clarified and rectified prior to NRC permit approval.

ER Table 4.4-3 presents *estimates of consumptive use* of water during all phases (ER, p. 4-73) as follows:

Operations: 62 gpm

Concurrent Operation & Aquifer Restoration: 227 gpm

Aquifer Restoration: 190 gpm

Calculating the consumptive water usage for longer periods of time we obtain:

Max. Amount Consumed (gpm)

Operations: 62 gpm = 89,280 gpd = 32,587,200 gpy. Assuming 10 yrs. = **325,872,000 gals.**

Concurrent Operation & Aquifer Restoration: 227 gpm = 326,880 gpd = 119,311,200 gpy. Assuming 10 yrs. = **1.19 billion gals.**

Aquifer Restoration: 190 gpm = 273,600 gpd = 99,864,000 gpy; assume 10 yrs. = **approx. 998 million gals.**

59. However, another perspective on the volumes of water to be used is presented in the TR, pg. 3-1 and 3-2. Here it reports that the Production Area (wellfields and CPP) will have a maximum recovery flow of 7,500 gpm. The ER further states that the maximum restoration

flow is 1,100 gpm. And then a third perspective on the volumes of water to be used is presented in the estimated project Water Balance, shown in ER Figs. 4.13-1 thru 4.13-3 and TR Figs. 3.1-11 thru 3.1-13. Some details on these water balance figures are unclear, but again they assume a maximum source flow of 7,500 gpm during the Operations phase.[6]

60. Essentially all of these volumes of water will come from pumping local ground water sources. The Ross-Oshoto area is extremely dry, with average annual precipitation being about 12 in. per yr. (TR, p. 4-23). Therefore, most rural residents most likely rely upon ground water for domestic and livestock purposes. ISL projects will be able to pump tremendous volumes of ground water rapidly, but with such low precipitation, recharging the aquifers and recovery of local water levels may require much longer periods of time than are predicted in the Application, especially if numerous other ISL projects are approved. Hence, it is imperative that the public and regulators have reliable, *conservative* information for the predictions of water level declines around the perimeter of the proposed project.[7] Similar information on cumulative volumes pumped and cumulative predicted water level declines with cumulative predicted aquifer recharge rates should also be presented assuming that several additional phases of ISL uranium development occur within the regions surrounding the Ross Project (i.e. the neighboring Lance areas). Such cumulative simulations would provide a more conservative picture of the actual stresses likely to occur in the region.

61. Long-term ISL operations are likely to lower water levels in the shallow aquifers (both confined and unconfined), causing surface springs and seeps to go dry. Unfortunately, I see no evidence that Strata preformed a detailed seep and spring survey throughout the region.

[6] Strangely, Strata has presented these Water Balance figures within TR Section 4.2 Liquid Waste, more specifically in a subsection entitled "Permeate Disposal Water Balance" (TR, p. 4-19). A more transparent approach would have presented these water balances within a "Water Use" section.

[7] While Strata's Application discusses some potential declines in water levels in surrounding wells in ER Table 4.4-2, this information is nowhere near sufficient for a full cumulative impacts analysis.

Hence, there would be no way to relate potential future impacts to any ISL operations activities, or any other activities. Such surveys are routinely performed as part of environmental impact assessments, and when correctly performed, identify (and map) the locations of such springs / seeps, measure flow volumes throughout the various seasons and collect spring water quality samples, identifying the detailed water quality characteristics throughout the various seasons.

62. Apparently the NRC does not regulate the total volumes of ground water an ISL project can use, throughout the operation of the project. If correct, the Ross Project could pump unlimited volumes of ground water from the local aquifers. Even if the NRC does not limit ground water consumption, the application should disclose the total consumptive amount in the environmental report because it will need to be analyzed by the NRC through its National Environmental Policy Act analysis. Consumptive amounts should be estimated for both operational periods and restoration, as needed to restore water to pre-mining quality as required by the NRC's primary restoration standards.

63. In my opinion, Strata's application unreasonably relies upon assumptions and computer model simulations to project impacts. There is a great deal of potential error in the use of such computer models and their assumptions. In my experience, such predictions made in environmental permit documents are generally far too optimistic and do not reveal the whole story. For instance, ER, p. 4-63, states that Strata's ground water model predicts that, as a result of Ross Project operations, maximum water level declines in the SM aquifer within the permit boundary would be 5 to 15 ft. However, the reader is left wanting to know what the declines in this and other local aquifers out to a radius of 2 miles from the project boundary will be, as required to be disclosed in the application.

Potential Impacts to Ground Water Quality

64. The TR, p. 7-36, 37, and section 7.2, and the ER, Section 4.4, describe possible impacts to private wells outside the project boundary---potential impacts to well yields, declines in water levels, and degradation of water quality. As discussed in other sections of this report, there will be no way to reliably demonstrate that such impacts have occurred without reliable baseline data on ground water quality and related water levels---using both historic and recent data. It is naïve to rely simply on the predictions coming from company-developed computer simulations.

65. I have reviewed decades of technical literature relating to uranium mining, both traditional and ISL, which make it clear that sediments containing uranium also contain elevated concentrations of numerous chemical constituents (i.e. Gabelman, 1977; Deutsch, et. al. 1984). Once leach solutions react with the ore-bearing and surrounding rock and sediments, the pregnant solutions mobilize elevated concentrations of numerous trace elements, anions, cations, and organic compounds. Selected constituents of concern in leach solutions because of potential toxicity to humans, livestock, fish, wildlife and agriculture are: uranium, molybdenum, vanadium, selenium, arsenic, copper, lead, radium, thorium, strontium, lithium, and others. (i.e. Mudd, 1998; Hall, 2009). Many of these constituents form chemical complexes that are mobile in both acidic and alkaline environments (Hem, 1989). As such pregnant leach solutions can readily contaminate surface and ground waters, soils, and vegetation if released into the environment. Strata should not make the same mistake as the NRC's Generic Environmental Impact Statement in presenting partial chemical composition data for pregnant leach solutions, (NRC (2009), pg. 2-16), as this implies that only a few

constituents are present at elevated concentrations. Instead, Strata needs to analyze all constituents that will be mobilized or released through the ISL process.

66. In reviewing the application, it is my opinion that Strata has not proposed anything differently that will limit the mobilization of trace elements. Strata is proposing to utilize the same technology that has resulted in contamination concerns at previous ISL mining sites. Even after ISL mining sites have completed restoration, these trace elements continue to be mobilized and are therefore present in greater levels than pre-mining conditions.

67. Since Strata is not proposing to do anything differently than previous ISL sites, it is likely that ISL mining at the Ross site will mobilize heavy metals and other toxic constituents. This will result in elevated levels of these constituents from baseline pre-mining conditions and will subsequently result in impacts to groundwater chemistry and quality. These impacts are un-mitigated in Strata's application.

68. In reviewing the literature and history of ISL mining, there is significant evidence that liners from evaporation ponds used to store waste from ISL projects will leak and cause possible contamination of shallow aquifers. It is my opinion that these possible impacts are not fully considered in the application.

69. There may also be water quality problems from liquid waste disposal. Much of the liquid waste will be disposed of via deep well injection (ER, pg. 4-66, 67) into (up to) 5 wells completed in the Deadwood and Flathead Formations. Strata has assumed that because these formations are deep and already contain high-TDS waters that no significant impacts can occur. However, numerous other regional energy-industrial projects—especially oil and gas projects disposing brines-- are also disposing their liquid wastes into these formations. The

Application fails to present any evidence that such cumulative, long-term disposal of large volumes of wastes into these formations will not result in long-term negative impacts.

Aquifer Restoration and Cleanup Criteria

70. The Application describes great uncertainty as to the actual, detailed procedures that will be employed for aquifer restoration and fails to adequately define the specific aquifer restoration criteria / standards. For example, ER, pg. 4-67—69 states: "Strata proposes to conduct aquifer restoration concurrently with operations where possible as the potential exists for the two phases to interfere with one another." Therefore, the exact timing of restoration activities is unknown. On TR, pg. 1-12, Strata states that the actual procedures for aquifer restoration are unknown and merely describes several possible methods. Without up-front review of restoration methods or criteria, it is impossible to know whether restoration will be successful and whether the NRC's primary restoration standard of returning water to pre-mining conditions will be achieved. In my opinion, the application is greatly deficient in this area and needs to be revised to contain a robust discussion about restoration techniques and success probabilities.

71. The Application does not clearly define the specific chemical constituents that will be sampled during aquifer restoration monitoring. More importantly, it fails to clearly define the specific chemical constituents / field measurements that will be used as aquifer restoration criteria, and their specific numerical limits. Any reasonable list of aquifer restoration criteria should be detailed and extensive.

72. Importantly, the technical and regulatory literature amply documents the numerous *failures to restore aquifer water quality at other ISL sites to pre-mining conditions*. Thus, because Strata is proposing to use the same mining and milling methods as other ISL sites, it is

reasonable to assume that portions of the ground water surrounding the leached zones will have degraded water quality and may be unfit for future uses.

73. Information from the Nubeth project shows that it may be difficult, if not impossible, to adequately restore the local aquifers. It is instructive to note that Nubeth testing ended in 1979, but aquifer restoration was not deemed to be completed until several years later in April 1983 when the Wyoming DEQ gave their approval. Final NRC decommissioning continued for three more years, from 1983 through 1986 (TR pg. 1-3). TR Addenum 1.2-A contains correspondence between the State of Wyoming and NRC regulators and the Nubeth Venture partners regarding the Sundance Project. TR Addenum 1.2-A, pg. 12—16, is a Memo (June 9, 1983) to Docket File No. 40-8663 from Ted Johnson, Project Manager, Uranium Recovery Field Office. This memo discusses the existence of baseline data for several wells, and that in a 1980 Nubeth report reviewed by NRC, additional restoration was needed "…because levels of arsenic, molybdenum, selenium, vanadium, and uranium exceeded baseline values."[8] As stated previously, the Nubeth tests and subsequent restoration activities occurred following Congress's passage of the Clean Water Act so it seems likely that much more extensive ground water quality and quantity data are available for the pre-Strata years at this site than is disclosed in the application.

74. Information from the Nubeth project also shows that there may be operational problems with conducting ISL mining at this location, which could translate to restoration problems down the road. TR, pg. 3-13 states: "While injectivity (sic) issues plagued the Nubeth R&D site….." This could indicate that the Nubeth operators over-pressured and hydro-fracked the

[8] Water quality in the aquifer / ore zone leached during the Nubeth testing in 1978-79 was never adequately restored for domestic, livestock or agricultural uses due to elevated gross alpha concentrations (TR, pg. 2-172). It is unclear whether the "restored" aquifer had elevated concentrations of other chemical constituents because the Strata Application (TR Table 2.7-54) presents only selected data on gross alpha, radium-226, and uranium. All other details on aquifer water quality are lacking.

field. According to information in the application, the Nubeth tests had limited success due to "…fines and organic material buildup in the wellfields…" (TR pg. 1-3). No additional details are given, but clearly the operators were not successful in developing a viable program---not entirely due to the drop in world uranium prices.

75. Throughout the Application, Strata repeatedly makes optimistic statements about assured aquifer restoration. However, attempts at aquifer restoration at other in-situ operations fail to support such optimism. Indeed, the historical reality from other operating or closed ISL sites demonstrates an inability to restore to pre-operational or baseline water quality conditions for all constituents. (Otton, 2009; Hall, 2009).

Future Uses of Ground Water – Failure to Consider Cumulative Impacts

76. Strata's application carves up the potential impacts into pieces, preventing the public and regulators from realistically looking at long-term, cumulative impacts. Here it seems short-sighted to evaluate only the potential impacts from long-term pumping of Ross Project ground waters. The long-term scenario presented by Strata clearly involves the possibility of developing several additional ISL projects adjacent to the Ross Project. All would require use of tremendous volumes of ground water for both operations and recovery.

77. The truly conservative approach – which should be required for this application – would require ground water simulations to be conducted combining the anticipated pumping from the operation of the Ross Project (assuming ground water extraction occurred at maximum anticipated rates) with those assuming the operation of several other nearby ISL operations. Numerous possible worst-case scenarios would be developed. Thus, water planners / regulators would receive much more useful information for deciding what volumes of local / regional ground water can be sustainably pumped, long-term.

78. In addition, it is only intelligent that those tasked with making long-term decisions regarding local ground water use foresee that uses of these waters may change drastically in the distant future---not simply 10 or 20 years in the future. Such uses may be quite different than the present predominant livestock and agricultural uses, and conceivably require high water quality. If local ground water quality is degraded by ISL operations, such alternative future uses may be precluded. Or, these ground waters might require treatment at public expense to allow these other future uses.

Problems with Water Monitoring Programs

79. On TR pg. 5-78 the application states that the monitoring programs will follow the details presented in TR Table 5.7-1. TR pg. 5-79 states that: "Existing private wells within two kilometers of the proposed project area boundary are to be sampled on a quarterly basis with the landowner's consent. Samples will be analyzed for the parameters listed in Table 5.7-2." This table also indicates that operational environmental monitoring for *ground water monitoring wells* will be limited to: dissolved uranium, Ra-226, Th-230, Pb-210, Po-210, gross alpha and gross beta. Similar monitoring of existing water supply wells will be limited to: dissolved and suspended uranium, Ra-226, Th-230, Pb-210, Po-210, gross alpha and gross beta. In my opinion, both suites are far too limited to provide a detailed understanding of possible impacts to ground water quality. TR Table 5.7-2 is much more extensive, but still largely neglects to include data from unfiltered (total) samples for most constituents. TR, 5-83 states that Table 5.7-2 constituents will be monitored for the first two quarterly sampling periods, and then the list may be reduced.

80. Monitoring samples need to be analyzed for a broad range of inorganic and organic compounds. Such analyses should include, as a minimum: field and lab pH, specific conductance, water temperature, together with total determinations (and in some cases dissolved determinations) of: aluminum, antimony, arsenic, barium, cadmium, copper, chromium, cobalt, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, zinc, calcium, magnesium, sodium and potassium, sulfate, nitrate, ammonia, boron, phosphorus, fluoride, chloride, and natural radioactive constituents (uranium, thorium, potassium-40, gross alpha and beta, in general), cyanide and related breakdown compounds (metal-cyanide complexes, cyanate, thiocyanate, organic carbon, oils and greases, together with a comprehensive scan for organic compounds.
81. No excursion parameters are discussed in the application. TR, pg.3-19 states that *excursion parameters* are presented in Sect. 5.7.8.1 However, *no detailed list of excursion parameters was found in that section.*
82. The application is missing field sample collection and handling details for ground and surface water quality, including bottles, preservatives, filtration, handling, etc. TR, pg. 2-289 says all ground water samples were collected according to SOP 9, in Addendum 2.9A [Radiological Sampling and Analysis Plan (RS&AP), Aug. 6, 2010]. This SOP is not actually mentioned in the Radiological Sampling Plan, nor is it listed in the Table of Contents, but follows the RS&AP. When one finally locates SOP 9, pg. 3 states: "Section 3.9 of the Sampling and Analysis Plan defines sampling locations and radiochemical analysis requirements for the preoperational baseline program." Thus, with no guidance as to page, the reader is sent back to the SAP---which presents almost no useful details on actual field sample collection and handling details. Section 4.3 of the RS&AP (p. 34) then states:

"Specific field sampling procedures for the program elements presented in this SAP are described in the SOPs which are provided in Appendix A." But there is no Appendix A. So, one returns to SOP 9, pg. 6: Sample Collection: Field measurements taken while purging well. However, that document also does not disclose the field sampling methodology. While the company claims that its procedures produced stable readings, from what I was able to review in the application, I do not think that is likely.

The Application Fails to Present Detailed Chemical Composition Data for Expected Process Fluids, Liquid Wastes, Pregnant Leach Solutions, Other Chemicals, and Ores

83. The Application needs to present *detailed* chemical composition data for barren and pregnant leach solutions. Application information presented at TR, p. 3-10 and Table 3.1-1 is insufficiently detailed to be meaningful. Thus, the actual detailed impacts that will result from leaching and mobilization of chemical constituents are not known.
84. The Application fails to provide details on the chemical composition of the liquid wastes to be injected. TR, Table 4.2-5 fails to present detailed chemistry of the brines. It seems likely that such details have been developed, as part of Feasibility Report testing that would have been performed to inform potential investors or as part of its state Underground Injection Control permit application.
85. Detailed chemical composition data for representative ores should also be included in the Application, so that one will be able to determine whether the proposed ground water monitoring will adequately sample for all relevant chemical constituents.
86. A detailed tabulation of all process chemicals, hazardous materials, fuels and explosives to be utilized during the life of the Ross Project should be compiled. The table(s) should

identify chemicals by common chemical names, and where appropriate commercial names; quantities / volumes for each to be used per year should also be included.

87. Full chemical composition data should be released, partly to allow regulators and the public to evaluate impacts that might result from potential spills of these liquids.

Other Uncertainties about Actual Project Operational Details

88. The Ross Project Application often presents large ranges of uncertainty when describing numerous proposed operational details. For example, TR, pg. 3-1 and 3-2 state that two mine units will be operated with estimates of modules between 15 and 25, each module estimated to contain approximately 40 recovery wells (TR, p. 3-11). However, elsewhere in the application, the total number of recovery / injection wells is estimated to be between 1400 and 2200.

89. Strata also expresses uncertainty regarding well placement and uranium ore zones. ER at 1-16.

90. Strata also estimates that they will produce 750,000 lbs of uranium per year but they are requesting a license application to produce 3 million lbs per year. ER, pg. 1-4.

91. TR, pg. 1-14 states that the final Facilities Engineering Report will be prepared later, presumably following NRC license approval. A "Site Operation Plan" detailing wellfield operations "that relate to protecting against and responding to any potential excursion from the recovery zone" will also be prepared "after issuance of the requested NRC license." ER, pg. 1-15.

92. Evaporation from lined retention ponds is calculated to be only about 1.5 gpm per acre of pond, thus evaporation ponds will not actually provide viable alternatives for disposing of permeate. TR, pg. 4-19. Nevertheless, they are proposed in the Application.

93. “By treating part of the injection stream, Strata hopes to help maintain the water quality of the injection solution.” TR, pg. 3-15. In order to receive an ISL license application, Strata should demonstrate that the water quality will be maintained, not just hope that it will be the case.

94. Despite the normal large degrees of error / uncertainty associated with various ground water models, the following comments regarding the Ross model simulations demonstrate that there is even more uncertainty than normal. 1) At ER, pg. 4-64-65 Strata states that many of the modeling results may not come to pass because of numerous uncertainties. Modeling simulations “…..do not include injection of lixiviant or RO permeate, only an average bleed (1.25%) from recovery wells…..” 2). At TR, pg. 3-15 and 16 Strata states that the Application has used a “one size fits all simulation.” Such uncertainty regarding project operational details should warn both the public and regulators that Strata’s pronouncements about the extent of expected impacts are also subject to a great range of error and uncertainty.

Prerequisites to NRC License Approval

95. The Application implies that Strata will perform numerous tasks and obtain subsidiary permits following issuance of the NRC license to Strata. These tasks / permits should be completed / obtained prior to NRC licensing of the Ross Project in order for the NRC to determine that the project will not cause harm to public safety or the environment. For instance, a wetlands determination permit (U.S. Army Corps of Engineers) approval should be evaluated prior to awarding an NRC license so the NRC will be able to determine that those impacts are appropriately avoided or mitigated.

Financial Assurance

96. The NRC and the general public know several general facts about the usefulness of most company-generated financial assurance estimates:

a) Financial assurance estimates generally are based on overly-optimistic assumptions about future water quality, thereby under-estimating costs. Kuipers (2000) conducted a survey of bonding practices at metal mines throughout the western U.S. and found that the bond amounts available were hundreds of millions of dollars below that necessary to conduct actual clean-ups. Many of the "problem" sites have been foreign-owned entities.

b) Aquifer restoration at most, if not all previously-licensed and operated ISL sites has failed to actually return ground water quality to baseline conditions [Hall (2009); Otton and Hall (2009)]. Nevertheless, since restoring to baseline conditions is the primary restoration goal, ISL facilities should be bonded for the amount it would take to do that restoration. ISL facilities are not often bonded for that amount.

c) Predictions of future aquifer restoration success made by the project proponents seldom use truly conservative assumptions. Calculations of financial assurance amounts made by representatives of the party that stands to profit from project licensing represent an extreme conflict of interest.

d) The technical literature is filled with documentation that quantitative predictions of future water quality at specific sites cannot be done reliably [Sarewitz, et. al. (2000); Moran (2000); Pilkey & Pilkey-Jarvis (2007); Kuipers & Maest (2006)], and the general failure to restore aquifers back to pre-operational baseline concentrations supports this. At an academic level, this approach must be totally rejected because it assumes one can make accurate and precise *deterministic* predictions.

97. For these reasons, the financial assurance calculations should be made by some independent party, not paid or directed by the project proponents. These calculations should also consider the actual reclamation and restoration costs incurred, long-term, from a statistical sampling of the previously-licensed ISL sites. Furthermore, these financial assurance amounts and mechanisms should be made public prior to award of any licenses.

98. To ensure protection of the general public, such financial assurance vehicles should be made with the parent corporation, not simply the local operating entity.

NRC Capabilities to Reliably Oversee Strata Activities and Importance of Agency Oversight because of Flawed Assumptions and Conclusions in the Application

99. The application (ER p. 4-55) implies that NRC oversight activities of ISL sites are detailed and efficient. However, I have heard from the NRC regional office in Texas that there are only 2 NRC staff available to inspect and oversee all ISL projects in the entire western U.S. This detail should be verified. In my opinion, the ability of the NRC to enforce its own regulations and license conditions is limited.

100. Nevertheless, the NRC's oversight role in this license proceeding is critical. Given the inherent conflict of interest in having the Application preparation directed, partially-prepared, and paid for by the project proponent, some independent party needs to take a more assertive oversight role, including in oversight of actual monitoring methods in the field. This is especially evident in the biased decisions made throughout these Application documents regarding aquifer isolation and baseline water quality and quantity decisions, as discussed below.

101. The Application frequently intends to show that existing water quality is already impacted; i.e. plant-area piezometers, leakage from SM unit wells, etc. Rather than explain data using science, the application focuses on arguments to minimize liability (i.e. it focuses on comparing water quality to various regulatory standards).

102. Unfavorable conclusions are often presented in disjointed fashion throughout several sections. Hence it is difficult to determine the actual impacts [i.e. role of "baseline" water quality for NUBETH wells (TR, p.2-169, 2-171, etc.); impact of improperly abandoned boreholes, etc.].

103. The Application states that no impact to nearby aquifers is expected, but the application discloses already seen impacts in SM wells. 30 yrs of oilfield well pumping at about 30 gpm (total) has dropped water levels in SM unit wells about 10 ft. Hence, leakage has occurred between the aquifers. Pumping from the OZ unit would actually have started in the late '70s. Thus, Strata has purposely avoided mentioning that the various geologic units surrounding the uranium ore zone leak.

104. In my opinion, the application contains numerous overly-optimistic discussions and explanations. For instance, ER, p. 4-67 refers to potential impacts to the surficial aquifer (SA) during restoration, but then states: "Water management within the central plant area will continue in a similar fashion during aquifer restoration, with utilization of the lined retention ponds for temporary storage of permeate and brine pending injection. Again, engineered controls utilized during operations will prevent impacts to the system."

Confusing Organization

105. The Ross Application is an enormous set of documents composed of the Technical Report (TR) plus Addenda (6 volumes) of more than 3577 pages and the Environmental Report (ER) composed of 3 volumes comprising 1206 pages.

106. Discussions of many of the topics are divided between several unrelated sections throughout the ER and TR so that the reader fails to receive a coherent picture of the topic. The data are not adequately summarized in tables and /or maps. The reader must wade through numerous sections of both the ER and TR and their Addenda, checking dozens of separate tables and maps, many of which could easily have been combined in order to realize that Strata has avoided answering the basic questions.

107. The Tables of Contents for both the TR and ER are insufficiently detailed to allow easy access to the important topics. The Addenda Tables of Contents have no page numbers for most portions. Many important addenda are "sequestered" in other addenda sections that are unrelated to the topic at hand and their presence is not listed in the Table of Contents. For example, what methods were employed for sampling and handling ground waters for naturally-occurring water quality constituents? Sampling methods are not mentioned in the Tables of Contents for either the ER or TR. The ER text makes no reference to such details, but, finally, in an unrelated section of the TR entitled Background Radiological Characteristics, (TR, pg. 2-289) one reads: "All groundwater sampling was completed in accordance with procedures outlined in SOP 9, provided in Addendum 2.9-A." This addendum is entitled: Radiological Sampling and Analysis Plan (SAP), with no mention of non-radiological constituents. This SAP contains no mention of SOP 9. On pg. 34 of the SAP (TR Addendum 2.9-A), it states: "Specific field sampling procedures for the program

elements presented in this SAP are described in the SOPs which are provided in Appendix A." No Appendix A is present! Finally, by paging through the entire Addendum 2.9-A one finds SOP 9 sitting unannounced at the back.

108. Often the titles of sections, addenda, tables and figures are unclear as to what is actually being described or portrayed. A typical example is TR Addendum 2.6-B, entitled: "Exploration / Delineation Drillhole Tabulation." As with so many other examples, the title is unclear about whether this is a compilation of pre-Strata or Strata-constructed boreholes.

109. These are only a few examples of the recurring disorganization and confusion that exist throughout the Application and which make comprehension of the main points unnecessarily cumbersome.

Summary

110. An official baseline data set for all site aquifers should be developed and presented publicly before NRC permit approval is given. These data should include (as a minimum) all pre-Strata and Strata data for ground waters, surface waters and surficial soils within a 2-mile area of the project boundary. All data should be statistically summarized by monitoring site, aquifer, etc. so that the reader can determine the number of determinations (n), and the minimum and maximum concentrations for these sites, median and mean concentrations (where appropriate). Such baseline data should similarly include the water quality and water level data (historic and recent) for all private wells within a 2-mile radius of the project boundary.

111. A complete sampling database of surface and ground waters, water levels, pump tests, soils, etc. should be compiled and made public prior to NRC license approval. These should include all historic and recent data. [ER, pg. 1-2 states: "The development of these wellfield

modules and the accumulation of a complete sampling database will begin when Strata is issued an NRC license……"]

112. Strata also needs to develop and identity aquifer restoration criteria / cleanup criteria / excursion criteria. Specific numeric criteria for these categories should be defined and made public prior to NRC license approval. If Strata does not intend to restore to pre-mining conditions and instead rely on Alternative Concentration Limits, those limits also should be defined and made public prior to NRC license approval.

113. Strata needs to present a detailed summary (in tabular form) of all exploration borehole data, both pre-Strata and Strata, showing all relevant completion, depth, and detailed abandonment information where available. The summary should clearly identify boreholes not located or not plugged and abandoned. TR, p. 3-20, 21 states: many exploration / delineation holes are still not located and correctly abandoned. This task should be completed prior to license approval to ensure that there will not be pathways for groundwater contamination.

114. Details regarding Financial Assurance should be made public prior to NRC license approval and should be based on the primary restoration goal of returning waters to pre-mining conditions.

I declare under penalty of perjury that the foregoing is true and correct, to the best of my knowledge, information, and belief.

Dated: 24 Oct. 2011

Robert E. Moran

Signature

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References Cited

Abitz, R.J., 2003 (Mar. 3), Declaration of Dr. Abitz, Before U.S. NRC, Atomic Safety & Licensing Board Panel, Administrative Judges, in Matter of: HYDRO Resources, Inc., Crown Point, NM; Docket No. 40-8968-ML.

Abitz, R.J. and Bruce Darling, 2010, Anthropogenic Reduced Redox Disequilibrium in Uranium Ore Zones; Geological Society of America Abstracts 2010, Paper 15-4; presentation at GSA National Meeting, Denver, CO, (31 October –3 November 2010).

Buswell, M.D., 1982, Subsurface geology of the Oshoto Uranium Deposit, Crook County, Wyoming; M.S. Thesis, South Dakota School of Mines; 212 pg.

Chapelle, F.H., 1994, Ground-Water Microbiology and Geochemistry; John Wiley & Sons, 424 pg.

COGEMA, 2003, Irigaray Project (IR), Quarterly Progress Report of Monitor Wells on Excursion Status, License SUA-1341.

Crancon, P., E. Pili, and L. Charlet, 2010, Uranium facilitated transport by water-dispersible colloids in field and soil columns: Science of The Total Environment, Vol. 408, No., (1 April 2010), Pg. 2118-2128.

Davis, J.A., G.P. Curtis (U.S. Geological Survey), 2007, Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities: U.S. NRC, NUREG / CR-6870.

Ecometrix Inc., Nov. 2008, A Review of Environmental Criteria for Selenium and Molybdenum: prepared for The MEND INITIATIVE; MEND Rept. 10.1.1.

Deutsch, W. J., N. E. Bell, B. W. Mercer, R. J. Serne, J. W. Shade, and D. R. Tweeton, 1984, Aquifer Restoration Techniques for In-Situ Leach Uranium Mines: NUREG/CR-3104 PNL-4583 RU; prepared by Pacific Northwest Laboratory for US NRC; 68 pg.

Fisher,W.L., L.F. Brown, Jr., A.J. Scott, J.H. McGowen, 1969, Delta Systems in the Exploration for Oil and Gas: a Research Colloquium; Texas Bureau of Economic Geology.

Freeze, R.A. and J.A. Cherry, 1979, Groundwater; Prentice-Hall, 604 pg.

Gabelman, J.W., 1977, Migration of Uranium and Thorium—Exploration Significance: American Assoc. of Petroleum Geologists, Studies in Geology No.1, 168 pg.

Galloway, W.E., 1982, Epigenetic Zonation and Fluid Flw History of Uranium-Bearing Fluvial Aquifer Systems, south Texas Uranium Province; Texas Bur. Econ. Geology, Rept. of Investigations No. 119, 31 pg.

DECL 50

Gotkowitz, M.B., M.E. Schreiber, J.A. Simo, 2004, Effects of Water Use on Arsenic Release to Well Water in a Confined Aquifer; Ground Water, Vol. 42, No. 4, pg. 568—575.

Hall, Susan, 2009, Groundwater Restoration at Uranium In-Situ Recovery Mines, South Texas Coastal Plain: U.S.G.S. Open-File Report 2009–1143, 36 pgs.

Harshman, E. N., 1972, Geology and Uranium Deposits, Shirley Basin Area, Wyoming; U.S.G.S. Prof. Paper 745, 82 pg.

Hem, John, 1985, Study and Interpretation of the Chemical Characteristics of Natural Waters, 3rd Edit.; U.S.G.S. Water-Supply Paper 2254, 264 pg.

Henry, C.D. and R.R. Kapadia, 1980, Trace Elements in Soils of the South Texas Uranium District: Concentrations, Origin, and Environmental Significance; Texas Bur. Econ. Geology, Rept. of Investigations No. 101; 52 pg.

Henry, C.D., W.E. Galloway, G.E. Smith, C.L. Ho, J.P. Morton, J.K. Gluck, 1982, Geochemistry of Ground Water in the Miocene Oakville sandstone—A Major Aquifer and Uranium Host of the Texas Coastal Plain; Texas Bur. Econ. Geology Rept. of Investigations No. 118; 63 pg.

Kruseman, G.P. and N.A. De Ridder, 1979, Analysis and Evaluation of Pumping Test Data; International Institute for Land Reclamation and Improvement, Bulletin 11, Wageningen, the Netherlands, 200pg.

Kuipers, J.R. (2000). Hardrock Reclamation Bonding Practices in the Western United States: National Wildlife Federation. Boulder, Colorado, U.S.A., 416 pgs. [This document and a summary can be obtained at: http://www.mineralpolicy.org/publications/pdf/Bonding_Report_es.pdf]

Kuipers, J.R. and A. S. Maest, et. al., 2006, Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements, 228 pages. Available at: http://www.mine-aid.org/ and http://www.earthworksaction.org/publications.cfm?pubID=213 http://www.earthworksaction.org/pubs/ComparisonsReportFinal.pdf

Leybourne, M.I. and E.M. Cameron, 2010, Groundwater in geochemical exploration; Geochemistry: Exploration, Environment, Analysis, V. 10; p. 99-118, Geological Society of London. http://geea.geoscienceworld.org/cgi/content/short/10/2/99

Leybourne, M.I., S. M. Hamilton, C. J. Mwenifumbo, W. D. Goodfellow and D. R. Boyle, 2009, Hydrogeochemical and geophysical evidence for borehole oxidation of massive sulphides below the water table and generation of self-potential anomalies; Geochemistry: Exploration, Environment, Analysis 2009; v. 9; p. 39-50; Geological Society of London. http://economicgeology.org/cgi/content/abstract/71/5/925

Mazor, Emanuel, 1991, Applied Chemical and Isotopic Groundwater Hydrology; Halsted Press, 274 pg.

McCarthy, J.F. and J. M. Zachara, 1989, Subsurface Transport of Contaminants: mobile colloids in the subsurface environment may alter the transport of contaminants. Environ. Sci. Technol.. Vol. 23. No. 5. Abstract available at: http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/1989/23/i05/fpdf/f_es00063a001.pdf?sessid=6006l3

Moran, R.E., 1976, Geochemistry of Selenium in Groundwater near Golden, Jefferson County, Colorado. Abstracts with Programs, Geological Society of America. 1976 Annual Meeting. November 8-11, 1976. 8(6):1018.

Moran, Robert E., 2000, Is This Number To Your Liking? Water Quality Predictions in Mining Impact Studies, p. 185-198, *in* Prediction: Science, Decision Making and the Future of Nature. D. Sarewitz, R. Pielke, Jr., and R. Byerly, Jr., eds., Island Press, Washington, D.C., 405 pg. http://www.unc.edu/~mwdoyle/riverretreat2009/Moran_2000.pdf

Mudd, Gavin, 1998, An Environmental Critique of In Situ Leach Mining :*The Case Against Uranium Solution Mining;* Research report prepared for Friends of the Earth (Fitzroy) with The Australian Conservation Foundation, 154 pg.
www.sea-us.org.au/pdfs/isl/no2isl.pdf

Otton, J.K., & S. Hall, 2009, In-situ recovery uranium mining in the United States: Overview of production and remediation issues.
IAEA-CN-175/87
www-pub.iaea.org/mtcd/meetings/PDFplus/2009/.../08_56_**Otton**_USA.pdf

O.H. Pilkey & Linda Pilkey-Jarvis, 2007, Useless Arithmetic: Why Environmental Scientitsts Can't Predict the Future;Columbia Univ. Press, 230 pg.

Ramirez, P. & B. Rogers. 2000. Selenium in a Wyoming grassland conmmunity receiving wastewater from an in situ uranium mine. U.S. Fish and Wildlife Service Contaminant Report # R6/715C/00. Cheyenne, WY. Sept. 31.

Ramirez, P. Jr. and B.P. Rogers. 2002. Selenium in a Wyoming grassland community receiving wastewater from an *in situ* uranium mine. Arch. Environ. Contain. Toxicol. 42:431-436.

Ramsey J.L., R. Blaine, J. W. Garner, J. C. Helton, J. D. Johnson, L. N. Smith and M. Wallace, 2000, Radionuclide and colloid transport in the Culebra Dolomite and associated complementary cumulative distribution functions in the 1996 performance assessment for the Waste Isolation Pilot Plant. Reliability Engineering & System Safety, Vol. 69, Issues 1-3, September 2000, Pages 397-420.

Ripley, E.A., Redman, R.E., and Crowder, A.A., 1996, Environmental effects of mining: Delray Beach, Florida, St. Lucie Press, 356 p.

Rose, A.W., H.E. Hawkes, J.S. Webb, 1979, Geochemistry in Mineral Exploration; Academic Press, 657 pg.

Sass, R.L., 2011, Uranium Mining in Texas: Why is it Done that Way?: James A. Baker Institute for Public Policy, Rice University, 330g.
http://www.bakerinstitute.org/publications/GCC-pub-SassUraniumMining-032811.pdf

Slowey, Aaron J., S. B. Johnson, M. Newville, G. E. Brown, Jr. , 2007,
Speciation and Colloid Transport of Arsenic from Mine Tailings: Applied Geochemistry, Volume 22, Issue 9; pages 1884-1898

Staub, W.P., N.E. Hinkle, R.E. Williams, F. Anastasi, J. Osiensky, and D. Rogness, 1986, An Analysis of Excursions at Selected In Situ Uranium Mines in Wyoming and Texas,; NUREG / CR-3967, ORNL / TM-9956, Oak Ridge Nat'l. Lab, TN.

Strata Energy, 2010, Ross ISR Project US NRC License Application, Crook County, WY, Environmental Report.

Strata Energy, 2010, Ross ISR Project US NRC License Application, Crook County, WY, Technical Report.

Todd, D.K., 1976, Groundwater Hydrology, 2nd Edit.; John Wiley & Sons, 535 pg.

URS, 2006, Phase I Hydrogeologic Characterization of the Mamm Creek Field Area in Garfield County [Mar. 23, 2006]. Available at:
http://www.oilgas.state.co.us/Library/PiceanceBasin/GarCo_PhaseI_Hydrogeo_Rpt/Final%20Report.pdf

U.S. EPA, 2007, TENORM Uranium Occupational and Public Risks Associated with In-Situ Leaching; Append. III, PG 1-11.

US EPA, 2008, Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining, Volume 1: Mining and Reclamation Background: Previously published on-line and printed as Vol. 1 of EPA 402-R-05-007, January 2006, Updated June 2007 and printed April 2008 as EPA 402-R-08-005, Pg. 3-10.
http://www.epa.gov/rpdweb00/docs/tenorm/402-r-08-005-voli/402-r-08-005-v1.pdf

U.S. Energy Information Administration (U.S. DOE), 2005, U.S. Uranium Production Facilities: Operating History and Remediation Cost Under Uranium Mill Tailings Remedial Action Project as of 2000
http://www.eia.doe.gov/cneaf/nuclear/page/umtra/title1map.html
http://www.eia.doe.gov/cneaf/nuclear/page/umtra/background.html

U.S. Fish & Wildlife Service, 2007, Comments (FWS/R6 FR-ES) on Generic Environmental Impact Statement for Uranium Milling Facilities (GETS); prepared for U.S. NRC, Wash., D.C.

U.S. Geological Survey, 1993, Understanding Our Fragile Environment-- Lessons from Geochemical Studies: U.S.G.S. Circular 1105, 44 pg.

U.S. NRC (Lusher, J.), 2003, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Final Report: NUREG-1569.

U.S. NRC, May 2009, Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities: NUREG-1910, Vol. 1.

U.S. NRC (R.C. Linton), 2006(?), Evaluation Report, Review of COGEMA Mining, Inc., Irigaray Mine Restoration Report, Production Units 1 Through 9, Source Materials License SUA-1341.

Vance, D.B., 1995, Arsenic: Chemical Behavior and Treatment: National Environmental Journal 1995 Vol. 5 No. 3, p. 60-64.
http://www.2the4.net/arsenicart.htm
Wyoming DEQ, 2008, Settlement Agreement with Power Resources / Cameco Resources, regarding Highland and Smith Ranch Uranium projects.
http://deq.state.wy.us/out/downloads/LQ%20SA%204231-08.pdf

Zielinski, R.A., Otton, J.K. Schumann, R. R., and Wirt, L., 2008, **Uranium in surface waters and sediments affected by historic mining in the Denver West 1:100,000 quadrangle**: U.S. Geological Survey Scientific Investigations Report 2007-5246, 54 p.
http://pubs.usgs.gov/sir/2007/5246/

EXHIBIT 3

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
STRATA ENERGY, INC.,	)	Docket No. 40-9091-MLA
	)	
(Ross In Situ Recovery Uranium Project)	)	

SECOND DECLARATION OF DR. RICHARD ABITZ ON BEHALF OF THE NATURAL RESOURCES DEFENSE COUNCIL & POWDER RIVER BASIN RESOURCE COUNCIL

I. INTRODUCTION

I, Dr. Richard Abitz, declare that the following statements are true and correct to the best of my knowledge.

1. I previously submitted a declaration in support of Petitioners' motion to intervene and contentions in this proceeding, and that declaration explains my background and experience relevant to this proceeding. *See* Oct. 23, 2011 Declaration of Dr. Richard Abitz ¶¶ 1-3.
2. The Natural Resources Defense Council has contracted my services to supply technical analysis and comments on both Strata the Energy's Ross Project In Situ Uranium Recovery[1] License Application before the Nuclear Regulatory Commission (NRC) and on the NRC's Draft Supplemental Environmental Impact Statement (DSEIS) for the Ross Project.
3. My expert opinions and comments in this declaration are based both on my professional experience and on my review of relevant portions of the NRC's DSEIS, Strata's application, and other documents listed in the References Cited section of this declaration.

[1] *In situ* recovery ("ISR") is also commonly referred to as *in situ* leaching ("ISL"). For the purposes of this declaration, the two phrases are used interchangeably.

4. My declaration focuses on the technical issues at the foundation of each of Petitioners' admitted contentions in this proceeding. I begin with the overarching observation that in terms of technical presentation and analysis, there are few differences between Strata's ER and the Staff's DSEIS with respect to the Petitioners' admitted contentions. And what few differences exist are not substantial and do not in any way alter the nature of the dispute between the parties as they relate to the admitted contentions pertaining to baseline water quality, analysis of the environmental impacts of alternative concentration limits, fluid migration, or cumulative impacts.
5. Included in my initial assessment of the lack of substantive difference in the two documents is a review of Strata's Responses to NRC Staff's Requests for Additional Information submitted since the admission of the four contentions and reference to the Declarations submitted by Drs. Moran and Sass.

Contention 1 – Baseline Water Quality

6. An element of the first contention addressed the lack of pre-industrial (pre-Nubeth) baseline water quality. *See* Moran Decl. ¶¶ 36-41, at 12 of NRDC's and PRBRC's Petition to Intervene (hereinafter "Petition"); Sass Decl. ¶¶ 22-23, Petition at 14. The DSEIS first states that "in the case of the Ross Project, because an earlier uranium-recovery operation was conducted within the Ross Project area, this operation could potentially have impacted 'background values.'" DSEIS at 2-24. But later the DSEIS claims: "[t]he similarity between the pre-licensing baseline concentrations in the ore zone and aquifer above the ore zone suggests that Nubeth did *not* alter the baseline water quality." DSEIS at 3-42 (emphasis added).
7. First, and most importantly, there are no 'background' values from Nubeth (1978) or Strata (2010). Background values can only be determined if statistically valid, random groundwater

samples are collected from wells that are constructed and developed without the addition of oxidizing fluids and air. This was not done by Nubeth or Strata. Second, Buswell (1982, p.25) notes that in 1976 Nubeth initiated a single-well, push-pull study (i.e., the injection and extraction of lixiviant from a single well), nearly two years *before* the first baseline samples were collected in April 1978 (Nubeth 1978). Therefore, the ore was injected with lixiviant *before* baseline water-quality samples were collected and pre-mining baseline does not exist for the Nubeth pilot-scale study.

8. The DSEIS's lack of analysis on the pre-industrial baseline water quality issue is similar to the lack of analysis on this issue in Strata's application and ER. The DSEIS simply presents a range of values for water quality, and no discussion on how baseline will be developed from these measurements, or data obtained from other wells, until *after* the license has been issued. Thus, Petitioners' fundamental concern with the pre-industrial baseline water quality aspect of the analysis remains. Specifically, in Section 3.5.3, "Ground-Water Quality," the DSEIS references Strata (2011a, 2012a) and Nuclear Dynamics (1978) for average concentrations of the major ions (Table 3.6), and for ranges for the trace ions and radionuclides (Table 3-7), for the six monitor-well clusters (SA, SM, OZ, and DM horizons) and for the Nuclear Dynamics data for the Nubeth Pilot Project. The NRC does not present the 2011 water-quality data but notes that "The data from 2011 are generally consistent with the 2009 and 2010 data, indicating a representative characterization of ground-water quality." (DEIS at p.3-39, lines 11-12). In my expert opinion, this statement is likely in error. Water quality results could not be located for the 2011 quarterly data from the Strata six regional wells (Strata 2012a) in a publicly accessible location. The Strata 2012b reference cited in the DSEIS (p. 3-118) was also searched, and 2011 quarterly water-quality data were not found. The NRC staff requested an

update to all monitoring data (ER RAI EM-1; Strata 2012b), but the Strata response indicates that the request for additional data beyond the 12 months of pre-license monitoring (i.e., 2010) is not a requirement of 10 CFR Part 40, and they questioned why this additional data request is necessary for NRC staff's review. It is my finding that the NRC should not, without the public having an opportunity to review, state that the 2011 data are consistent with 2009 and 2010.

9. Additionally, it is my finding that water quality data are not presented for all of the existing monitoring wells. The DSEIS states 51 pre-licensing ground-water monitoring wells are present as of the end of August 2011 (DEIS, p. 4-23, lines 15-18). The data presented in the DSEIS pertains only to six regional cluster wells each containing four monitoring wells (24 wells), which leaves a balance of 27 monitoring wells for which water-quality data are absent. In my expert opinion, the absence of data from more than half of the ground-water monitoring wells must be explained, and analyzing the missing half of the ground-water monitoring data could plausibly alter expert conclusions on the interpretation of the entire set of measurements.

10. Remarkably, with no presentation of the new water-quality data, the DSEIS concludes there is a small impact on the groundwater resources even though: (1) these are not the data that will set baseline water quality (as such a standard will not be known until after licensing) and, in any event, (2) there is no discussion of the following water-quality issues, which would have to be addressed to ensure that the proper scientific and statistical methods are utilized to establish valid baseline values:

    - The impact of the use of oxidizing fluids during drilling operations, and the impact of air-lifting during well development - processes which can cause uranium ore to be oxidized during the drilling and development of monitoring wells and therefore alter true baseline water quality values (Abitz, 2010; Laaksoharju et al., 2008);

- Inclusion of a statistically sufficient number of randomly located wells to collect representative groundwater samples from the proposed aquifer exemption zone (VSP 2013);
- Assurance that baseline wells are screened through the entire sand interval of the aquifer horizon, in order to eliminate a high bias towards ground-water contamination when the sample is obtained only from the ore-rich interval of the aquifer horizon;
- Inclusion of proper statistical analysis and methods to establish valid baseline values (Gilbert, 1987; Matzke et al., 2007; ASTM, 1998; EPA, 1989; 1992a; 1992b; 2009; NRC, 2003);
- Inclusion of the explanation for the anomalous results that the Nubeth average values in Tables 3-6 and 3-7 of the DSEIS exceed the Nubeth high baseline values as given in Addendum 1.2-A in the Strata TR (note that by mathematical definition it is not possible for an average value to exceed a maximum value).

11. Although page 2-24 of the DSEIS (lines 15-44) notes that post-licensing/pre-operational baseline values and excursion upper-control limits (UCLs) would be established for each separate well field, there is no indication in the DSEIS as to how the NRC will ensure that Strata collects representative samples prior to mining (as noted in the above list), and then applies proper statistical methods to establish the pre-mining baseline and excursion UCL values. Moreover, the DSEIS does not present the scientific basis to support sequential establishment of baseline water quality and excursion UCLs in new well fields after mining has taken place in adjacent well fields. It is my finding that if NRC allows Strata to proceed in this fashion these actions would be inconsistent with accepted scientific methodology for definition of pre-mining baseline water quality.

12. While specific terminology used in the DSEIS to describe the Applicant process for establishing baseline water quality has changed somewhat from the ER, the issues raised in Petitioners contentions (concerning the ER's failure to document the establishment of a scientifically valid baseline for groundwater quality and assess a full range of plausible environmental outcomes from the proposed "aquifer restoration" process) remain unaddressed.
13. The DSEIS states (at 2-24, line 14): "Prior to commencing ISR operations, these [monitoring] wells [around the perimeter of each wellfield] would allow sampling and analysis of ground water and, in this DSEIS, this type of monitoring is called 'post-licensing, pre-operational.' The resulting post-licensing, pre-operational data would be used to determine concentration-based baseline levels and upper control limits (UCLs) that would permit identification of any excursions from the respective wellfields. These post-licensing, pre-operational baseline values would be established for each separate wellfield (and they would be codified in the Applicant's license)." In my expert opinion, these "post-licensing, pre-operational baseline values" have not been clearly stated to be the functional equivalent of the "Target Restoration Values" (TRVs) referenced in the ER at 6 -11 as "defin[ing] the aquifer restoration goals." (ER at 6-10). Too little information is provided about either to make this assessment.
14. The DSEIS also states (at 2-24, line 41): "Later, prior to actual uranium-recovery wellfield operation, but after the initial NRC license is issued for wellfield construction, the ground water in each wellfield would be analyzed for the post-licensing, pre-operational baseline concentrations of constituents specified by the NRC (NRC, 2003a), and (at 2-32, line 18): "The purpose of aquifer restoration is to restore the respective aquifer to its baseline conditions, as defined by post-licensing, pre-operational constituent concentrations…so as to ensure public health and safety."

15. From these descriptions in the DSEIS, it apparently remains the case that monitoring to determine baseline values (i.e., TRVs), and excursion UCLs to guide individual wellfield aquifer restoration efforts, would be undertaken only when a given wellfield's construction and testing is complete and a perimeter ring of monitoring wells has been established around the wellfield. In my expert judgment this scenario raises a consistent set of concerns that Petitioners lodged against the ER. The DSEIS offers no valid scientific or technical rationale for using "post-licensing, pre-operational," rather than "pre-licensing baseline" measurements, to establish "baseline" water quality data.
16. Moreover, if these excursion UCLs and post-licensing baseline concentrations are to be established "prior to commencing ISL operations….for each separate wellfield" as described on page 2-24 of the DSEIS, and there are "15-25 wellfield areas" in the "Ross Project" alone, as described on page xix of the DSEIS, how can all these multiple well-field limits simultaneously be "codified in the Applicant's NRC license," as the DSEIS asserts, when the "Applicant" must logically become the "Licensee" upon commencing operation of the first wellfield?
17. The DSEIS does not explain how the Applicant and/or the terms of its NRC License will prevent such "post-licensing, pre-operational baseline" water quality measurements from being contaminated by the combined effects, prior to sampling, of drilling, casing and testing large numbers of injection and recovery wells, and from the effects of previous and ongoing exploratory drilling to delineate the boundaries of the economically recoverable uranium resource. Nor does the DSEIS address how, in the course of simultaneously constructing, operating, and "restoring" numerous individual wellfields in sequence over many years, the Applicant and the License terms will avoid the obvious pitfall of operational wellfields degrading the "post-licensing, pre-operational" water quality baselines in subsequent adjacent

monitoring wells targeting the same aquifers. As demonstrated by the statistically invalid baseline values reported for the Kingsville Dome ISL operations in Texas (TWC 1988; TWC 1990)[2], this flawed methodology will have the effect of creating a cascading deterioration in nominal "baseline" water quality measurements from wellfield to wellfield in the course of building-out the "Ross Project," and pursuing adjacent "Lance District Development." In my expert opinion, the effect of this flawed methodology will be to permit Strata Energy to pollute ground-water in a manner inconsistent with the NRC's regulatory intent.

18. Another element of the Petitioners' first contention is the failure of the NRC materials license process to accurately and independently assess the ore zone. *See* Sass Decl. ¶ 15, Petition at 13. The review in the DSEIS primarily relies on the data in the application, which in my expert judgment is insufficient to conclude that the regional water quality in the ore zone exceeds the EPA drinking water Maximum Concentration Limits (MCLs) for uranium and radium-226. Although NRC admits that data are available, the NRC simply states: "The data from 2011 are generally consistent with the 2009 and 2010 data, indicating a representative characterization of ground-water quality." (DSEIS at 3-39). The 2011 data are not provided in the DSEIS and, until they are provided, it is my finding that these data are insufficient to establish representative water quality in the regional baseline wells.

19. Another element of the Petitioners' first contention was the failure of the NRC materials license process to provide a scientifically sound sampling regime prior to the issuance of a license and during the course of the public environmental review. See Abitz Decl. ¶¶ 16-19, Petition at 14. As with a number of other elements in dispute, there has been no substantive change between

[2] Baseline for Kingsville Dome Production Area Authorization (PAA) 1 and PAA 2 were established two years apart and much higher values were measured for PAA2 (PAA1: uranium = 0.164 mg/L; radium-226 = 22 pCi/L. PAA2: uranium = 1.89 mg/L; radium-226 = 92 pCi/L). Note that baseline was established for these PAAs with invalid statistical methods, as outlined in paragraph 10 of this declaration.

the ER and the DSEIS. As noted in our original declaration, in my expert judgment, Strata must lay out a systematic grid covering the project area, and select at random points in that grid to locate baseline wells. Existing water-quality data from Strata's six regional wells can be used to estimate the approximate standard deviation of the population (which must be done for each quarter to eliminate temporal trends), and this methodology can be used to estimate the number of wells needed to reach the stated statistical confidence for obtaining a representative number of samples from the regional project area aquifer.[3] Such an industry-standard, statistical sampling approach, with a stated level of decision confidence, is the only valid scientific method available to Strata if they wish to conclude that the water quality in the ore zone does not meet the EPA MCLs for uranium and radium-226.

20. We provide an example (using VSP software) and subsequent explanation of how this sampling might look.

2010 Uranium Results (ug/L)

	1st Q	2nd Q	3rd Q	4th Q
22-18OZ	0.070	0.033	0.069	0.033
14-18OZ	0.096	0.109	0.109	0.085
21-19OZ	0.017	0.008	0.024	0.005
34-7OZ	0.041	0.038	0.044	0.028
34-18OZ	0.062	0.059	0.046	0.041
42-19OZ	0.011	0.010	0.010	0.009
Median	0.052	0.036	0.045	0.031
Mean	0.050	0.043	0.050	0.034

[3] NRC guidance is to place one baseline well in every four acres (NRC, 2003; p. 5-39), but Petitioners are not suggesting that 312 wells (1248 acres proposed for ISL well fields divided by 4) are strictly necessary to obtain representative water samples. Fewer locations can be achieved with good statistical design, but no such effort has been made or suggested by the NRC. In any event, a systematic grid and well-designed statistical sampling plan is necessary.

std dev	0.033	0.038	0.035	0.029
SW test statistic 95% conf	0.952	0.883	0.948	0.892
SW critical value 95% conf	0.788	0.788	0.788	0.788
95% LCL mean	0.023	0.012	0.021	0.010
95% UCL mean	0.076	0.074	0.080	0.057
t stat	1.46	0.837	1.42	0.298
t critical value 90% conf	1.48	1.48	1.48	1.48
Conclusion	accept null hypothesis because t stat < t crit value			
Null hypothesis	regional groundwater < 0.03 mg/L			
Type I error (alpha)	0.1; 90% confident we will accept null hypothesis when it is true			
gray area	0.005 above uranium MCL (0.035 mg/L)			
Type II error (beta)	0.5; 50% chance to accept null hypothesis if the true mean is 0.035 mg/L			
Sample Requirements	73	96	82	57
Null hypothesis	regional groundwater < 0.03 mg/L			
Type I error (alpha)	0.1; 90% confident we will accept null hypothesis when it is true			
gray area	0.01 above uranium MCL (0.04 mg/L)			
Type II error (beta)	0.5; 50% chance to accept null hypothesis if the true mean is 0.04 mg/L			
Sample Requirements	19	25	21	15
Null hypothesis	regional groundwater < 0.03 mg/L			
Type I error (alpha)	0.1; 90% confident we will accept null hypothesis when it is true			
gray area	0.01 above uranium MCL (0.04 mg/L)			
Type II error (beta)	0.2; 20% chance to accept null hypothesis if the true mean is 0.04 mg/L			
Sample Requirements	50	66	57	39

21. The statistical summary in paragraph 20 indicates that the six regional monitor wells are an insufficient number of wells to conclude, with a stated level of confidence (90% in this example), that uranium exceeds the EPA MCL in the OZ aquifer. To perform this analysis with parametric statistical tests (e.g., student t test), the data must be evaluated with the Shapiro-Wilk (SW) test to determine if the distribution is normal or lognormal. If the data are neither normal nor lognormal, non-parametric test methods must be used. The SW test statistic is greater than the SW critical value, which indicates that the six results for each quarter follow a normal distribution, and the 95% lower control limit (LCL) of the mean is below the EPA MCL, which indicates that the true uranium mean of the regional aquifer could be below 0.03 mg/L. Because the data are normally distributed, the student t test can be used to test the hypothesis (90% confidence level used in this example) that the true uranium mean is less than the EPA MCL (0.03 mg/L). The results of the student t test show that the t statistic is above the t critical value, and we have to accept the null hypothesis that the true uranium mean for the groundwater in the OZ horizon is less than the EPA MCL of 0.03 mg/L. If Strata believes the true uranium mean in the OZ horizon is above the EPA MCL, they must collect additional random samples and rerun the SW and Student t tests to determine if the null hypothesis can be rejected, which would demonstrate that the true uranium mean is above the EPA MCL. The sample requirements for different Type II errors and contamination scenarios indicate a minimum of 15 and maximum of 96 locations would be needed to test the alternative hypothesis that the true uranium mean is above the EPA MCL.

22. Another element of the Petitioners' first contention is the statistically invalid biased collection of non-representative samples from screens placed through part of the OZ water horizon that only sample water in contact with the ore zone, rather than the entire column of water in the OZ

sand interval. *See* Abitz Decl. ¶ 22, Petition at 14. Regarding this element, little has changed between the ER and DSEIS, as screen lengths for the existing six monitor wells in the OZ zone are approximately ¼ to ½ the thickness of the OZ sand (Table 1 in Abitz 2011) and centered on the ore zone. This has the effect of biasing the groundwater sample to high values for uranium, radium-226 and other uranium progeny and associated ore metals (e.g., arsenic, molybdenum, vanadium, etc) due to the disturbance and oxidation of the ore during well construction and development. I am aware that NRC Guidance (2003; p.5-43) also recognizes this bias and the NRC states that fully screened intervals are more accurate in their representation of the water quality that a user of the water will encounter. Therefore, in my expert opinion, the present monitor wells in the OZ horizon do not collect a representative groundwater sample.

23. Further, the lack of analysis found in the DSEIS exacerbates the dispute between the parties over the need for a meaningful environmental review of baseline water quality prior to any final licensing decisions. For example, in Tables 3.6 and 3.7 of the DSEIS, Strata's six cluster wells are grouped together to report average and ranges for each water horizon, and there is no mention of the proper statistical methods for evaluating individual wells prior to grouping them and calculating an average or range for the aquifer horizon (Gilbert, 1987; Matzke et al., 2007; ASTM, 1998; EPA, 1989; 1992a; 1992b; 2009; NRC, 2003). A simple averaging or simply reporting a range of the values from all wells is inappropriate, unless it can be shown with proper statistical methods that (i) the samples from the individual wells follow a normal or log-normal distribution, and (ii) an analysis of the data variance of each well demonstrates that the wells can be combined into a single population for statistical calculations. These standard statistical practices for the environmental industry (random grid sampling, statistically significant number of sampling locations, proper statistical tests, etc) are routinely and easily

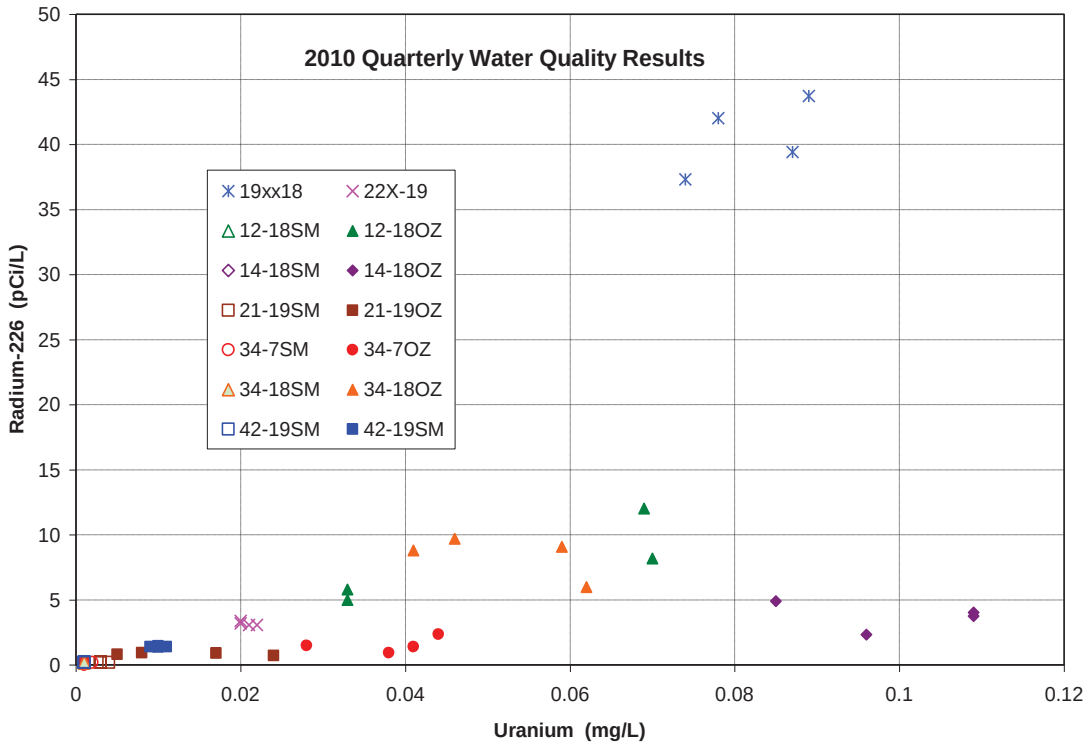
carried out using available statistical software (e.g., Visual Sampling Plan, available free from Pacific Northwest National Laboratory: http://vsp.pnnl.gov), and I note that the use of these standard industry practices is enforced by EPA when groundwater and soil samples are collected at CERCLA and RCRA sites (DOE 1998a-e; DOE 1999a-e; DOE 2000a-e; DOE 2001a-e; DOE 2002a-c; DOE 2003a-c; DOE 2004a-f; DOE 2005 a-d; DOE 2006a-o; DOE 2007a-j; DOE 2008a-b; DOE 2009).

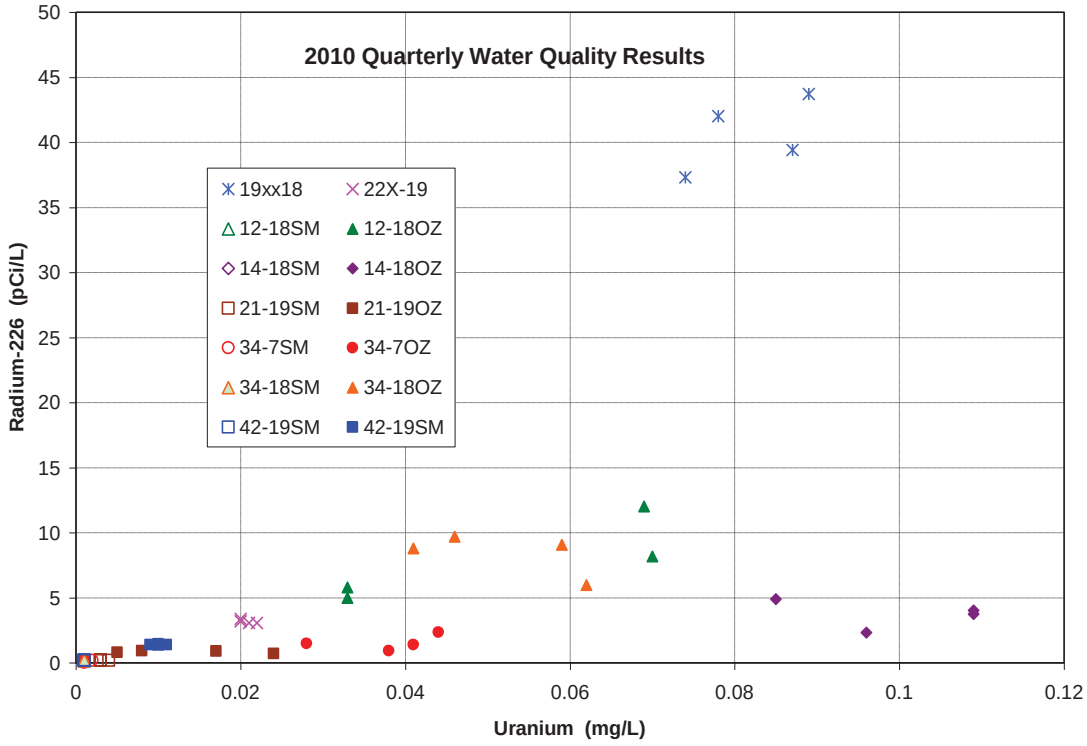
Contention 2 – Analysis of Environmental Impact of Alternative Concentration Limits

24. An element of the Petitioners' second contention, which concerns uncertainty as to the detailed procedures employed for aquifer restoration (*see* Moran Decl. ¶ 70, Petition at 17), has not been functionally altered by treatment in the DSEIS. Indeed, it is my finding that the same elements that precipitated Petitioners' contentions are found in the DSEIS. As an example, Strata "estimates that aquifer restoration for each wellfield would take approximately eight months" (DSEIS at 2-33, but *see*, suggestion of six months at 4-34). However, the DSEIS treatment of restoration is based on what Strata informed the agency, and not an independent analysis of how long restoration would take. The DSEIS provides a general description of aquifer restoration techniques but does not say which would be deployed in which wellfield for how long and why; and there is no differentiation in aquifer restoration techniques between the 15-25 estimated wellfields. It is well established that no pilot-scale or full-scale ISL mining operation has restored their contaminated groundwater to the baseline values cited in the <u>initial</u> license permit (Hall, 2009; Staub et al., 1986; Deutsch et al., 1984). Importantly, ISL operators are unable to restore the groundwater to baseline values, even erroneously poor baseline values that are biased by high by oxidation of the ore zone during drilling and well development, invalid sampling protocols, and improper statistical manipulation of analytical results.

Examining the established scientific facts it is apparent, in my expert judgment, that the probability is vanishingly small that ISL-contaminated groundwater can be restored to baseline values when those values are properly determined with valid scientific and statistical techniques (*i.e.*, lower concentrations than heretofore presented by Strata or NRC).

25. Failure to restore the groundwater under the Nubeth pilot-scale ISL operation is clearly evident in the consistently elevated uranium and radium-226 concentrations observed in samples from industrial well 19xx18 (Figure 1), which served as the extraction well to the Nubeth pilot-scale test (Figure 3.15 in the SEIS). The uranium-radium-226 trend observed for all Strata cluster wells from the OZ horizons and industrial well 22x19 lies well below the radium-226 values for 19xx18, and the high radium-226 values can only be explained by the capture of the contaminated plume that remains from Nubeth's failure to restore groundwater after their six-month pilot-scale test. In my expert opinion, failure to restore the groundwater after a short six-month pilot-scale project should have clearly communicated to the NRC staff that it will not be possible to restore a full-scale ISL operation in 8 months (DSEIS at 2-33).
26. Figure 1. Variation plot for uranium and radium-226 showing distinct radium-226 values for 19xx18, which are due to the capture of the Nubeth contamination plume.





27. Given overwhelming scientific evidence of the failure of the ISL industry to restore groundwater to pre-mining water-quality standards, NRC should be analyzing the actual

likelihood of restoring groundwater to true baseline conditions, and not simply accept Strata's position that restoration to baseline values is possible because of the Nubeth project "demonstration of successful ground-water restoration and site reclamation." *See* DSEIS at 2-11 line 43.

28. Another element of the Petitioners' second contention, the failure to adequately define the specific aquifer restoration criteria/standards during the NEPA process and prior to licensing the facility (see Moran Decl. ¶ 70, Petition at 17), is also unaltered by treatment in the DSEIS. Here, NRC Staff admits that the restoration criteria are not known at this time. *See* contention 1 above: "The purpose of aquifer restoration is to restore the respective aquifer to its baseline conditions, as defined by post-licensing, pre-operational constituent concentrations." DSEIS at 2-32

29. Another element of the Petitioners' second contention, the suggested six-month restoration period, is far too short given the past history of failed ISL restoration at all ISL sites, including the Nubeth pilot-scale project (see Abitz Decl. ¶ 28, Petition at 18). Again, the DSEIS does not discuss or analyze the credibility of Strata's estimated restoration timeframe.

Contention 3 – Fluid Migration

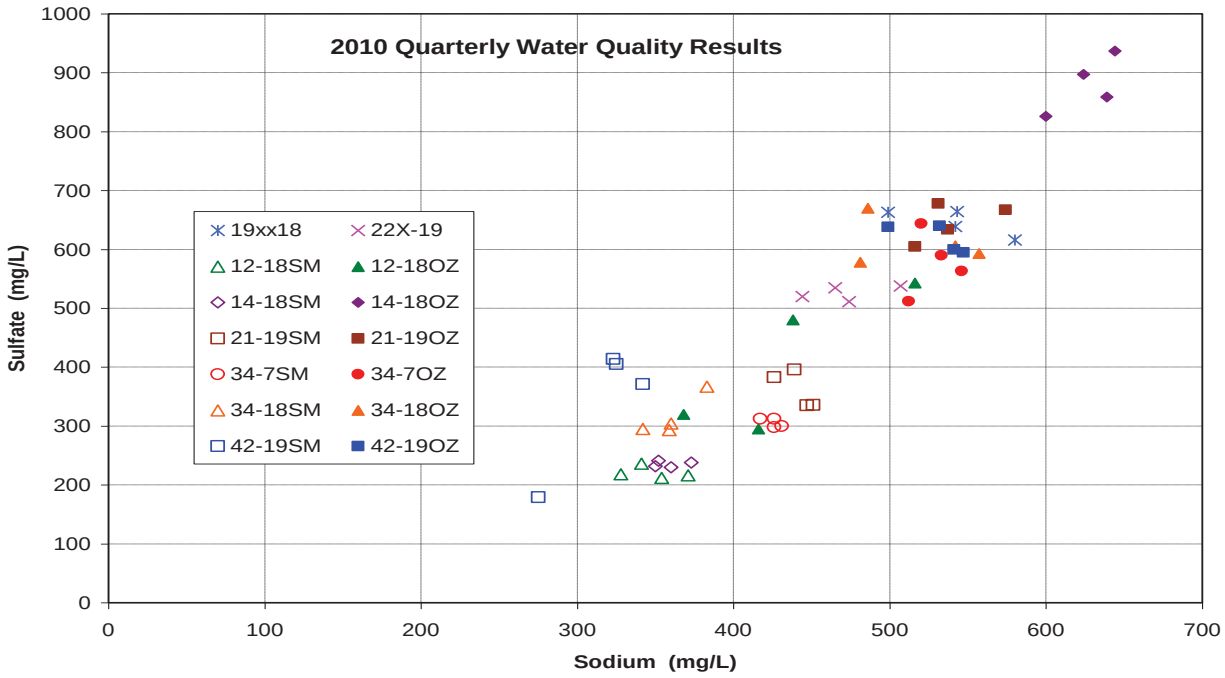
30. With respect to Petitioners' third contention, Strata's failure to sufficiently describe and analyze information about boreholes and aquifer isolation to demonstrate that fluids would be contained during and after mining operations, Petitioners focused on the over 5,000 exploration boreholes drilled in the area which can serve as pathways for fluid migration. *See* Moran Decl. ¶¶ 22,31; Abitz ¶13 Petition 21-23. Again, there is little alteration in this fundamental dispute with the issuance of the DSEIS.

31. The DSEIS admits there are abandoned wells but does not disclose any total amount beyond information Strata has relayed to the agency. Indeed, the DSEIS discloses that hydrologic connection between the OZ aquifer and DM aquifer exists "due to improperly plugged previous exploration drillholes that have not yet been properly abandoned." DSEIS at 4-35. But, DSEIS does not consider the water quality impacts of these wells in relation to the Ross Project because NRC says groundwater impacts would be "minimized by the Applicant locating the drillholes within the wellfields beneath the Proposed Action as well as plugging and abandoning them." DSEIS at 4-36. In short, the DSEIS simply assumes the feasibility of locating and plugging these thousands of drillholes and relies on the applicant to correctly perform these actions, stating that, "[t]o prevent communication between aquifers during uranium-recovery operation, the Applicant proposes to actively locate and plug all exploration drillholes prior to beginning wellfield operations." DSEIS at 3-38.[4]

32. Strata constructed and developed six monitor-well clusters within the project boundary and performed 24-hour pump tests on four of these wells in July 2010 (12-18OZ, 21-19OZ, 34-7OZ, 42-19OZ; Addendum 2.7-J of Strata TR 2011). In my expert opinion, neither the number of wells tested for hydrological parameters nor the short duration of the pump test establish adequate hydrological information to demonstrate control of groundwater over 1,866 acres of complex fluvial stratigraphy (Addendum 2.6-C of Strata TR 2011). Moreover, hundreds of exploration boreholes remain unplugged and there is no clear indication that all the boreholes will be found and abandoned in accordance with proper procedures (Addendum 2.6-B of Strata TR 2011).

[4] However, "As of October 2010, the Applicant has located 759 of the 1682 holes thought to exist from Nubeth exploration activity and has plugged 55 of them." DSEIS at 2-44.

33. The DSEIS does not at all address any of the significant data gaps in the conceptual and numerical hydrologic models put forward to support Strata's license application. This silence is inexcusable because the DSEIS does note that horizontal and vertical excursions of mining fluids occur at all ISL operations, and the vertical excursions were traced to thinning of the confining layer in the complex fluvial stratigraphy and improperly abandoned exploration bore holes (SEIS, p. 4-32, lines 41-43).
34. Demonstration of adequate hydrologic control is not a trivial matter because groundwater communication between the SM and OZ horizons is evident in the 24-hour pump test data from well 12-18OZ and the water-quality results for sodium and sulfate (Figure 2). Groundwater from the ore horizon (OZ; solid symbols) generally has higher sodium and sulfate, relative to the overlying groundwater (SM). However, mixing of the groundwater from these two horizons is clearly indicated by the linear trace of the sodium and sulfate trend on Figure 2. In my expert opinion this is unquestionably demonstrated by the mid-location of plotted samples from 22X-19, a well that is screened through the OZ and SM zones (Section 2.7.3.3.1, p.2-169, Strata TR). If 14-18OZ is taken as the unmixed groundwater from the ore horizon, all other OZ samples are shown to have a component of SM water, as they lie between 14-18OZ and 22x-19. Note that the strong mixing between the horizons is unequivocal for samples from 12-18OZ, which plot with the samples from 22x-19 and the SM horizon.
35. Figure 2. Water-quality results for sodium and sulfate indicate groundwater mixing of the ore zone (OZ) and overlying horizon (SM).



36. Figure 2 also illustrates that, the closer that a pair of samples plots for a given cluster well (e.g., 12-18SM and 12-18OZ), the higher the probability for groundwater contamination by communication between the two groundwater zones during ISL operations. In contrast to mixing between the 12-18 horizons, 14-18SM and 14-18OZ samples cluster tightly and are well separated on the plot. An explanation for the distinct separation of the 14-18 horizons on the sodium-sulfate plot may be that the density of exploration boreholes is lower around this cluster well and less communication between the SM and OZ horizons has occurred (*i.e.*, 14-18 may provide a snapshot of the distinct chemistry of the horizons prior to the drilling of thousands of exploration boreholes).

37. Additionally, it is also known that 22x19 is screened through the SM and OZ zones, and there is no detailed engineering analysis to show the effect of the industrial well operation on the ISL operations. The complexity of the stratigraphy coupled with hundreds of unplugged boreholes, established mixing between the SM and OZ zones, and the high-yield industrial wells requires

many more test wells over the 1,866 acres and much longer pump test intervals to obtain the needed hydrologic data to assess the control of mining fluids during ISL operations. The DSEIS is silent on these complexities and provides no convincing hydrologic data to support Strata's contention that mining fluids will be controlled to prevent groundwater pollution.

Contention 4 – Cumulative Impacts

38. With respect to the Petitioners' fourth admitted contention, the failure to sufficiently describe cumulative groundwater quantity impacts and the failure to quantitatively evaluate impacts of the proposed Lance District expansion and the project as a whole reflects a problematic perspective. While the DSEIS acknowledges cumulative impacts will occur from foreseeable projects (see DSEIS at 2-13), there is a dearth of meaningful analysis in the agency's document and the petitioners' concerns remain unaddressed.

39. The DSEIS briefly notes cumulative impacts to water drawdown from future "satellite" projects: stating consumption could increase to 356 gal/min from the 122 gal/min estimated for the Ross Project. DSEIS at 5-24. This estimate is based on aquifer yield that is proportional to uranium recovery amount, and the DSEIS lacks specific analysis about projected drawdown amounts. The DSEIS also lacks analysis about irreversible trends - it simply estimates that quantity "would also be essentially restored within 24 years after the issuance of the NRC license" and therefore suggests impacts would be small. DSEIS at 5-25. Further, there is no analysis of cumulative water quality impacts - just the Nubeth pilot-scale ISL operation, but no analysis of the prospective parts of the entire Ross project or even the greater Lance District project.

40. Indeed, what NRC does look at is essentially limited to the OZ zone, due to the proposed confining layers (p.5-22, lines 44-46). This conflicts with scientific data and NRC statements

that horizontal and vertical excursions of mining fluids occur at all ISL operations, and that the vertical excursions were traced to thinning of the confining layer in the complex fluvial stratigraphy and improperly abandoned exploration bore holes (DSEIS, p. 4-32, lines 41-43). Therefore, the layers are not confining due to complex fluvial stratigraphy (Addendum 2.6-C of Strata TR 2011), unplugged boreholes (Addendum 2.6-B of Strata TR 2011), hydrological evidence for connection between OZ and SM during the July 2010 24-hr pump test on 12-18OZ, and water quality analyses that show mixing between SM and OZ (Figure 2).

41. Further, NRC considers cumulative groundwater impacts for the Ross Project to occur over 24 years. DSEIS at 5-23, lines 9-15. The agency notes average consumption of 122 gal/min over 6 years for the Ross Project; but the basis and calculation to derive the quantity of groundwater over this period is absent (p. 5-24, lines 12-14). NRC then states the average increases to 356 gal/min when including the Kendrick, Richards, and Barber satellite areas; based on scaling water consumption to uranium production between Ross Project and all satellite operations, but no period of consumption is given by the agency. It is perplexing why there is a lack of mass balance calculations, because information is given to estimate total gallons consumed (i.e., 356 gal/min over 24 years equates to 4.5 billion gallons of groundwater, or enough water to cover 13,800 acres to a depth of 1 foot). Note that NRC and Strata are mute on groundwater loss due to failure to restore aquifers to true baseline conditions, which could be another 56,000 acre-ft (assuming 1866 acres multiplied by 100 feet of sand thickness with a porosity of 0.3)
42. NRC states that Strata cannot estimate the current withdrawal of groundwater from the Lance and Fox Hills formations because the geological interval is not recorded by the Wyoming engineer's office (p. 5-24, lines 23-28). It is my finding that this conclusion is grossly disingenuous, as location and depth of wells are given (line 24) and both the NRC and Strata

have intimate knowledge of the regional geology to correlate these locations and depths with the geological interval.

43. Again, without any independent analysis, NRC cites Strata on concluding that the OZ horizon is unattractive as a groundwater source due to depth (400 fbgs), and due to the presence of overlying aquifers (p. 5-24, lines 31-33). This statement contradicts the NRC statement (p.5-24, lines 1-4) on the city of Gillette, which extracts groundwater from the Fox Hills Formation at a depth of 500 fbgs and mixes this high TDS water with groundwater of lower TDS to produce potable water for the city. The use of Fox Hills groundwater by the city of Gillette also exposes the fallacy of the NRC/Strata argument that the groundwater in the OZ is unsuitable for human consumption. Clearly, the groundwater from the OZ horizon can be blended with lower TDS water to produce potable water for human consumption.

/s/ Dr. Richard Abitz (electronic signature approved)

Dated: May 6, 2013

REFERENCES

Abitz, R. J. and B. Darling, 2010, Anthropogenic Induced Redox Disequilibrium in Uranium Ore Zones, *Geological Society of America Abstracts w/Programs*, Vol. 42.

American Society for the Testing of Materials (ASTM), 1998, *Standard Guide for Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring Programs*, D6312, Washington DC.

Deutsch, W.J., N.E. Bell, B.W. Mercer, R.J. Serne, J.W. Shade, and D.R. Tweeton, 1984, *Aquifer Restoration Techniques for In Situ Leach Uranium Mines,* NUREA/CR-3104, PNL-4538, Pacific Northwest Laboratory, prepared for the U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington DC.

Gilbert, R.O., 1987, *Statistical Methods for Environmental Pollution Monitoring*, Van Reinhold, New York, New York.

Hall, S., 2009, *Groundwater Restoration at Uranium In Situ Recovery Mines, South Texas Coastal Plain,* Open-File Report 2009-1143, U.S. Geological Survey, Reston, Virginia.

Laaksoharju, M., J. Smellie, E. Tullborg, M. Gimeno, J. Molinero, I. Gurban, and L. Hallbeck, 2008. Hydrogeochemical evaluation and modeling performed within the Swedish site investigation programme, *Applied Geochemistry*, v. 23, no. 7.

Matzke, B.D., J.E. Wilson, L.L. Nuffer, S.T. Dowson, R.O. Gilbert, N.L. Hassig, J.E. Hathaway, C.J. Murray, L.H. Sego, B.A. Pulsipher, B. Roberts, and S. McKenna, 2007, *Visual Sample Plan, Version 5.0, User's Guide,* PNNL-16939, Pacific Northwest National Laboratory, Richland, Washington.

Madansky, A., 1988, *Prescriptions for Working Statisticians,* Springer-Verlag, New York, New York.

Shapiro, S.S. and M.B. Wilk, 1965, An analysis of variance test for normality (complete samples), *Biometrika*, v. 52, pp. 591-611.

Shapiro, S.S., M.B. Wilk and J. Chen, 1965, A comparative study of various tests for normality, *Bjournal of the American Statistical Association*, v. 63, pp. 1343-1372.

Staub, W.P., N.E. Hinkle, R.E. Williams, F. Anastasi, J. Osiensky, and D. Rogness, 1986, *An Analysis of Excursions at Selected In Situ Uranium Mines in Wyoming and Texas*, NUREG/CR-3967, ORNL/TM-9956, Oak Ridge National Laboratory, prepared for the U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington DC.

Texas Water Commission (TWC), 1988, Production Area Authorization for Kingsville Dome Mining Project, Permit UR02827-001, Production Area UR02827-011, April 12, 1988.

Texas Water Commission (TWC), 1990, Production Area Authorization for Kingsville Dome Mining Project, Permit UR02827-001, Production Area UR02827-021, June 28. 1990.

U.S. Department of Energy, (DOE), 1998a, Certification Report for Area 1 Phase I, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1998b, Certification Report for Area 1 Phase II, and Conveyance Ditch, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1998c, Certification Report for Area 8 Phase I, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1998d, Fernald 1997 Sitewide Environmental Report, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1998e, Sitewide Excavation Plan, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1999a, Certification Report for Area 1 Phase I – Sediment Traps 2 and 3, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1999b, Certification Report for Area 1 Phase II – Sector 2B, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1999c, Certification Report for Area 8 Phase II and Area 6 Triangle Area, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1999d, Certification Report for Area 2 Phase III Part One, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1999e, Fernald 1998 Sitewide Environmental Report, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2000a, Certification Report for Area 1 Phase II – Sector 2 Certification Units West of Former North Access Road, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2000b, Certification Report for Area 1 Phase III Part Two, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2000c, Certification Report for Area 2 Phase III Part Two, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2000d, Certification Report for Area 8 Phase III South, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2000e, Fernald 1999 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.
DOE, 2001a, Certification Report for Area 1 Phase II, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2001b, Certification Report for Area 2 Phase I Active Flyash Pile and Adjacent Area East of the South Construction Road, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2001c, Certification Report for Former Soil Stockpile 3 Footprint, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2001d, Certification Report for Area 1 Phase III Part One, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2001e, Fernald 2000 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2002a, Addendum 1 to Certification Report for Area 1 Phase II for the Reuse Areas, Trap Range, Sector 2C and Sector 3, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2002b, Certification Report for Area 5 – Eastern Field, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2002c, Fernald 2001 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2003a, Certification Report for Area 2 Phase I – Former Inactive Flyash Pile, South Carolina Area, East-West Construction Road and Equipment Wheel Wash Facility, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2003b, Certification Report for Area 6 Phase I Part One, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2003c, Fernald 2002 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004a, Certification Report for Area 8 Phase III North, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004b, Certification Report for Area 6 Phase I Part Two, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004c, Certification Report for Area 1 Phase IV Part One, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004d, Certification Report for Area 2 Phase II Subareas 1, 2, and 4, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004e, Certification Report for Area 1 Phase IV Parts Two and Three, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004f, Fernald 2003 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2005a, Certification Report for Area 3A/3B, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2005b, Certification Report for Area 4A, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2005c, Certification Report for Stream Corridors and Storm Sewer Outfall Ditch, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2005d, Fernald 2004 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006a, Certification Report for Area 4B Part One, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006b, Certification Report for Area 6 – Waste Pits 4, 5 and 6, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006c, Certification Report for Area 2 Phase II – Subarea 3 Equipment Wash Facility, Subcontractor Laydown Area, Trailer Complex Area, and Aquifer Project Laydown Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006d, Addendum to the Certification Report for Area 2 Phase II – Subareas 1, 2 and 4, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006e, Certification Report for Area 6 – Former Production Area and Main Drainage Corridor Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006f, Addendum to the Certification Report for Area 4A, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006g, Addendum to the Certification Report for Area 2 Phase III – Part Two for Area Boundary, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006h, Certification Report for the Former Storm Water Retention Basin Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006i, Certification Report for Stream Corridors, Pilot Plant Drainage Ditch and Paddys Run, the Former Storm Water Retention Basin Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006j, Addendum 4 to the Certification Report for Area 1 Phase II for the Dissolved Oxygen Building Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006k, Addendum to the Certification Report for Area 4B Part One, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006l, Certification Report for Area 6 General Area East, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006m, Addendum to the Certification Report for Area 6 – Former Production Area and Main Drainage Corridor Area for Soil Pile 8, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006n, Certification Report for Various Areas Outside of the Historically Radiologically Controlled Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006o, Fernald 2005 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007a, Certification Report for Area 1 Phase IV – Decontamination Facility Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007b, Certification Report for Area 5 Administrative Area and East and West Parking Lots, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007c, Certification Report for the Former Solid Waste Landfill and Soil Pile 7, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007d, Certification Report for Area 7 Silos and Support Areas, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007e, Certification Report for Area 6E, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007f, Certification Report for Area 6 – General Area West, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007g, Certification Report for Area 6 – Sitewide Rail Line System, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007h, Certification Report for Area 6 – Waste Pits 1, 2 and 3, the Burn Pit, The Clearwell, and Areas West and North of the Waste Pits, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007i, Certification Report for Area 7 – Miscellaneous Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007j, Fernald 2006 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2008a, Fernald 2007 Sitewide Environmental Report, Fernald Preserve, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2008b, Evaluation of Aqueous Ions in the Monitoring Systems of the On Site Disposal Facility, Fernald Preserve, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2009, Fernald 2008 Sitewide Environmental Report, Fernald Preserve, DOE Fernald Area Office, Cincinnati, Ohio.

U.S. Environmental Protection Agency (EPA), 1989, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Office of Solid Waste, Washington DC.

EPA, 1992a, *Addendum to Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Office of Solid Waste, Washington DC.

EPA, 1992b, *RCRA Ground-Water Monitoring: Draft Technical Guidanc*e, Office of Solid Waste, Washington DC.

EPA, 2009, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Unified Guidance, EPA 530-R-09-007, Office of Resource Conservation and Recovery, Program Implementation and Information Division, Washington DC.

U.S. Nuclear Regulatory Commission (NRC), 2003, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications*, NUREG-1569, Office of Nuclear Material Safety and Safeguards, Washington DC.

Visual Sampling Plan, version 6.3, Pacific Northwestern National Laboratory, http://vsp.pnnl.gov

EXHIBIT 4

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
STRATA ENERGY, INC.,	)	Docket No. 40-9091-MLA
	)	
(Ross *In Situ* Recovery Uranium Project)	)	

JOINT THIRD DECLARATION OF DR. RICHARD ABITZ AND FIRST DECLARATION OF DR. LANCE LARSON ON BEHALF OF THE NATURAL RESOURCES DEFENSE COUNCIL & POWDER RIVER BASIN RESOURCE COUNCIL

I. INTRODUCTION

We, Dr. Richard Abitz and Dr. Lance Larson, declare the following statements are true and correct to the best of our knowledge.

1. I, Dr. Abitz, previously submitted a declaration in support of Petitioners' motion to intervene and contentions in this proceeding, and that original declaration explains my background and experience relevant to this proceeding. *See* Oct. 23, 2011 and May 2013 Declarations of Dr. Richard Abitz ¶¶ 1-3.
2. I, Dr. Lance Larson, am submitting my first declaration in this proceeding in support of Petitioners' contentions. Attachment A to this exhibit explains my background and experience relevant to this proceeding.
3. The Natural Resources Defense Council has contracted Dr. Abitz's services to supply technical analysis and comments on both Strata the Energy's Ross Project *In Situ* Uranium Recovery[1] License Application before the Nuclear Regulatory Commission (NRC) and on the NRC's Final

[1] *In situ* recovery ("ISR") is also commonly referred to as *in situ* leaching ("ISL"). For the purposes of this declaration, the two phrases are used interchangeably.

Supplemental Environmental Impact Statement (FSEIS) for the Ross Project. Dr. Larson is a Science Fellow at NRDC.

4. Our expert opinions and comments in this declaration are based both on our professional experience and on our independent and combined review of relevant portions of the NRC's FSEIS, Draft Supplemental Environmental Impact Statement (DSEIS), Strata's application, and other documents listed in the References Cited section of this declaration.
5. Our declaration focuses on the technical issues at the foundation of each of Petitioners' admitted contentions in this proceeding. We begin with the overarching observation that in terms of technical presentation and analysis, there are few meaningful differences between Strata's ER, the Staff's DSEIS, and now the FSEIS with respect to the Petitioners' admitted contentions. And what few differences exist are not substantial in this latest iteration of the EIS and do not alter the nature of the dispute between the parties as they relate to the admitted contentions pertaining to baseline water quality, analysis of the environmental impacts of alternative concentration limits, fluid migration, or cumulative impacts.
6. Included in our initial assessment of the lack of substantive difference between the DSEIS and the FSEIS is a review of Strata's Responses to NRC Staff's Requests for Additional Information submitted since the admission of the four contentions and reference to the Declarations submitted by Drs. Moran and Sass.
7. This declaration provides the factual and analytical basis underpinning our identification of the following deficiencies in the FSEIS: (1) It fails to present any empirical characterization of the pre-mining baseline water quality values that will be used to (a) assess the impacts of *in situ* leach uranium mining on the portion of the ore zone aquifer exempted from Safe Drinking Water Act requirements; (b) detect horizontal and vertical migration of lixiviant ("excursions")

outside the exempted portion of the mined aquifer; and (c) establish binding and achievable water-quality values for aquifer restoration. (2) The FSEIS fails to present a consistent and credible sampling methodology to develop water quality values that Strata will employ for the sole purpose of defining, for NEPA documentation purposes, the "Affected Environment" that will be altered as a consequence of the NRC's proposed licensing action. (3) The FSEIS ignores the mobility of uranium in the oxygen-carbonate rich lixiviant and fails to (a) include uranium with the proposed excursion parameters alkalinity, chloride and conductivity; and (b) propose valid sampling and statistical protocols to establish upper control limits for reporting excursions. (4) The cumulative-impact analysis for groundwater is incomplete in the FSEIS; as it fails to include resource loses in the ore zone, the overlying and underlying aquifers, and the Ross Project expansion into the entire Lance District.

Contention 1 – Baseline Water Quality

NRC's FSEIS Provides No Description of a Current Baseline

8. The NRC's FSEIS does not address the Intervenors' contentions regarding the failure of Strata to establish baseline conditions using proper scientific and statistical protocols. As a technical matter, we find it disconcerting that the term 'baseline', as used in the Ross DSEIS has been <u>systematically removed</u> and replaced with the phrase "post-licensing, pre-operational" in the Ross FSEIS, thereby introducing regulatory confusion:

    a. The DEIS stated: "*As part of site-characterization efforts, ground-water monitoring wells are installed and ground-water samples are obtained. These samples are analyzed for certain water-quality constituents, or parameters, that are important to the characterization of existing conditions at a particular site. These concentrations*

are known as the "pre-licensing baseline" values of the respective water-quality constituents."

DSEIS at 2-24

b. However, the FEIS states: "*After the NRC has issued a license to an applicant, the licensee begins construction of its facility as well as installation of its uranium-recovery wellfields. A single wellfield consists of many ground-water wells; when all of these wells have been installed; water-quality samples are obtained from these new wells and are analyzed for the constituents that the NRC specifies in the license, before any uranium-recovery may occur. These sampling and analysis efforts, and the data values that are established as a result of these efforts, are called in this SEIS, "post-licensing, pre-operational." These post-licensing, pre-operational data, after some statistical analysis, are the values to which excursion-detection and/or aquifer-restoration monitoring are compared.*"

FSEIS at 2-25

9. The NRC's four previous FSEIS documents for ISR operations (Moore Ranch, Nichols, Lost Creek, Dewey-Burdock) did not introduce this confusion. Allowing an applicant to establish baseline concentrations after a license is issued and after all wells are placed in a well field ignores the regulatory intent of the word baseline and provides inadequate representation of the water quality in the ore zone and overlying and underlying aquifers. As explained below, inherent biases are introduced into the project's post-license, pre-operational 'baseline' values to establish higher concentrations of contaminants relative to a proper scientific and statistical baseline obtained before the aquifer is mechanically and chemically disturbed by the

installation and development of hundreds to thousands of injection, extraction and monitoring wells.

10. Terminology aside, the FSEIS carries forward the DSEIS's lack of analysis on the pre-industrial baseline water-quality issue. The FSEIS simply presents a range of values for water quality and lacks a thorough technical discussion on how a valid scientific and statistical representation of "baseline" will be developed for the project. Further, the NRC Staff makes it clear that no "baseline" will be developed from the pre-license initial measurements Strata does take and data obtained from this work have no meaning until *after* the license has been issued. Indeed, the text box on p.2-25 of the FSEIS explicitly states "[these] *post-licensing, pre-operational data, after some statistical analysis, are the values to which excursion-detection and/or aquifer-restoration monitoring are compared.*" Thus, the Intervenors' fundamental concern with establishing a valid scientific and statistical, pre-license baseline remains unchanged through each successive stage of this proceeding.[2]
11. In comparison with RCRA and CERCLA sites, the NRC proposed ISR option to establish the baseline post-licensing; pre-operational is only viable if the baseline is established with samples collected from wells hydraulically up gradient of the disturbed area. That is, when baseline is established at disturbed and contaminated RCRA and CERCLA sites, groundwater wells are placed hydraulically up gradient of the contaminated and disturbed areas to establish clean-up standards in the unaffected media. However, the intent of the NRC language is to allow Strata to establish groundwater baseline within the disturbed zone. This clearly violates all scientific and statistical principles behind the definition of groundwater baseline values and it is in

[2] We use pre-license and pre-industrial in this paragraph and define these terms as such: pre-license implies disturbance from exploration boreholes and previous oil and mining activities. Pre-industrial means natural background conditions, which would be difficult to demonstrate due to the thousands of exploration boreholes and ongoing activities in the oil and mining sectors.

conflict with regulations for establishing baseline at RCRA and CERCLA sites hydraulically up gradient of the disturbed area (40 CFR 264.97).

12. Additionally, Section 120(a)(2) of CERCLA provides that all guidelines, rules, regulations, and criteria for preliminary assessments, site investigations, National Priorities List (NPL; *See* 55 FR 8666-8865 [March 8, 1990]) listing, and remedial actions are applicable to Federal facilities to the same extent as they are applicable to other facilities. It states the following: "No department, agency, or instrumentality of the United States may adopt or utilize any such guidelines, rules, regulations, or criteria which are inconsistent with the guidelines, rules, regulations, and criteria established by the Administrator under this Act." In other words, the NRC has no basis to suggest that post-licensing, pre-operational baseline in a disturbed area meets the intent of regulations directed at establishing proper baseline (e.g., 40 CFR 264.97).
13. Next, we find the FSEIS's conclusion that impacts on groundwater resources are SMALL (p. xxxi), and in the case of the confined aquifers SMALL to MODERATE (FSEIS; p. 4-45 to 4-48) are without basis because: (1) pre-license water-quality data reported in Tables 3-6 and 3-7 of the FSEIS will not be used to set baseline (note that the pre-license baseline data in Tables 3-6 and 3-7 remain biased to high values due to improper well installation, development, and previous ISR mining by Nubeth) and (2) there is no discussion of the proper scientific and statistical methods that must be executed to establish valid baseline values. For example:
    - The impact of the use of oxidizing fluids during drilling operations, and the impact of air-lifting during well development - processes which can cause uranium ore to be oxidized during the drilling and development of monitoring wells and therefore alter true baseline water quality values (Paragraph 15 in this declaration; Abitz, 2010; Laaksoharju et al., 2008);

- Statistical requirements for inclusion of a sufficient number of randomly located wells to collect representative groundwater samples from the proposed aquifer exemption zone (VSP 2013) prior to wellfield development;
- Assurance that baseline wells are screened through the entire sand interval of the aquifer horizon, in order to eliminate a high bias towards ground-water contamination when the sample is obtained only from the ore-rich interval of the aquifer horizon; and
- Inclusion of proper statistical analysis and methods to establish valid baseline values (Gilbert, 1987; Matzke et al., 2007; ASTM, 1998; EPA, 1989; 1992a; 1992b; 2009; NRC, 2003);

14. The FSEIS (p. 2-34) carries forward the DSEIS's deficiency (see DSEIS; p. 2-32) that groundwater monitoring to determine baseline values and excursion Upper Control Limits (UCLs), parameters that guide individual wellfield aquifer restoration efforts, will be undertaken only when a given wellfield's construction and testing is complete and a perimeter ring of monitoring wells has been established around the wellfield. In our expert judgment, this scenario raises a consistent set of concerns that Intervenors' lodged originally against the ER. The FSEIS offers no valid scientific or technical rationale for using "post-licensing, pre-operational," rather than "pre-licensing baseline" measurements to establish "baseline" water quality data.

NRC's FSEIS Allows Post-Licensing / Pre-Operational Monitoring to Bias Sample Concentrations Towards Higher Baseline Values.

15. The FSEIS fails to explain how the Applicant and/or the terms of its NRC License will prevent such "post-licensing, pre-operational baseline" water quality measurements from being contaminated by the combined effects, prior to sampling, of drilling, casing, well development

and testing of hundreds to thousands of injection and recovery wells; and the FSEIS is silent on the mechanical and chemical effects associated with previous and ongoing exploratory drilling to delineate the boundaries of the economically recoverable uranium resources in the Lance District. Nor does the FSEIS address how, in the course of simultaneously constructing, operating, and "restoring" numerous individual wellfields in sequence over many years, the Applicant and the License terms will avoid the obvious pitfall of operational wellfields degrading the "post-licensing, pre-operational" water quality baselines in subsequent adjacent monitoring wells targeting the same aquifers. As demonstrated by the statistically invalid baseline values reported for the Kingsville Dome ISR operations in Texas (TWC 1988; TWC 1990)[3], this flawed methodology will have the effect of creating a cascading deterioration in nominal "baseline" water quality measurements from wellfield to wellfield in the course of building-out the "Ross Project," and pursuing adjacent "Lance District Development."

16. Another example where previous ISR mine operators failed to set an accurate baseline – and the problems that emerge from that failure – is found in the data reported for the Irigaray Project, Mine Unit 1 (NRC, 2013b). The uranium concentrations for well AP-4 in Mine Unit 1 display clear evidence of extensive mechanical and chemical disturbance of the aquifer prior to establishing the baseline uranium value (Table below paragraph 16). The average uranium 'baseline' concentration at well AP-4 is thermodynamically unfeasible for natural groundwater in contact with uranium ore (uraninite) under reducing conditions (Langmuir 1978); and this conclusion is substantiated by the observation that the 'baseline' value is almost 2.5 times higher than the post-mining concentration.

[3] Baseline for Kingsville Dome Production Area Authorization (PAA) 1 and PAA 2 were established two years apart and much higher values were measured for PAA2 (PAA1: uranium = 0.164 mg/L; radium-226 = 22 pCi/L. PAA2: uranium = 1.89 mg/L; radium-226 = 92 pCi/L). Note that baseline was established for these Production Area Authorizations (PAA) with invalid statistical methods, as outlined in paragraph 10 of this declaration. (TWC 1988; TWC 1990)

Well AP-4 – Irigaray, Mine Unit 1 – Uranium (mg/L)

'Baseline' Average	Post-Mining
13.57	4.95

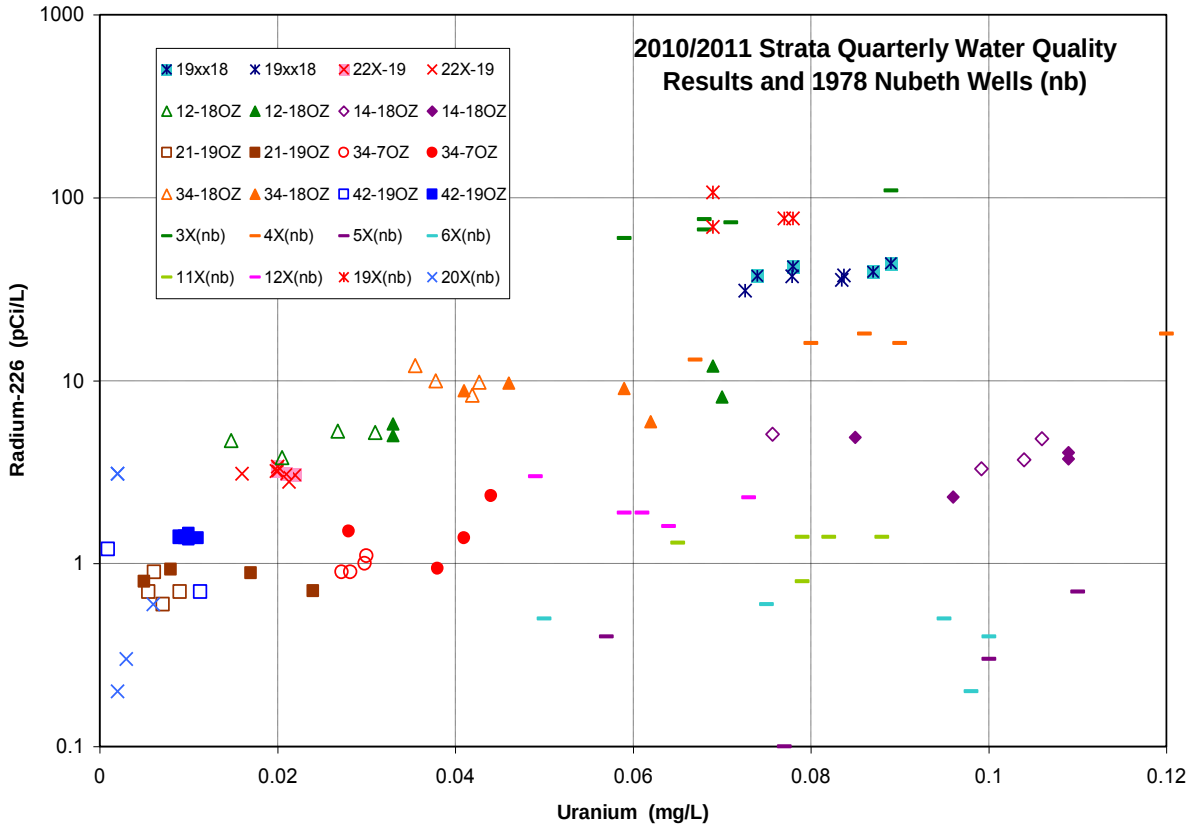
17. Further investigation of operational history at Irigaray demonstrates how the invalid 'baseline' was affected by previous mining and exploratory activities. Research and development activities occurred at the Irigaray site in 1975. Specifically, the 517 site and Well Field A (now Mine Unit 1) began pilot operations in 1975 (Staub et al. 1983; p. A-6). Well Field A was ISR mined using an ammonium bicarbonate lixiviant from 1975 to mid-1976 (Staub et al. 1983; p. A-6). According to the 1978 draft environmental impact statement for commercial operations at Irigaray, baseline sample data for Well Field A were taken "from 11/9/76 to 2/24/77" (NRC, 1978). Therefore, the 'baseline' data used for Well Field A were collected immediately after pilot-scale research and development mining activities. The implications of approving high 'baseline' values in an ISR license are discussed in detail in paragraphs 37-41.
18. The NRC notes that, for each well field in the Ross Project, Strata will re-drill, plug and abandon all open exploration boreholes prior to mining. The plug and abandonment actions will also occur before collecting water-quality samples. Furthermore, the NRC states baseline samples will be collected after all of the wells are in place, "*A single wellfield consists of many ground-water wells; <u>when all of these wells have been installed, water-quality samples are obtained</u> from these new wells and are analyzed for the constituents that the NRC specifies in the license, before any uranium-recovery may occur. These sampling and analysis efforts, and the data values that are established as a result of these efforts, are called in the SEIS, "post-*

licensing, pre-operation (FSEIS; p. 2-25)*."* Specifically, the FSEIS estimates that the total number of injection and recovery wells installed will be between 1,400 – 2,200, not including monitoring wells (FSEIS; B-105). Thus, FSEIS's plan for extensive mechanical and chemical disturbance of the aquifer *prior* to collecting baseline water-quality samples demonstrates a lack of statistical and scientific rigor; replaced with actions that bias baseline values to high concentrations. NRC Staff's permissive allowance for this switch from pre-licensing baseline in the DSEIS to post-licensing, pre-operational baseline in the FSEIS is outside the accepted industry and regulatory protocols for establishing baseline water quality. (See paragraph 10, 11; *see also* 10 CFR 40 Appendix A Criterion 7 – "At least one full year prior to any major site construction, a preoperational monitoring program must be conducted to provide complete baseline data on a milling site and its environs.").

19. Pre-operational data are given in Section 3.5.3.3 of the FSEIS (Ground-Water Quality), which references Strata (2011a, 2012) and Nuclear Dynamics (1978) for average concentrations of the major and trace ions (Tables 3.6 and 3.7) for the six monitor-well clusters (SA, SM, OZ, and DM horizons) and for the Nuclear Dynamics data for the Nubeth Pilot Project. These tables now contain the 2011 monitoring data from the six monitor-well clusters. The NRC did not present the 2011 water-quality data in the DSEIS; they noted that "*The data from 2011 are generally consistent with the 2009 and 2010 data, indicating a representative characterization of ground-water quality*." (DEIS at p.3-39, lines 11-12). The late addition of 2011 water-quality data in the FSEIS supports Intervenors' contention that Strata has failed to (and should be required to) establish proper baseline before the aquifer is further disturbed.

20. In Appendix C of the FSEIS, the 2011 data are tabulated and it is disconcerting that the NRC has no comment on the significance of the 2011 results relative to the 2010 values. Plotting the 2011 and 2010 radium-226 and uranium results (below figure) reveals trends that support our conclusions on the degradation of water-quality parameters from mechanical and chemical disturbance of the ore zone during drilling operations and well development before the license has been issued. The 2011 ore-zone data for Strata's six regional wells (open symbols) show uranium has decreased in 4 of the 6 wells (12-18, 21-19, 34-07, 34-18) and radium-226 is essentially unchanged, relative to the 2010 data (filled symbols). Uranium decreases over this time interval as the aquifer begins to return to reducing conditions following the initial disturbance and oxidation of the uranium ore when the wells were installed and developed. Radium-226 remains at the 2010 levels as radium is insensitive to redox changes once it is released from the uranium bearing ore. The initial magnitude of disturbance and oxidation of the uranium ore varies from location to location, as it is dependent on the time spent in developing the well with air lift and jetting techniques. For well 14-18, the similar results for 2010 and 2011 indicate the ore zone may have been disturbed for a longer period of time during well development. Importantly, the trends for uranium and radium-226 show that the ore zone is disturbed by well installation and development activities and it is inaccurate of the NRC Staff to assert that baseline can be developed after hundreds to thousands of wells are drilled in the

well fields (i.e., NRC's definition of post-licensing, pre-operational baseline).



21. Moreover, the FSEIS does not present the scientific basis to support sequential establishment of baseline water quality and excursion UCLs in new well fields after mining has taken place in adjacent well fields. Based on the data presented in paragraph 19 and 20 of this declaration, it is clear that the ore zone is impacted by well installation and development and it is our finding that the NRC is ignoring these scientific data to allow Strata to bias elevated baseline water-quality data as they develop new well fields.

NRC's FSEIS Fails to Account for the Impacts of the Nubeth Site

22. An element of the first contention addressed the lack of pre-industrial (pre-Nubeth) baseline water quality. *See* Moran Decl. ¶¶ 36-41, at 12 of NRDC's and PRBRC's Petition to Intervene (hereinafter "Petition"); Sass Decl. ¶¶ 22-23, Petition at 14. The DSEIS states "*in the case of the Ross Project, because an earlier uranium-recovery operation was conducted within the Ross Project area, this operation could potentially have impacted background values."* DSEIS at 2-24. But later the DSEIS claimed: "*[t]he similarity between the pre-licensing baseline concentrations in the ore zone and aquifer above the ore zone suggests that Nubeth did not alter the baseline water quality.*" (DSEIS; p. 3-42). This problem is carried over to the FSEIS. Moreover, NRC Staff now explicitly maintain in the FSEIS that the Nubeth Project groundwater restoration was successful and complete (FSEIS; p. 2-11 – 2-12). We explore this assertion in the paragraphs that follow.

23. First, we have noted repeatedly, there are no 'pre-industrial baseline' values from Nuclear Dynamics (1978) or Strata (2011a). Pre-industrial baseline values can only be determined if statistically valid, random groundwater samples are collected from wells that are constructed and developed without the addition of oxidizing fluids and air; and collected before the well field is developed. This was not done by Nubeth or Strata. Second, Buswell (1982, p.25) notes that in 1976 Nubeth initiated a single-well, push-pull study (i.e., the injection and extraction of lixiviant from a single well), nearly two years ***before*** the first baseline samples were collected in April 1978 (Nuclear Dynamics 1978). The impact of this test is evident over the area defined by the monitoring wells that were sampled two years after the testing (see figure under paragraph 20). Therefore, the ore was injected with lixiviant *before* baseline water-quality samples were collected and pre-industrial baseline does not exist for the Nubeth pilot-scale

study (see Paragraphs 15 and 16, where invalid baseline was determined in the same manner for the Irigaray Project).

24. The figure under paragraph 20 also shows the impact of the Nubeth 1976 lixiviant injection prior to establishing the Nubeth 'baseline' values two years after lixiviant injection. Well 19xx(nb) was the injection and extraction location and the elevated uranium and radium-226 indicate the ore was oxidized. Based on similar uranium and radium-226 results for well 3x(nb), and to a lesser extent 4x(nb), these wells were within the zone disturbed by the injection of the lixiviant at 19xx(nb) (Nuclear Dynamics 1978). Other wells used to define the Nubeth 1978 'baseline' (except 20x(nb)), which appears unaffected by the test) have elevated uranium but low radium-226 (see figure under paragraph 20). These wells are impacted by the transport of uranium in a carbonate lixiviant. Therefore, the Nubeth wells used to collect water-quality samples were contaminated by the injection of the lixiviant prior to sample collection and there is no pre-industrial 'baseline' for the Nubeth ISR test project. Despite the fact that the pre-industrial 'baseline' reported by Nuclear Dynamics (1978) is not representative of pre-industrial conditions and is biased to high values, restoration at this test site was unsuccessful (see paragraph 33).

A Valid Scientific and Statistical Method to Establish Baseline Prior to Licensing and For a Draft NEPA Review

25. Another element of the Petitioners' first contention was the failure of the NRC materials license process to provide a scientifically sound sampling regime prior to the issuance of a license and during the course of the public environmental review. (See 2011 Abitz Decl. ¶¶ 16-19 on ER, Petition at 14). As with a number of other elements in dispute, there has been no substantive change between the ER, the DSEIS, and now the FSEIS. As noted in the first Abitz declaration

(2011), in our expert judgment, Strata must lay out a systematic grid of the proposed project area, and select at random points in that grid to locate baseline wells. Existing water-quality data from Strata's six regional wells can be used to estimate the approximate standard deviation of the population (which must be done for each quarter to eliminate temporal trends), and this methodology can be used to estimate the number of wells needed to reach the stated statistical confidence for obtaining a representative number of samples from the regional project area aquifer.[4] Such an industry-standard, statistical sampling approach (Matzke et al., 2007), with a stated level of decision confidence, is the only valid scientific method available to Strata if they wish to conclude that the water quality in the ore zone does not meet the EPA MCLs for uranium and radium-226.

26. Another element of the Intervenors' first contention is the statistically invalid, biased collection of non-representative groundwater samples from wells screened only through the part of the OZ water horizon that is in contact with the ore zone, rather than the entire column of water in the OZ sand interval. *See* 2011 Abitz Decl. ¶ 22, Petition at 14. Regarding this element, little has changed in the FSEIS on the issue of collecting representative groundwater samples, as screen lengths for the existing six monitor wells in the OZ zone are approximately ¼ to ½ the thickness of the OZ sand (Table 1 in Abitz 2011) and centered on the ore zone. This has the effect of biasing the groundwater sample to high values for uranium, radium-226 and other uranium progeny and associated ore metals (e.g., arsenic, molybdenum, vanadium, etc) due to the disturbance and oxidation of the ore during well construction and development. We are

[4] NRC guidance is to place one baseline well in every four acres (NRC, 2003; p. 5-39), but Intervenors are not suggesting that 312 wells (1248 acres proposed for ISL well fields divided by 4) are strictly necessary to obtain representative water samples. Fewer locations can be achieved with good statistical design, but no such effort has been made or suggested by the NRC Staff. In any event, a systematic grid and well-designed statistical sampling plan is necessary.

aware that NRC Guidance (NRC, 2003; p. 5-43) also recognizes this bias and the NRC states that fully screened intervals are more accurate in their representation of the water quality that a user of the water will encounter. Therefore, in our expert opinion, the present monitor wells in the OZ horizon do not collect a representative groundwater sample.

27. We provide an example (using VSP software) and subsequent explanation of how this sampling might look (Abitz May 2013 declaration).

	2010 Uranium Results (mg/L)			
	1st Q	2nd Q	3rd Q	4th Q
22-18OZ	0.070	0.033	0.069	0.033
14-18OZ	0.096	0.109	0.109	0.085
21-19OZ	0.017	0.008	0.024	0.005
34-7OZ	0.041	0.038	0.044	0.028
34-18OZ	0.062	0.059	0.046	0.041
42-19OZ	0.011	0.010	0.010	0.009
Median	0.052	0.036	0.045	0.031
Mean	0.050	0.043	0.050	0.034
std dev	0.033	0.038	0.035	0.029
SW test statistic 95% conf	0.952	0.883	0.948	0.892
SW critical value 95% conf	0.788	0.788	0.788	0.788
95% LCL mean	0.023	0.012	0.021	0.010
95% UCL mean	0.076	0.074	0.080	0.057
t stat	1.46	0.837	1.42	0.298
t critical value 90% conf	1.48	1.48	1.48	1.48
Conclusion	accept null hypothesis because t stat < t crit value			
Null hypothesis	regional groundwater < 0.03 mg/L			
Type I error (alpha)	0.1; 90% confident we will accept null hypothesis when it is true			
gray area	0.005 above uranium MCL (0.035 mg/L)			
Type II error (beta)	0.5; 50% chance to accept null hypothesis if the true mean is 0.035 mg/L			

Sample Requirements	73	96	82	57
Null hypothesis	regional groundwater < 0.03 mg/L			
Type I error (alpha)	0.1; 90% confident we will accept null hypothesis when it is true			
gray area	0.01 above uranium MCL (0.04 mg/L)			
Type II error (beta)	0.5; 50% chance to accept null hypothesis if the true mean is 0.04 mg/L			
Sample Requirements	19	25	21	15
Null hypothesis	regional groundwater < 0.03 mg/L			
Type I error (alpha)	0.1; 90% confident we will accept null hypothesis when it is true			
gray area	0.01 above uranium MCL (0.04 mg/L)			
Type II error (beta)	0.2; 20% chance to accept null hypothesis if the true mean is 0.04 mg/L			
Sample Requirements	50	66	57	39

28. The statistical summary in paragraph 23 indicates that the six regional monitor wells are an insufficient number of wells to conclude, with a stated level of confidence (90% in this example), that uranium exceeds the EPA MCL in the OZ aquifer. To perform this analysis with parametric statistical tests (e.g., student t test), the data must be evaluated with the Shapiro-Wilk (SW) test to determine if the distribution is normal or lognormal (Shapiro and Wilk, 1965; Shapiro et al. 1965). If the data are neither normal nor lognormal, non-parametric test methods must be used. The SW test statistic is greater than the SW critical value, which indicates that the six results for each quarter follow a normal distribution, and the 95% lower control limit (LCL) of the mean is below the EPA MCL, which indicates that the true uranium mean of the regional aquifer could be below 0.03 mg/L. Because the data are normally distributed, the student t test can be used to test the hypothesis (90% confidence level used in this example) that the true uranium mean is less than the EPA MCL (0.03 mg/L). The results of the student t test

show that the t statistic is above the t critical value, and we have to accept the null hypothesis that the true uranium mean for the groundwater in the OZ horizon is less than the EPA MCL of 0.03 mg/L. If Strata believes the true uranium mean in the OZ horizon is above the EPA MCL, they must collect additional random samples and rerun the SW and Student t tests to determine if the null hypothesis can be rejected, which would demonstrate that the true uranium mean is above the EPA MCL. The sample requirements for different Type II errors and contamination scenarios indicate a minimum of 15 and maximum of 96 locations would be needed to test the alternative hypothesis that the true uranium mean is above the EPA MCL.

29. Further, the lack of analysis found in the FSEIS exemplifies the need for a meaningful environmental review of baseline water-quality data prior to any final licensing decisions. For example, in Tables 3.6 and 3.7 of the FSEIS, Strata's six cluster wells are grouped together to report average and ranges for each water horizon, and there is no mention of the proper statistical methods for evaluating individual wells prior to grouping them and calculating an average or range for the aquifer horizon (Gilbert, 1987; Matzke et al., 2007; ASTM, 1998; EPA, 1989; 1992a; 1992b; 2009; NRC, 2003). A simple averaging or simply reporting a range of the values from all wells is inappropriate, unless it can be shown with proper statistical methods that (i) the samples from the individual wells follow a normal or log-normal distribution, and (ii) an analysis of the data variance of each well demonstrates that the wells can be combined into a single population for statistical calculations. Examination of the figure under paragraph 20 clearly shows samples from the six cluster wells do not fall into a single population with respect to uranium and radium-226. Standard statistical practices for the environmental industry (random grid sampling, statistically significant number of sampling locations, proper statistical tests, etc) are routinely and easily carried out using available

statistical software (e.g., Visual Sampling Plan, available free from Pacific Northwest National Laboratory: http://vsp.pnnl.gov), and we note that the use of these standard industry practices is enforced by EPA when groundwater and soil samples are collected at CERCLA and RCRA sites (DOE 1998a-e; DOE 1999a-e; DOE 2000a-e; DOE 2001a-e; DOE 2002a-c; DOE 2003a-c; DOE 2004a-f; DOE 2005 a-d; DOE 2006a-o; DOE 2007a-j; DOE 2008a-b; DOE 2009).

30. Presently, the NRC materials license process fails to develop an accurate and independent assessment of water quality in the ore zone (*See* Sass Decl. ¶ 15, Petition at 13). NRC's review of the FSEIS primarily relies on an invalid analysis of the data in the Strata application, which in our expert judgment is insufficient to conclude that the regional water quality in the ore zone exceeds the EPA drinking water Maximum Concentration Limits (MCLs) for uranium and radium-226.

Contention 2 – Failure to Analyze the Environmental Impacts of Alternative Concentration Limits

ISR Restoration Has Failed In Virtually Every Instance

31. It is well established that no pilot-scale or full-scale ISR mining operation has restored their uranium contaminated groundwater to the baseline values cited in the initial license permit (Deutsch et al., 1984; Hall, 2009; Staub et al., 1986). Importantly, ISR operators are unable to restore the groundwater to baseline values, even erroneously poor baseline values that are biased by high by oxidation of the ore zone during drilling and well development, invalid sampling protocols, and improper statistical representations of analytical results. It is apparent, in our expert judgment, that the probability is vanishingly small that ISR-contaminated groundwater can be restored to baseline values when those values are properly determined with valid scientific and statistical techniques.

The Nubeth Project Demonstrates this Failure to Restore Groundwater

32. Failure to restore the groundwater under the Nubeth pilot-scale ISR operation is evident in the consistently elevated uranium and radium-226 concentrations observed in samples from industrial well 19xx18 (Figure under Paragraph 20), which served as the extraction well to the Nubeth pilot-scale test (Figure 3.15 in the FSEIS). The uranium-radium-226 trend observed for all Strata cluster wells from the OZ horizons and industrial well 22x19 lies well below the radium-226 values for 19xx18, and the high radium-226 values can be explained by the capture of the contaminated plume that remains from Nubeth's failure to restore groundwater after their six-month pilot-scale test. Also, note that the water collected from the 19xx18 well is derived from the OZ and SM zones (see paragraphs 59-61), which dilutes the uranium and radium values in the Nubeth OZ zone (i.e., the uranium and radium values in the Nubeth OZ zone are higher than measured in the 19xx18 samples). In our expert opinion, failure to restore the groundwater after a short six-month pilot-scale project should have clearly communicated to the NRC Staff that it will not be possible to restore a full-scale ISR operation in 8 months (DSEIS at 2-33; Fig 2-6 in FSEIS).

33. The table presented below displays the complete results of the Nubeth restoration (FSEIS p. 5-28). Samples for individual wells associated with the Nubeth ore zone operation (3x, 4x, 5x, 6x, 11x, 12x, 19x, and 20x) are shown for 'baseline' and Restoration/Post-Restoration. Issues using the term 'baseline' for this project were discussed previously (Paragraph 20). The NRC Staff presented the highlighted data in Table 5.4 of the FSEIS, and omitted four other 1981 samples taken post-restoration (ND Resources 1980 and Nuclear Resources 1982). When the <u>average</u> restoration/post-restoration values are compared to the <u>average</u> 'baseline', the percent increase for post-restoration, average uranium values (range from 109 – 2640 %) are greater

than the values the NRC Staff provided in Table 5.4. Well 4x, 6x, and 12x were near or below uranium concentrations reported by the NRC Staff, yet all post-restoration sample averages exceeded average 'baseline' uranium concentrations. These data are critical to assessing the potential environmental impacts to water quality from previous ISR restorations near the applicant's proposed mining activities, yet the FSEIS did not provide a complete analysis with the available data. Similarly, average stability concentrations, using the entire dataset, were used to justify restoration efforts at Crow Butte (Crow Resources, 2001; paragraph 35).

	Baseline - (Nuclear Dynamics 1978 - ML12135A358) Nubeth Well - Uranium Concentration (mg/L)									Restoration and Post-Restoration Nubeth Well - Uranium Concentration (mg/L)					
Date	3x	4x	5x	6x	11x	12x	19x	20x		3x*	4x*	5x ^	6x ^	11x ^	12x ^
	0.071	0.08	0.1	0.075	0.079	0.073	0.3	0.006		0.12	0.21	0.1	0.09	0.1	0.09
	0.059	0.067	0.077	0.08	0.065	0.049	0.069	0.002		0.18	0.12	0.09	0.1	0.1	0.09
6/1978	0.068	0.086	0.068	0.1	0.079	0.064	0.069	0.003		0.64	0.16	0.09	0.1	0.1	0.09
	0.089	0.12	0.057	0.098	0.088	0.059	0.077	0.002		0.51	0.16		0.1	0.1	0.09
	0.068	0.09	0.11	0.095	0.082	0.067	0.078	0.002		0.24	0.22	0.08	0.1	0.08	0.11
Average =	0.071	0.089	0.082	0.090	0.079	0.062	0.119	0.003	Average =	0.338	0.174	0.090	0.098	0.096	0.094
Max =	0.089	0.12	0.11	0.1	0.088	0.073	0.3	0.006	Max =	0.64	0.22	0.1	0.1	0.1	0.11
							Percent Change (Averages) =			**476**	**196**	**109**	**109**	**122**	**151**

Highlighted values presented by the NRC staff in Table 5-4, p. 5-28, FEIS

^ - May - September 1979 (Nuclear Dynamics 1980 - ML13274A287)

* - March - October 1981 (ND Resources 1982 - ML13274A178)

NRC's FSEIS Examples of Restoration Demonstrate A Repeated Failure to Restore Groundwater

34. Given overwhelming scientific evidence of the failure of the ISR industry to restore groundwater to pre-industrial water-quality standards (Hall 2009; and examples below), none of the new information in the selective and limited restoration results provided in the FSEIS demonstrates successful groundwater restoration for uranium and other water quality parameters of concern. The NRC Staff provides analysis of historical ISR restoration results (FSEIS; p. 4-46) regarding ISR restorations at the Crow Butte Wellfield 1, Smith Ranch-

Highland A Wellfield, and Irigaray Mine Units 1-9. We discuss the NRC's misleading analysis and conclusion of "*improvement in water quality*" in detail in the following paragraphs.

35. With respect to Crow Butte Wellfield 1: briefly, the NRC approved the restoration of Wellfield 1 after 30 of 37 water-quality parameters were returned to 'baseline' or Wyoming Class I Domestic Use Standards. Similar to other ISR groundwater restoration results, radium-226 and uranium concentrations were not restored and NRC Staff justified the failure with this statement: "*The NRC determined that the radium-226 and uranium concentrations at 31 percent and 18 percent above post-licensing, pre-operational concentrations were protective of human health and the environment (Crow Butte Resources, 2001). The applicable condition in Crow Butte's NRC license was changed to require stability monitoring beyond the six-month period, as necessary to ensure no increasing concentration trends were exhibited*." (FSEIS; p. 4-46) NRC Staff's justification is flawed. First, there is no risk or dose calculation to support the contention that the elevated radium-226 and uranium concentrations pose no threat to human health and the environment. Second, the NRC states that uranium concentrations remained 18% above baseline concentrations, which is incorrect (Crow Butte Resources, 2001). According to Crow Butte Resources (2001), post-stabilization uranium concentrations were nearly 18.8 times higher than baseline, not 18% percent above baseline (Figure below paragraph 35). The difference is significant. In perspective, a car going 18% over a 55 MPH speed limit would be driving roughly 65 MPH. A car going 18.8 times 55 MPH, would be driving roughly 1,034 MPH. Also of note, average arsenic concentrations went from being non-detectable to exceeding the USEPA MCL (10 ppb). This first NRC example or restoration demonstrates their failure to thoroughly analyze the significant environmental impacts that arise when ISR operators fail to restore contaminated groundwater at ISR sites.

Table 3: Parameters Below UIC Permit Standards

Parameter	Baseline Average (Primary Goal)	UIC Permit Standard	Stabilization Average Water Quality
Arsenic (mg/l)	<0.002	0.05	0.017
Calcium (mg/l)	12.5	125	19.9
Total Carbonate (mg/l)	351	609	421
Iron (mg/l)	<0.044	0.30	<0.09
Potassium (mg/l)	12.5	125	13.2
Magnesium (mg/l)	3.2	32	5.3
Molybdenum (mg/l)	<0.069	1.00	0.10
Vanadium (mg/l)	<0.066	0.2	0.11
Radium-226 (pCi/l)	229.7	584	303
Uranium (mg/l)	0.092	5.0	1.73

It should be noted that, of the ten parameters that meet the UIC permit standards but were not returned to baseline concentrations, when standard statistical methods are applied to the baseline data, the concentrations of five of these parameters are statistically the same as baseline. The NRC states in NUREG-1569[2] that "...the baseline average plus three standard deviations is another method for establishing primary restoration targets that has been found acceptable by the NRC." CBR recognizes that this method of determining baseline concentrations is not the method approved in CBR's License. CBR is required to restore the affected groundwater on a mine unit average to the average baseline concentration with no statistical analysis of the data. However, CBR believes that NRC should consider statistical methods when determining whether acceptable efforts have been made to return Mine Unit 1 to baseline condition. Using NRC-accepted methods, five of the ten parameters are statistically at baseline concentration on a mine unit average.

[2] USNRC, NUREG-1569, *DRAFT STANDARD REVIEW PLAN for In Situ Leach Uranium Extraction License Applications*, October 1997.

36. The FSEIS next discussed restoration at Smith Ranch-Highland Wellfield A (FSEIS; p. 4-46). There, the NRC states 31 of 35 water-quality parameters were restored to 'baseline' concentrations; but again, little analysis is provided with respect to constituents not restored to

'baseline' values. Specifically, the NRC Staff does not discuss the post-restoration concentrations of uranium and heavy metals in the ore field. The Smith Ranch-Highland facility observed elevated post-restoration contaminant concentrations, relative to 'baseline', for arsenic (3000%), selenium (7000%), and uranium (7060%). All three of these parameters exceeded their respective water quality MCLs (Borch et al. 2012). Furthermore, long-term sampling at two wells in the ore zone (MP-4 and I-21) reveal that groundwater samples had reached peak uranium concentrations in 2012 (17.3 and 2.13 mg/L, respectively)(Cameco Resources 2012). This is evidence that reducing conditions has not re-established in the ore zone at this site and uranium concentrations in the ore zone are increasing over-time.

37. Next, the FSEIS referenced the restoration approval at Irigaray Mine Units 1-9 (FSEIS; p.4-46). Results from the Irigaray Mine Units reflect similar failures to restore uranium to baseline concentrations. The table below shows the restoration results for average baseline and average stability uranium concentrations. Data were provided from (NRC, 2013b). Issues associated with the elevated 'baseline' concentrations at Mine Unit 1, due to research and development mining prior to collection of 'baseline' samples, were discussed in paragraphs 16 and 17. In the restoration summary report, the results are described as acceptable due to a best-effort approach: "*COGEMA has expended significant effort to restore the groundwater quality within the Irigaray wellfield to baseline conditions. At the completion of the Irigaray groundwater restoration program, the ore zone aquifer has been restored to standards consistent with Best Practicable Technology (BPT) and NRC's ALARA (As Low As Reasonably Achievable) principle. In this regard, over 840 million gallons of water were processed over an 11.5-year period, and an average of 13.7 pore volumes were treated for the entire wellfield. Treatment*

volumes exceeded the amounts included in the approved treatment plan." (COGEMA Mining, Inc. 2005)

Irigaray Mine Unit	Average Baseline	Average Stability Rounds 1-4	% Change Average Stability 1-4
Mine Unit 1	3.042	0.988	32%
Mine Unit 2	0.130	3.782	2908%
Mine Unit 3	0.023	2.878	12515%
Mine Unit 4	0.046	2.420	5292%
Mine Unit 5	0.020	1.493	7467%
Mine Unit 6	0.112	1.854	1663%
Mine Unit 7	0.119	1.456	1226.8%
Mine Unit 8	0.041	1.591	3923%
Mine Unit 9	0.066	1.825	2751%

Uranium Concentrations (mg/L)

38. Furthermore, 'baseline' values from Irigaray (Mine Unit 1), which were elevated from research and development mining activities prior to 1976 (paragraphs 16, 17), were presented as the minimum, maximum, and average for all wellfields (wellfields 1-9) (Figure below paragraph 39). This was not coincidental; as industry and Wyoming state regulators agreed to present the entire Irigaray restoration results for all wellfields as a single combined wellfield.

"*In May 2003, COGEMA Mining, Inc. met with WDEQ personnel to discuss the restoration status of the Irigaray and Christensen Ranch projects. At that time, it was proposed and agreed that one restoration report package (this report [referring to the original document]) would be submitted for the Irigaray project. This would entail combining all baseline data from Units 1 through 9 together for a larger database. It was recognized that the data from Units 1 through 9 are more meaningful when combined as a whole than if presented as several individual packages. Thus, a combined baseline data set was compiled*

from the ore zone baseline wells located in Production Units 1 through 9 and is included in Table 4-2 [original document]." (COGEMA Mining, Inc. 2005b)[5]

39. Subsequently, the table of restoration data (below paragraph 39) was presented to the NRC, which includes the elevated 'baseline' uranium concentrations that were determined after research and development activities (COGEMA Mining Inc, 2006). All wellfields (1-9) were combined for a composite average 'baseline' and compared to restoration composite concentrations, as determined by COGEMA and WDEQ. However, 8 of the 9 wellfields (Wellfields 2 through 9) have significantly lower average 'baseline' uranium concentrations (range 0.023 – 0.13 mg/L) (table under paragraph 34) relative to the composite average 'baseline' value of 0.52 mg/L. Thus, the elevated 'baseline' samples collected after research and development activities at Wellfield 1 skewed the composite wellfield average uranium concentration to a higher average value of 0.52 mg/L. Consequently, the new restoration table gives the illusion that the overall post-restoration average uranium concentrations increased from only 0.52 to 1.83 mg/L (352% increase). However, when compared to the initial average 'baseline' uranium concentrations for each wellfield, the average post-restoration uranium increases for Wellfields 1 through 9 are substantially higher (table under paragraph 39). This post-operations and post-restoration manipulation of data essentially masks the reality of the groundwater impacts of the mining operations.

[5] We assume this meeting occurred on 5/27/03, as public reports show - "*Meeting in Casper among industry representatives (COGEMA, PRI and WMA), Land Quality and Water Quality representatives to discuss restoration progress and alternatives.*" (COGEMA Mining Inc. 2009)

Table 1. Comparison of 4th Round Stability Data Range to Baseline Range, Irigaray, Wyoming

IRIGARAY DESIGNATED RESTORATION WELLS - WATER QUALITY SUMMARY

	Unit 1-9 Baseline			Unit 1-9 Round 4			No of Samples Exceeding Baseline Range	Comments
	Minimum	Maximum	Mean	Minimum	Maximum	Mean		
Major Ions mg/l:								
Ca	1.6	27.1	7.8	11.6	65	28.8	17	No groundwater standard
Mg	0.02	9	0.9	2.8	13	7.0	7	No groundwater standard
Na	95	248	125	107	275	185.6	2	No groundwater standard
K	0.92	17.5	2.4	1.1	4.9	2.9	0	
CO3	0	96	13.2	< 1.0	< 1.0	0.8	0	
HC03	5	144	88.3	5.1	631	409.0	31	No groundwater standard
SO4	136	504	188.1	62.8	237	132.0	0	
Cl	5.3	15.1	11.3	0.1	117	39.4	32	All values below WDEQ Standard
NH4	0.05	1.88	0.3	0.05	36.1	8.5	13	NH3 equivalent is below WDEQ Standard
NO2 (N)	< 0.1	1	< 0.4	< 0.1	< 0.1	< 0.1	0	
NO3 (N)	0.2	1	0.9	< 0.1	0.12	0.1	0	
F	0.11	0.68	0.29	0.1	0.22	0.12	0	
SiO2	3.2	17.2	8.3	2.5	7.3	4.99	0	
TDS	308	784	404	343	968	626	5	Exceeds WDEQ and EPA secondary standard
Cond. (mmho/cm)	535	1343	658	604	1970	1094	5	No groundwater standard
Alk. (as CaC03)	67.8	232	104	127	518	345	30	No groundwater standard
pH (units)	6.6	11.00	9.00	7.07	8.40	7.76	0	
Trace Metals mg/l:								
Al	0.05	4.25	0.160	< 0.1	0.140	0.102	0	
As	< 0.001	0.105	0.007	< 0.001	0.029	0.005	0	
Ba	< 0.01	0.12	0.060	0.03	0.200	0.095	1	All values below WDEQ and EPA standard
B	< 0.01	0.225	0.110	<0.05	0.100	0.088	0	
Cd	< 0.002	0.013	0.005	< 0.002	0.005	0.004	0	
Cr	< 0.002	0.063	0.020	< 0.005	0.050	0.039	0	
Cu	< 0.002	0.04	0.011	< 0.01	0.020	0.010	0	
Fe	0.019	11.8	0.477	< 0.03	0.500	0.113	0	
Pb	< 0.002	0.05	0.020	< 0.001	0.090	0.039	1	One sample exceeds WDEQ and EPA standard
Mn	< 0.005	0.19	0.014	0.060	0.950	0.215	13	Exceeds WDEQ and EPA secondary standard
Hg	< 0.0002	0.001	0.0004	< 0.0002	< 0.001	< 0.001	0	
Mo	< 0.02	0.1	0.060	< 0.01	<0.1	0.069	0	
Ni	< 0.01	0.2	0.100	< 0.05	< 0.05	< 0.05	0	
Se	< 0.001	0.416	0.013	< 0.001	0.086	0.019	0	
V	< 0.05	0.55	0.070	< 0.05	< 0.1	0.088	0	
Zn	0.009	0.07	0.016	< 0.01	< 0.01	< 0.01	0	
Radiometric pCi/l:								
U (mg/l)	0.0003	18.60	0.52	0.08	6.03	1.83	0	
Ra 226	0	247.7	39.6	23.50	521.0	130.7	3	Exceeds WDEQ and EPA standard

40. The post-stabilization data were submitted and accepted by the WDEQ in 2005. Recall, this occurred after the 2003 meeting between COGEMA and WDEQ to discuss combining the restoration results for all wellfields. In other words, WDEQ had prior knowledge of COGEMA's intent to submit a combined wellfield restoration package (COGEMA Mining, Inc. 2005b). In brief, WDEQ approved a restoration and concluded further attenuation monitoring was not required and wells withing the wellfield may be abandoned (COGEMA Mining, Inc. 2005a). Unfortunately, the NRC Staff agreed with WDEQ's assessment of the restoration on September 20, 2006 (NRC, 2006).

41. The examples from the Irigaray and Nubeth ISR projects demonstrate that previous mining activities and operations bias 'baseline' values to high concentrations, and pre-industrial baseline does not exist at any ISR mining site. These examples and observations support Intervenor's Contentions 1 and 2: in that, the NRC Staff and the applicant have neither established an adequate baseline nor addressed the almost certain impact to groundwater resources when alternative concentration limits are set after restoration fails. Based on the events which transpired between industry and state regulators at the Irigaray restoration described above, it is our concern that the creation of artificially elevated uranium baseline concentrations could mask restoration failures and the actual groundwater impacts.

The FSEIS Merely Relies on Failed Industry Restoration Efforts

42. Another element of the Intervenors' second contention, the failure to adequately define the specific aquifer restoration criteria/standards during the NEPA process and prior to licensing the facility (see Moran Decl. ¶ 70, Petition at 17), is also unaltered by treatment in the FSEIS. Here, NRC Staff admits the restoration criteria are not known at this time. *See* contention 1 above: "*The purpose of aquifer restoration is to restore the ground-water quality in the wellfield to the ground-water protection standards specified at 10 CFR Part 40, Appendix A,Criterion 5B(5) so as to ensure no hazard to human health or the environment*" (FSEIS; p. 2-34)
43. The FSEIS treatment of restoration is based on what Strata informed the agency, and not on an NRC independent analysis of a successful restoration timeframe. The FSEIS provides a general description of aquifer restoration techniques: (1) groundwater transfer, (2) ground-water sweep, (3) RO treatment with permeate injection, (4) groundwater recirculation, and (5) stabilization

monitoring, but does not say which would be deployed in what wellfield and for how long and why. Also, there is no differentiation in aquifer restoration techniques between the 15-25 estimated wellfields. This is demonstrated in the vague wording used by the NRC Staff: "*Not all five aquifer restoration activities would be used for restoration of a specific wellfield if determined by the Applicant to be unnecessary to achieve the applicable ground-water protection standards; however, should Strata submit a request for application of an Alternate Concentration Limit (ACL) at a designated wellfield, the NRC staff will review the aquifer-restoration activities to ensure that an approriate (sp) level of effort has been performed."* (FSEIS; p. 2-35)

44. The suggested eight-month restoration period is far too short; given the past history of failed ISR restorations at other ISR sites (see Abitz Decl. ¶ 28, Petition at 18). Proposed restoration timeframes are based on the NRC definition of a pore volume as "*a term used by the ISR industry to represent the volume of water that fills the void space in a given volume of rock or sediment* (FSEIS; 2-36)". Unfortunately, there is neither discussion nor analysis of the restoration dependency on anthropogenic-induced geochemistry, rather than the restoration techniques listed in paragraph 43; leaving little credibility in the FSEIS's estimated restoration timeframe given the industry's failed restoration history (See paragraphs 35-41 of this declaration).

45. The NRC Staff has not met the agency's obligations under NEPA to perform an adequate environmental impacts analysis of a proposed action and alternatives. The examples from unsuccessful restoration efforts at ISR sites (paragraphs 35-41) indicate the difficulty of predicting the number of pore volumes required for adequate restoration of uranium in the groundwater. Results from restoration failures at the Irigaray Project (paragraph 37) indicated

13.7 pore volumes (840 million gallons) were extracted and treated prior to approving the failed restoration. Yet, the FSEIS provides no analysis of the pore volume numbers for the Irigaray failed restoration and simply agrees with the arbitrary restoration timeframe or pore volume estimate provided by Strata: "*The NRC staff found that the Applicant's estimate of 9.5 pore volumes was acceptable because the estimate is within the range currently used by the uranium-recovery industry, and the Applicant commits to minimizing inefficiencies and adjusting the decommissioning estimate based upon its future experience (FSEIS, p. B-46).*" That is, the NRC Staff has agreed with Strata on using a pore volume estimation and arbitrary pore volume selection approach similar to the demonstrated failed restoration at numerous other mine units, including the Irigaray site.

46. As a further matter, the inability of the ISR industry to restore a wellfield to baseline uranium concentrations (even concentrations that are biased high with invalid sampling and statistical methods) is associated with the NRC Staff and industry failure to acknowledge the reaction kinetics and thermodynamics of uranium ore geochemistry. The ISR industry and NRC understand that ore deposits form over the period of hundreds of thousands to millions of years. During these immense time intervals, the fluvial deposits accumulate uranium where reducing conditions are favorable for precipitation of uranium. The ISR industry and NRC also understand that injection of an oxidizing-bicarbonate lixiviant destroys the natural balance in the ore-zone geochemical conditions over a period of a few years by pumping very high levels of oxidants and complexing agents through the ore zone. Under these anthropogenic induced changes, materials along the lixiviant flow path are oxidized and the reducing capacity built up in the sediments over hundreds of thousands to millions of years is substantially altered in a matter of years.

47. For all the reasons above and based on review of the relevant data, it is our professional opinion that no ISR mine site has ever fully restored the groundwater to 'baseline' conditions. And equally important, the FSEIS fails to consider and acknowledge this likelihood and any subsequent environmental impacts of permanently contaminated groundwater.

Contention 3 – Fluid Migration

NRC's FSEIS Provides Insufficient and Potentially Inaccurate Information to Make an Informed Analysis of Fluid Migration

48. The NRC has failed to analyze and model the subsurface geochemistry and potential for contaminant excursions. This is demonstrated in the FEIS at p.4-41, "*As described in Section 2.1.1.2 of this SEIS, chloride, conductivity, and total alkalinity would be measured twice monthly in the monitoring wells to detect excursions. These constituents move through the aquifer faster than other water-quality parameters, and therefore levels above these would indicate excursions before radionuclides and other elements move outside the production (i.e., uranium-recovery) zone.*" The quoted statement is inaccurate and an oversimplification of the dominant geochemical mechanisms which dictate subsurface transport of soluble uranium (U(VI)). Without the presence of carbonate anions, U(VI) is readily adsorbed to the surfaces of various iron oxides and clays. However, with the introduction of an oxidizing carbonate-rich lixiviant to artificially enhance U(VI) solubility, uranium adsorption to iron oxide surfaces decreases, as relatively non-reactive uranyl-carbonate complexes form in solution (Curtis et al. 2006; p. 41 ExxonMobil, 2010; Zhou and Gu, 2005). Thus, the aqueous uranium-carbonate species formed from ISR operations process will be highly mobile in the groundwater.

49. Furthermore, U(VI) subsurface modeling has reported that adsorption of uranium in the subsurface is highly complex and varies spatially and temporally (Curtis et al. 2006). Outside of reporting water-quality parameters and the slight mention of uranium minerals and pyrite in the fluvial deposits, the FSEIS presents very little about the current subsurface geochemical zonation and more importantly, is silent on how mining activities will disturb reducing geochemical conditions.

50. Another mechanism which could potentially remove U(VI) from solution is reductive precipitation to insoluble U(IV). This would require the presence of strongly reducing conditions in the subsurface; however the introduction of oxidizing agents during the ISR operation and restoration activities would disturb the reducing potential of the aquifer. Therefore, the NRC Staff's subjective assertion about constituent transport demonstrates a failure to adequately collect and analyze the amount of geochemical and hydrological data required to predict contaminant transport.

51. Furthermore, the FSEIS is vague and contradictory (FSEIS; p. 4-41) when it states: "*Temporary increases in concentrations of TDS outside the production zone would occur in the event of an excursion. Levels of radionuclides and elements such as arsenic, selenium, and vanadium that are mobilized with the uranium may increase in aquifers outside the production zone if excursions were to occur, but corrective actions in response to increased TDS would likely prevent increases of these elements.*" First, the NRC acknowledges that uranium and other metals will migrate during excursions, which agrees with our previous statements made in paragraphs 48-50 and with numerous observations from other sites (Staub et al. 1983; Uranium one, 2010; WDEQ, 2011). There are many documented cases of monitoring wells on excursion status for periods of months to years, where operators could not decrease elevated parameters

by adjusting pumping rates (Staub et al. 1983). In certain cases, uranium concentrations in monitoring wells were measured as high as 5.5 mg/L (WDEQ, 2011). Other horizontal excursions had little or no hydraulic explanation for observed uranium concentrations at a monitoring well; uranium ranged from 1.8 – 2.7 mg/L (Uranium one, 2010). Second, we assume NRC Staff is alluding to the corrective action of changing pumping rates to recapture the lixiviant plume. However, the proposed corrective actions do not have a credible scientific basis and analysis that addresses the hydrological properties in the exempted aquifer, redox conditions in the aquifer, the availability of various complexing anions, microbial community structure, and structural heterogeneity of the fluvial deposits.

52. In addition, empirical evidence from the Bison Basin ISR mine observed "*significant increases*" in sodium, sulfate, uranium, and conductivity when the M-2 monitoring well went on excursion status, February 4, 1981 (Staub et al. 1983). This example uses collected data to dispute the NRC assertion that the excursion monitoring constituents, alkalinity, chloride and conductivity are sufficient for establishing the excursion UCLs.
53. The USGS has studied and modeled U(VI) transport processes specifically to assist the NRC Staff with the evaluation of subsurface transport at ISR sites (Davis and Curtis 2007). Yet none of these considerations are discussed and applied by the NRC Staff in the FEIS. The aforementioned citation "*Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities*" is not used or cited within the FSEIS.

The FSEIS Fails To Analyze Sufficiently The Potential For And Impacts Associated With Fluid Migration And Communication Between Aquifer Units

54. The FSEIS notes that there are thousands of abandoned wells, but it does not disclose any total amount beyond information Strata has relayed to the agency. Indeed, the FSEIS discloses that hydrologic connection between the OZ aquifer and DM aquifer exists "*due to improperly plugged previous exploration drillholes that have not yet been properly abandoned*." DSEIS at 4-35; FSEIS at 4-34. But, the FSEIS does not consider the water quality impacts of these wells in relation to the Ross Project because NRC says groundwater impacts would be "*minimized by the Applicant locating the drillholes within the wellfields beneath the Proposed Action as well as plugging and abandoning them.*" (DSEIS at 4-36; FSEIS at 4-30). In short, both the DSEIS and now the FSEIS simply assume the feasibility of locating and plugging these thousands of drillholes and relies on the applicant to correctly perform these actions; stating that, "*[t]o prevent communication between aquifers during uranium-recovery operation, the Applicant proposes to actively locate and plug all exploration drillholes prior to beginning wellfield operations.*" DSEIS at 3-38.[6] "*…the applicant will attempt to locate and properly abandon all historical drillholes located within the ring of perimeter-monitoring wells in each wellfield…*" (FSEIS at 3-37).

55. The NRC Staff states in the FSEIS (p. 2-48) that, of the 1682 abandoned holes from Nubeth operations, the applicant had located 759 and plugged 55 wells. This was the exact number of wells presented in the DSEIS (p. 2-44); indicating from October 2010 to the FSEIS publication (February 2014), the applicant had not properly plugged a single abandoned Nubeth wellhole.

56. We find this disconcerting as the historical records at ISR mine sites indicate nearly all vertical excursions in the overlying aquifer were "*proportional to the intensity of mining activities*"

[6] However, "As of October 2010, the Applicant has located 759 of the 1682 holes thought to exist from Nubeth exploration activity and has plugged 55 of them." DSEIS at 2-44. These numbers were the same in the FSEIS (p. 2-48).

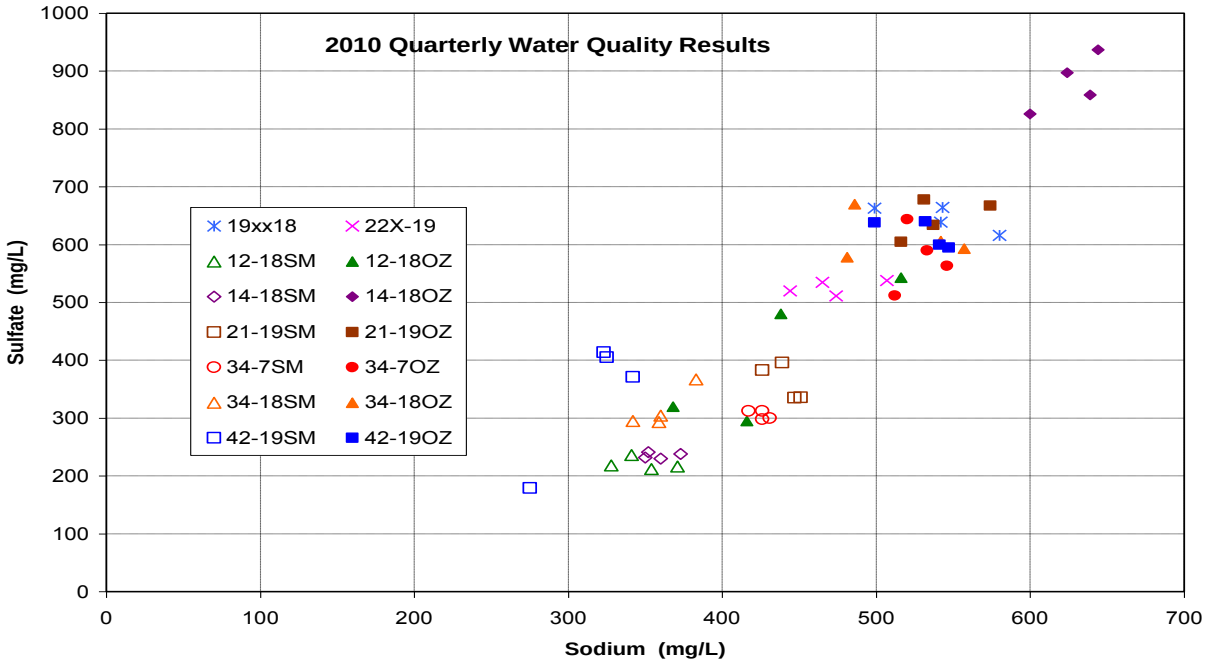
(Staub et al. 1986). That is, thinning of the fluvial confining unit, unidentified malfunctioning of equipment, or unsealed bore-holes into the ore zone aquifer have largely been responsible for vertical excursion into overlying ore bodies. The NRC Staff agrees and states, "*Vertical excursions tend to be more difficult to recover than horizontal excursions, and in a few cases, remained on excursion status for as long as eight years. The vertical excursions were traced to thinning of the confining geologic unit below the ore zone and improperly abandoned drillholes from earlier exploration activities*." (FSEIS, p. 4-37). The applicant has plugged roughly 3.3% (55/1682) of what they now report to be the known historical exploration boreholes in the permit boundary (96.7% of the known boreholes in the permit boundary have not been properly sealed). However, this 1682 figure contrasts with the over 5,000 exploration boreholes drilled in the area identified at the ER stage of this proceeding. *See* Moran Decl. ¶¶ 22,31; Abitz ¶13 Petition 21-23. Whether the figure is more than 5,000 or 1,682 there should be a full accounting of all improperly abandoned boreholes in the FSEIS; and the FSEIS must also present a clear discussion of the time table and requirements to locate, plug and abandon the boreholes before any wellfield is developed.

57. The FSEIS states that environmental impacts from horizontal and vertical excursions could be "MODERATE to LARGE" (FSEIS; p. 4-37). Control, prevention, and remediation of vertical excursions were largely unsuccessful at previous ISR sites in the United States (Staub et al. 1983). In other words, when a vertical excursion occurs in the SM aquifer, the applicant will have limited options to correct the excursion.
58. In our expert opinion, neither the number of wells tested for hydrological parameters nor the short duration of the pump tests run to date establish adequate hydrological information to demonstrate control of groundwater over 1,866 acres of complex fluvial stratigraphy (Strata,

2011b, Addendum 2.6-C) -- Strata constructed and developed six monitor-well clusters within the project boundary and performed 24-hour pump tests on four of these wells in July 2010 (12-18OZ, 21-19OZ, 34-7OZ, 42-19OZ; Strata 2011b, Addendum 2.7-J). The FSEIS does not at all address any of the significant data gaps in the conceptual and numerical hydrologic models put forward to support Strata's license application. This silence is inappropriate because the FSEIS does note that horizontal and vertical excursions of mining fluids occur at all ISR operations, and the vertical excursions were traced to thinning of the confining layer in the complex fluvial stratigraphy and improperly abandoned exploration bore holes (FSEIS; p. 4-37).

59. Demonstration of adequate hydrologic control is not a trivial matter because groundwater communication between the SM and OZ horizons is evident in the 24-hour pump test data from well 12-18OZ and the water-quality results for sodium and sulfate (Below paragraph 60). Groundwater from the ore horizon (OZ; solid symbols) generally has higher sodium and sulfate, relative to the overlying groundwater (SM). However, mixing of the groundwater from these two horizons is clearly indicated by the linear trace of the sodium and sulfate trend on Figure 2. In our expert opinion this is unquestionably demonstrated by the mid-location of plotted samples from 22X-19, a well that is screened through the OZ and SM zones (Section 2.7.3.3.1, p.2-169, Strata TR). If 14-18OZ is taken as the unmixed groundwater from the ore horizon, all other OZ samples are shown to have a component of SM water, as they lie between 14-18OZ and 22x-19. Note that the strong mixing between the horizons is unequivocal for samples from 12-18OZ, which plot with the samples from 22x-19 and the SM horizon.

60. Water-quality results for sodium and sulfate indicate groundwater mixing of the ore zone (OZ) and overlying horizon (SM).



61. The above figure also illustrates that, the closer that a pair of samples plots for a given cluster well (e.g., 12-18SM and 12-18OZ), the higher the probability for groundwater contamination by communication between the two groundwater zones during ISR operations. In contrast to mixing between the 12-18 horizons, 14-18SM and 14-18OZ samples cluster tightly and are well separated on the plot. An explanation for the distinct separation of the 14-18 horizons on the sodium-sulfate plot may be that the density of exploration boreholes is lower around this cluster well and less communication between the SM and OZ horizons has occurred (*i.e.*, 14-18 may provide a snapshot of the distinct major-ion chemistry of the horizons prior to the drilling of thousands of exploration boreholes).

62. Additionally, it is also known that 22x-19 is screened through the SM and OZ zones, and the FSEIS presents no detailed engineering analysis to show the effect of the industrial well operation on the ISR operations. <u>The complexity of the stratigraphy coupled with thousands of unplugged boreholes, established mixing between the SM and OZ zones, and the high-yield</u>

industrial wells requires many more test wells over the 1,866 acres and much longer pump test intervals to obtain the needed hydrologic data to assess the control of mining fluids during ISR operations. The FSEIS is silent on these complexities and provides no convincing hydrologic data to support Strata's contention that mining fluids will be controlled to prevent groundwater pollution.

63. Paragraph 62 is supported by the discussion and figure from (Staub et al.1983; p. 24), which provides evidence for alternative interpretations to aquifer tests and the complexities in adequately defining aquifer confinement:

> "*Conventional exploration methods as describe above seldom provide enough detail to determine whether an ore zone aquifer is sufficiently isolated from other aquifers. The complex stratigraphy of alluvial sediments is a serious obstacle to projection of lithologic units between boreholes even at short distances. Figure 2.8 [original document; see below] presents several interpretations of the same data. In the absence of proof of the contrary, stratigraphic units are often projected as continuous layers between boreholes which may lead to a false sense of security with respect to aquifer isolation. Furthermore, two-dimensional cross-sections do not necessarily portray accurate relationships between aquifers in three dimensions. Thus, an aquitard may be continuous in one direction and discontinuous in another.*" (Staub et al. 1983) (page 24).

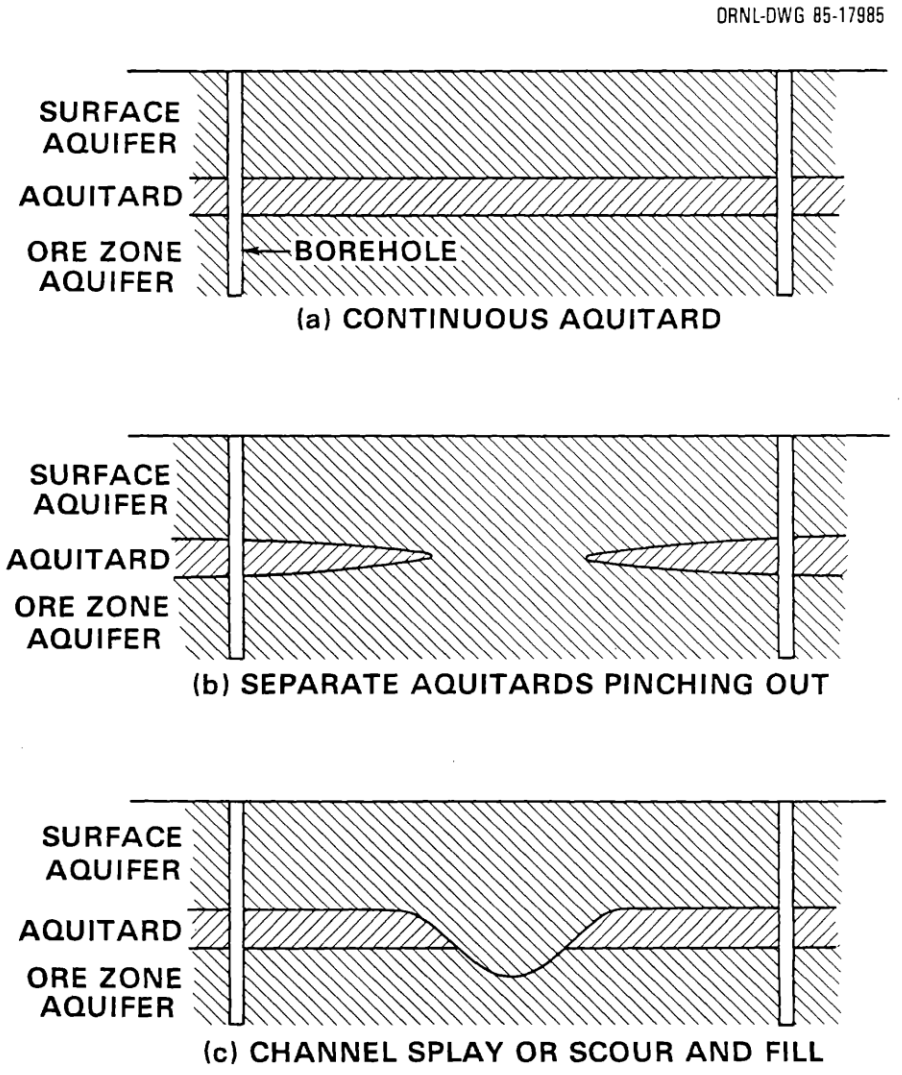


Fig. 2.8. Alternate interpretations of the same borehole data.

Contention 4 – Cumulative Impacts

64. With respect to the Intervenors' fourth admitted contention, the failure to sufficiently describe cumulative groundwater quantity impacts and the failure to quantitatively evaluate impacts of the proposed Lance District expansion and the project as a whole is technically unjustified. While the FSEIS acknowledges cumulative impacts will occur from ISR mining projects (see FSEIS at xxxviii), there is a dearth of meaningful analysis in the agency's document and the Intervenors' concerns remain unaddressed. Remarkably, the NRC notes that cumulative impacts are limited only to the OZ horizon because it is not in contact with aquifers above and below it. FSEIS at 5-23. This contradicts the numerous statements made by the NRC throughout the FSEIS on unplugged exploration boreholes and thinning confining units and ignores the hydrologic data on the 24-hr pump test from well 12-18, and water-quality data form 12-18, that indicates connection with the SM and OZ aquifer horizons (Paragraphs 54-63).
65. The FSEIS briefly notes cumulative impacts to water drawdown from future "satellite" projects: stating consumption could increase to 356 gal/min from the 122 gal/min estimated for the Ross Project. FSEIS at 5-25. This estimate is based on aquifer yield that is proportional to uranium recovery amount, and the FSEIS lacks specific analysis about projected drawdown amounts. The FSEIS also lacks analysis about irreversible trends - it simply estimates that quantity "*would be essentially restored within 24 years after the issuance of the Source and Byproduct Materials License to the Applicant*" (FSEIS; p. 5-27) and therefore suggests impacts would be small. But the FSEIS is contradictory in the analysis concerning groundwater recharge. Initially, the NRC Staff states that increased precipitation will replenish lost groundwater quantities "*There could be an increase in recharge to aquifers underlying the Ross Project area in future years, which would result from the predicted increased precipitation (i.e. higher*

precipitation would consequently increase infiltration in to the ground-water regime)."(FSEIS; p. 5-37). However, the NRC Staff later states that soil and runoff conditions, not precipitation, are the main drivers of aquifer recharge. "*The Applicant's ground-water model determined that infiltration from the land surface to the aquifer is only approximately 0.2-0.56 cm/yr [0.07 – 0.22 in/yr]. Most of that precipitation is lost to runoff, evaporation, and transpiration. The amount of precipitation available for recharge to the aquifer is primarily controlled by soil type and runoff conditions, and it could be little affected by the variation in the amount of precipitation.*"(FSEIS; p. B-102) In other words, the FSEIS presents a vague analysis of the water budget over the entire project and the 24 year recovery appears arbitrary.

66. The agency notes average consumption of 122 gal/min over 6 years for the Ross Project; but the basis and calculation to derive the quantity of groundwater over this period is absent (DSEIS p. 5-24, lines 12-14). NRC then states the average increases to 356 gal/min (FSEIS p. 5-25) when including the Kendrick, Richards, and Barber satellite areas; based on scaling water consumption to uranium production between Ross Project and all satellite operations, but no period of consumption is given by the agency. It is perplexing why there is a lack of mass balance calculations, because information is given to estimate total gallons consumed (i.e., 356 gal/min over 24 years equates to 4.5 billion gallons of groundwater, or enough water to cover 13,800 acres to a depth of 1 foot). Note that NRC Staff and Strata are mute on groundwater loss due to failure to restore aquifers to true baseline conditions, which could be another 56,000 acre-ft (assuming 1866 acres multiplied by 100 feet of sand thickness with a porosity of 0.3).
67. Further, there is no analysis of cumulative water quality impacts - just the Nubeth pilot-scale ISR operation, but no analysis of the prospective parts of the entire Ross project or even the greater Lance District project. Indeed, what FSEIS does examine is essentially limited to the

OZ aquifer in the Ross Area, due to the proposed confining layers (FSEIS; p.5-22, lines 44-46). This conflicts with scientific data and NRC statements that horizontal and vertical excursions of mining fluids occur at all ISR operations, and that the vertical excursions were traced to thinning of the confining layer in the complex fluvial stratigraphy and improperly abandoned exploration bore holes (DSEIS, p. 4-32, lines 41-43; FSEIS at 4-34). The layers are not confining due to complex fluvial stratigraphy (Strata 2011b; Addendum 2.6-C), hundreds (if not thousands) unplugged boreholes (Strata 2011b; Addendum 2.6-B), alternative interpretations of pump tests, and water quality analyses that demonstrate mixing between SM and OZ (see figure below paragraph 60).

68. The FSEIS states that Strata cannot estimate the current withdrawal of groundwater from the Lance and Fox Hills formations because the geological interval is not recorded by the Wyoming engineer's office (DSEIS p. 5-24, lines 23-28; FSEIS p. 5-25). It is our finding that this conclusion is inaccurate, as location and depth of wells are given (line 24) and both the NRC Staff and Strata have intimate knowledge of the regional geology to correlate these locations and depths with the geological interval.

69. Again, without independent analysis, NRC cites Strata on concluding that the OZ horizon is unattractive as a groundwater source due to depth (400 fbgs), and due to the presence of overlying aquifers (DSEIS p. 5-24, lines 31-33; FSEIS at p.5-25 & 5-26). This statement contradicts the NRC statement (DSEIS p.5-24, lines 1-4; FSEIS p.5-24) on the city of Gillette, which extracts groundwater from the Fox Hills Formation at a depth of 500 fbgs and mixes this high TDS water with groundwater of lower TDS to produce potable water for the city. The use of Fox Hills groundwater by the city of Gillette also exposes the weakness of the NRC/Strata assertion that the groundwater in the OZ is unsuitable for human consumption. Clearly, the

groundwater from the OZ horizon can be blended with lower TDS water to produce potable water for human consumption.

/s/ Dr. Richard Abitz (electronic signature approved)

/s/ Dr. Lance Larson (electronic signature approved)

Dated: March 31, 2014

REFERENCES

Abitz, R. J. and B. Darling, 2010. Anthropogenic Induced Redox Disequilibrium in Uranium Ore Zones, *Geological Society of America Abstracts w/Programs*, Vol. 42.

American Society for the Testing of Materials (ASTM), 1998. *Standard Guide for Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring Programs*, D6312, Washington DC.

Borch, T., Roche, N., & Johnson, T. E., 2012. Determination of contaminant levels and remediation efficacy in groundwater at a former in situ recovery uranium mine. *Journal of Environmental Monitoring*, *14*(7), 1814-1823.

Buswell, M. D., 1982. Subsurface Geology of the Oshoto Uranium Deposit Crook County, Wyoming. South Dakota School of Mines and Technology, Rapid City, SD, 1982.

Cameco Resources 2012. *Submittal of Power Resources, Inc., d/b/a Cameco Resources, 2011-2012 Annual Report for Permit 603, Highland Uranium Project, Cover through Appendix E,* Cheyenne Wy: Cameco Resources. July 31, 2012. ADAMS Accession No. ML12230A015.

COGEMA Mining, Inc., 2005a. *Postmining Groundwater Restoration Demonstration for the Irigaray Mine*, Permit No. 478, TFN 4 1/170, Change No. 34. ADAMS Accession No. ML060830597.

COGEMA Mining, Inc., 2005b. *Response to LQD/DEQ January 10, 2005 Comments, Irigaray Wellfield Restoration Report.* COGEMA Resources Company. May 5, 2005. ADAMS Accession No. ML053270037.

COGEMA Mining Inc, 2006. 08/11/06 E-mail from D. Wichers, COGEMA, to R. Linton, NRC, Attaching Summary Table Irigaray Mine Unit Restoration RAI Response. ADAMS Accession No. ML062400363.

COGEMA Mining Inc, 2009. *E-mail with Information on Christensen Ranch Mining Inc., Chronology*. ADAMS Accession No. ML091050306.

Crow Butte Resources, Inc. 2001. *Response to the U.S. Nuclear Regulatory Commission Request for Additional Information/Mine Unit 1 Groundwater Restoration Completion/Crow Butte Uranium Project.* Crawford, NE: Crow Butte Resources. August 2001. ADAMS Accession No. ML012710072.

Curtis, G. P., J. A. Davis, and D. L. Naftz, 2006. *Simulation of reactive transport of uranium(VI) in groundwater with variable chemical conditions*. Water Resour. Res., 42, W04404, doi:10.1029/2005WR003979.

Davis, J. and Curtis, G., 2007. *Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities*. U.S. Geological Survey, Menlo Park, Ca 94025. NUREG/CR-6870.

Deutsch, W.J., N.E. Bell, B.W. Mercer, R.J. Serne, J.W. Shade, and D.R. Tweeton, 1984. *Aquifer Restoration Techniques for In Situ Leach Uranium Mines,* NUREA/CR-3104, PNL-4538, Pacific Northwest Laboratory, prepared for the U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington DC.

ExxonMobil, 2010. *Presentation Slides From the Casper, WY Public Meeting on August 3, 2010 for the ExxonMobil Highlands Reclamation Project*. ADAMS Accession No. ML102170327.

Gilbert, R.O., 1987. *Statistical Methods for Environmental Pollution Monitoring,* Van Reinhold, New York, New York.

Hall, S., 2009. *Groundwater Restoration at Uranium In Situ Recovery Mines, South Texas Coastal Plain,* Open-File Report 2009-1143, U.S. Geological Survey, Reston, Virginia.

Laaksoharju, M., J. Smellie, E. Tullborg, M. Gimeno, J. Molinero, I. Gurban, and L. Hallbeck, 2008. Hydro*geochemical evaluation and modeling performed within the Swedish site investigation programme*, *Applied Geochemistry*, v. 23, no. 7.

Langmuir, D., 1978. *Uranium solution-mineral equilibria at low temperatures with applications to sedimentary ore deposits*. *Geochimica et Cosmochimica Acta*, *42*(6), 547-569.

Madansky, A., 1988. *Prescriptions for Working Statisticians,* Springer-Verlag, New York, New York.

Matzke, B.D., J.E. Wilson, L.L. Nuffer, S.T. Dowson, R.O. Gilbert, N.L. Hassig, J.E. Hathaway, C.J. Murray, L.H. Sego, B.A. Pulsipher, B. Roberts, and S. McKenna, 2007, *Visual Sample Plan, Version 5.0, User's Guide*, PNNL-16939, Pacific Northwest National Laboratory, Richland, Washington.

ND Resources, 1982. *Assessment Restoration Activities, Sundance Project*. ADAMS Accession No. ML13274A178

Nuclear Dynamics, 1978, Source Material License No. SUA-1331, Sundance Project, Crook County, Wyoming. Docket No. 40-8663. August 31, 1978. ADAMS Accession No. ML12135A358.

Nuclear Dynamics, 1980. *1980 Activity and Restoration Report on In Situ Solution Mining Test Site, Sundance Project Crook County, Wyoming*. Source Material License No. SUA-1331, Docket No. 40-8663. Casper, WY: ADAMS Accession No. ML13274A287

Shapiro, S.S., M.B. Wilk and J. Chen, 1965, *A comparative study of various tests for normality, Bjournal of the American Statistical Association*, v. 63, pp. 1343-1372.

Shapiro, S.S. and M.B. Wilk, 1965, *An analysis of variance test for normality (complete samples), Biometrika,* v. 52, pp. 591-611.

Staub, W.P., N.E. Hinkle, R.E. Williams, F. Anastasi, J. Osiensky, and D. Rogness, 1986. *An Analysis of Excursions at Selected In Situ Uranium Mines in Wyoming and Texas*, NUREG/CR-3967, ORNL/TM-9956, Oak Ridge National Laboratory, prepared for the U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington DC.

Strata, 2011a. *Ross ISR Project USNRC License Application, Crook County, Wyoming, Environmental Report, Volumes 1, 2 and 3 with Appendices*. Docket No. 40-09091. Gillette, WY: Strata. ADAMS Accession Nos. ML110130342, ML110130344, and ML110130348.

Strata, 2011b. *Ross ISR Project USNRC License Application, Crook County, Wyoming, Technical Report, Volumes 1 through 6 with Appendices*. Docket No. 40-0901. Gillette, WY: Strata. ADAMS Accession Nos. ML110130333, ML110130335, ML110130335, ML110130314, ML110130316, ML110130320, and ML110130327.

Strata, 2012. *Ross ISR Project USNRC License Application, Crook County, Wyomin, RAI Question and Answer Responses, Environmental Report, Volume 1 with Appendices*. Docket No. 40-09091. Gillette, WY: Strata. ADAMS Accession No. ML121030465.

Texas Water Commission (TWC), 1988. *Production Area Authorization for Kingsville Dome Mining Project*, Permit UR02827-001, Production Area UR02827-011, April 12, 1988.

Texas Water Commission (TWC), 1990. *Production Area Authorization for Kingsville Dome Mining Project*, Permit UR02827-001, Production Area UR02827-021, June 28. 1990.

U.S. Department of Energy, (DOE), 1995, Decommissioning of U.S. Uranium Production Facilities. Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, U.S. Department of Energy, Washington, DC 20585.

U.S. Department of Energy, (DOE), 1998a, Certification Report for Area 1 Phase I, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1998b, Certification Report for Area 1 Phase II, and Conveyance Ditch, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1998c, Certification Report for Area 8 Phase I, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1998d, Fernald 1997 Sitewide Environmental Report, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1998e, Sitewide Excavation Plan, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1999a, Certification Report for Area 1 Phase I – Sediment Traps 2 and 3, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1999b, Certification Report for Area 1 Phase II – Sector 2B, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1999c, Certification Report for Area 8 Phase II and Area 6 Triangle Area, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1999d, Certification Report for Area 2 Phase III Part One, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 1999e, Fernald 1998 Sitewide Environmental Report, Fernald Environmental Management Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2000a, Certification Report for Area 1 Phase II – Sector 2 Certification Units West of Former North Access Road, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2000b, Certification Report for Area 1 Phase III Part Two, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2000c, Certification Report for Area 2 Phase III Part Two, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2000d, Certification Report for Area 8 Phase III South, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2000e, Fernald 1999 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2001a, Certification Report for Area 1 Phase II, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2001b, Certification Report for Area 2 Phase I Active Flyash Pile and Adjacent Area East of the South Construction Road, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2001c, Certification Report for Former Soil Stockpile 3 Footprint, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2001d, Certification Report for Area 1 Phase III Part One, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2001e, Fernald 2000 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2002a, Addendum 1 to Certification Report for Area 1 Phase II for the Reuse Areas, Trap Range, Sector 2C and Sector 3, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2002b, Certification Report for Area 5 – Eastern Field, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2002c, Fernald 2001 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2003a, Certification Report for Area 2 Phase I – Former Inactive Flyash Pile, South Carolina Area, East-West Construction Road and Equipment Wheel Wash Facility, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2003b, Certification Report for Area 6 Phase I Part One, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2003c, Fernald 2002 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004a, Certification Report for Area 8 Phase III North, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004b, Certification Report for Area 6 Phase I Part Two, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004c, Certification Report for Area 1 Phase IV Part One, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004d, Certification Report for Area 2 Phase II Subareas 1, 2, and 4, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004e, Certification Report for Area 1 Phase IV Parts Two and Three, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2004f, Fernald 2003 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2005a, Certification Report for Area 3A/3B, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2005b, Certification Report for Area 4A, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2005c, Certification Report for Stream Corridors and Storm Sewer Outfall Ditch, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2005d, Fernald 2004 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006a, Certification Report for Area 4B Part One, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006b, Certification Report for Area 6 – Waste Pits 4, 5 and 6, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006c, Certification Report for Area 2 Phase II – Subarea 3 Equipment Wash Facility, Subcontractor Laydown Area, Trailer Complex Area, and Aquifer Project Laydown Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006d, Addendum to the Certification Report for Area 2 Phase II – Subareas 1, 2 and 4, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006e, Certification Report for Area 6 – Former Production Area and Main Drainage Corridor Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006f, Addendum to the Certification Report for Area 4A, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006g, Addendum to the Certification Report for Area 2 Phase III – Part Two for Area Boundary, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006h, Certification Report for the Former Storm Water Retention Basin Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006i, Certification Report for Stream Corridors, Pilot Plant Drainage Ditch and Paddys Run, the Former Storm Water Retention Basin Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006j, Addendum 4 to the Certification Report for Area 1 Phase II for the Dissolved Oxygen Building Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006k, Addendum to the Certification Report for Area 4B Part One, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006l, Certification Report for Area 6 General Area East, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006m, Addendum to the Certification Report for Area 6 – Former Production Area and Main Drainage Corridor Area for Soil Pile 8, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006n, Certification Report for Various Areas Outside of the Historically Radiologically Controlled Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2006o, Fernald 2005 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007a, Certification Report for Area 1 Phase IV – Decontamination Facility Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007b, Certification Report for Area 5 Administrative Area and East and West Parking Lots, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007c, Certification Report for the Former Solid Waste Landfill and Soil Pile 7, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007d, Certification Report for Area 7 Silos and Support Areas, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007e, Certification Report for Area 6E, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007f, Certification Report for Area 6 – General Area West, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007g, Certification Report for Area 6 – Sitewide Rail Line System, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007h, Certification Report for Area 6 – Waste Pits 1, 2 and 3, the Burn Pit, The Clearwell, and Areas West and North of the Waste Pits, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007i, Certification Report for Area 7 – Miscellaneous Area, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2007j, Fernald 2006 Sitewide Environmental Report, Fernald Closure Project, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2008a, Fernald 2007 Sitewide Environmental Report, Fernald Preserve, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2008b, Evaluation of Aqueous Ions in the Monitoring Systems of the On Site Disposal Facility, Fernald Preserve, DOE Fernald Area Office, Cincinnati, Ohio.

DOE, 2009, Fernald 2008 Sitewide Environmental Report, Fernald Preserve, DOE Fernald Area Office, Cincinnati, Ohio.

U.S. Environmental Protection Agency (EPA), 1989, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Office of Solid Waste, Washington DC.

EPA, 1992a, *Addendum to Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Office of Solid Waste, Washington DC.

EPA, 1992b, *RCRA Ground-Water Monitoring: Draft Technical Guidanc*e, Office of Solid Waste, Washington DC.

EPA, 2009, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Unified Guidance, EPA 530-R-09-007, Office of Resource Conservation and Recovery, Program Implementation and Information Division, Washington DC.

U.S. Nuclear Regulatory Commission (NRC), 1978, Draft Environmental Statement related to operation of Wyoming Mineral Corporation, Irigaray Solution Mining Project. April 1978, Docket No. 40-8502. ADAMS Accession No. ML091050582.

NRC, 2003, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications*, NUREG-1569, Office of Nuclear Material Safety and Safeguards, Washington DC.

NRC, 2006. Review of COGEMA Mining Inc., Irigaray Mine Restoration Report, Production Units 1 Through 9, Source Materials License SU-1341 (TAC LU0137). ADAMS Accession No. ML062570175.

NRC, 2013a. Environmental Impact Statement for the Ross ISR Project in Crook County, Wyoming: Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Mining Facilities. Draft Report for Comment. NUREG-1910 Supp5 DFC. ADAMS Accession No. ML13078A036

NRC, 2013b. ISR Wellfield Ground Water Quality Data. 22 Aug. 2013. Web. <http://www.nrc.gov/info-finder/materials/uranium/licensed-facilities/willow-creek/isr-wellfield-ground-water-quality-data.html>.

NRC, 2014. Environmental Impact Statement for the Ross ISR Project in Crook County, Wyoming, Supplemental to the Generic Environmental Impact Statement for In-Situ Leach Uranium Facilities. Final Report. NUREG-1910 Supp 5. February 2014. ADAMS Accession No. ML14056A096.

Uranium one, 2010, Mine Unit 5 Response, Irigaray-Christensen Ranch In Situ Operations, Permit No. 478. ADAMS Accession No. ML102710342.

Visual Sampling Plan, version 6.3, Pacific Northwestern National Laboratory, http://vsp.pnnl.gov

WDEQ, 2011, *Letter of Conference and Conciliation, Excursion at CM-32 Permit 603, Cameco Resources*. ADAMS Accession No. ML11152A093.

Zhou, P., & Gu, B., 2005, *Extraction of oxidized and reduced forms of uranium from contaminated soils: Effects of carbonate concentration and pH.* Environmental science & technology, 39(12), 4435-4440.