WYOMING MINING ASSOCIATION

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May 2, 2019

Ms. Annette Vietti-Cook, Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001
ATTN: Rulemakings and Adjudications Staff

Dear Ms. Vietti-Cook:

Subject: ***Ground Water Protection at Uranium In Situ Recovery Facilities*** **- Federal Register / Volume 84, Number 21 / Thursday, January 31, 2019 / Proposed Rules Docket ID NRC–2008–0421 - Comments of the Wyoming Mining Association (WMA)**

The Wyoming Mining Association (WMA) is an industry association representing mining companies, contractors, vendors, suppliers and consultants in the State of Wyoming. Among its mining industry members are uranium recovery licensees, including conventional and in-situ uranium recovery operators, several companies planning new uranium recovery operations and several companies conducting final reclamation/groundwater restoration operations.

Total uranium concentrate production in the United States in 2017 was 2,440,000 pounds (U.S. Energy Information Administration - *2017 Domestic Uranium Production Report*). 2017 Wyoming uranium production was 897,435 pounds (World Nuclear Association), accounting for 36.8% of United States' production.

The WMA has reviewed the request for comment on whether the Nuclear Regulatory Commission (NRC) should resume rulemaking to amend its regulations governing the domestic licensing of source material by codifying general requirements to address ground water protection at uranium *in situ* recovery (ISR) facilities and has the following comments:

If the NRC were to proceed with its ISR rulemaking that has been held in abeyance since 2010, the NRC would amend its current uranium milling regulations in appendix A to 10 CFR part 40 to add ISR-specific requirements. Should the NRC proceed with this rulemaking?

Provided that a non-industry source of funding is used, the WMA supports a narrowly focused risk-informed rulemaking that would amend 10 CFR Part 40 including 10 CFR Part 40 Appendix A to codify general requirements to address ground water protection at uranium *in situ* recovery (ISR) facilities. Funding of the rulemaking is critical as the costs to current uranium licensees would be prohibitive given the current price of uranium and the financial status of the industry generally.

Current rules regarding groundwater protection and groundwater restoration at uranium in-situ uranium recovery facilities are a collection of ad hoc decisions (court and Commission Decisions and Regulatory Issues Summaries (RISs) that were implemented without public notice or public comment. These decisions need to be replaced by a single coherent rulemaking that is subject to public input (public notice and comment). This need is now more apparent because in-situ recovery is being applied to other metals in the United States (copper in particular).

There should be regulatory parity between groundwater protection standards and groundwater restoration methods between uranium and other metals extracted via in-situ recovery since both types of recovery occur within the exempted portions of Underground Sources of Drinking Water (USDWs).

The initial extension of federal jurisdiction over in-situ uranium recovery wellfields under the Atomic Energy Act of 1954 as amended occurred with the so called "*milling underground decision*." Specifically SECY-99-0013 -

RECOMMENDATIONS ON WAYS TO IMPROVE THE EFFICIENCY OF NRC REGULATION AT IN SITU LEACH URANIUM RECOVERY FACILITIES (https://www.nrc.gov/reading-rm/doc-collections/commission/secys/1999/secy1999-013/1999-013scy.pdf), the associated Commission voting record found at: https://www.nrc.gov/reading-rm/doc-collections/commission/cvr/1999/1999-013vtr.pdf and the Staff Requirements Memorandum (SRM) entitled *STAFF REQUIREMENTS - SECY-99-0013 - RECOMMENDATIONS ON WAYS TO IMPROVE THE EFFICIENCY OF NRC REGULATION AT IN SITU LEACH URANIUM RECOVERY FACILITIES* (https://www.nrc.gov/reading-rm/doc-collections/commission/srm/1999/1999-013srm.pdf), dated July 26, 2000, that states:

> *Instead, the Commission has approved Option 2 - classify all liquid effluents as 11e.(2) byproduct material at in situ leach (ISL) uranium recovery facilities. Under Option 2, the NRC takes the position that any waste water generated during or after the uranium extraction phase of site operations, and all evaporation pond sludges derived from such waste waters, would be classified as 11e.(2) byproduct material. The staff would make no legal distinction among the waste waters produced at different stages in a facility's life cycle. This revised position should be implemented immediately and codified in the new rule and associated regulatory guidance.*

The term "*milling underground*" is derived from Commissioner Merrifield's discussion in the Commission Voting Record (https://www.nrc.gov/reading-rm/doc-collections/commission/cvr/1999/1999-013vtr.pdf) in which he states:

> *However, once the ore is taken to the mill and is initially crushed to start the removal of the uranium, NRC regulations come into force. NRC regulations do not state that in the first 20 feet of the mill (or some other arbitrary number) the crushed rock is not 11e.(2) byproduct material. Instead, if the mill operator subsequently determines that the specific uranium loading of the crushed ore does not meet the company's economic criteria for continued processing, the material must be transported directly to the mill tailings pile and is considered 11e.(2) byproduct material. I believe the same scenario applies to the ISL mining. When the chemicals are injected into the well field to initiate the process of leaching the uranium (as well as other minerals) out of the rock, I consider it equivalent to crushing the ore in a conventional mill. Therefore, I believe that NRC authority for this material starts at this point.*

This decision was affirmed on November 30, 2000 when the Nuclear Regulatory Commission (NRC) issued *NRC REGULATORY ISSUE SUMMARY 2000-23 RECENT CHANGES TO URANIUM RECOVERY POLICY* (https://www.nrc.gov/docs/ML0037/ML003773008.pdf) that stated:

> *NRC takes the position that any waste water generated during or after the uranium extraction phase of site operations, and all evaporation pond sludges derived from such waste waters, are classified as 11e.(2) byproduct material. The staff will make no legal distinction among the waste waters produced at different stages in a facility's life cycle.*

On April 29, 2009, the Nuclear Regulatory Commission (NRC) issued Regulatory Issues Summary (RIS) *NRC REGULATORY ISSUE SUMMARY 2009-05 URANIUM RECOVERY POLICY REGARDING: (1) THE PROCESS FOR SCHEDULING LICENSING REVIEWS OF APPLICATIONS FOR NEW URANIUM RECOVERY FACILITIES AND (2) THE RESTORATION OF GROUNDWATER AT LICENSED URANIUM IN SITU RECOVERY FACILITIES* (https://www.nrc.gov/docs/ML0835/ML083510622.pdf) that stated;

> *Under the existing requirements in Appendix A of 10 CFR Part 40, the staff will apply the Criterion 5B standards in evaluating all ISR groundwater restoration plans currently under review or submitted in the future. This policy includes reviews of applications for new ISR facilities, reviews of restoration plans at existing, licensed ISR facilities, and reviews of ISR license renewal applications.*

This conclusion was reached following a circuitous process that extended over many years. 10 CFR Part 40 Appendix A criterion 5B was initially developed to primarily focus on conventional uranium mills. The regulatory program for uranium milling activities was developed and began to mature throughout the 1980s especially with the development of the NUREG-0706 - Final Generic Environmental Impact Statement on Uranium Milling dated September 1980. In addition, substantial regulatory guidance was developed related to conventional uranium milling. At the same time, however, the uranium recovery industry began to experience a fundamental shift

away from conventional mining and milling. As the industry evolved, ISR operations grew from a small fraction of domestic production to the primary source of production.

In the late 1990s, the NRC considered development of a new Code of Federal Regulation section (10 CFR Part 41) in part to better tailor the regulations to ISR operations. This rulemaking was not completed due in part to the depressed state of the uranium recovery industry and difficulties that the industry would have in funding such an effort.

In 2006, with a significant increase in the price of uranium and the likelihood of new ISR licensees, NRC again reconsidered the need for a rulemaking to better address ISR operations. A unanimous Commission directed NRC staff to pursue amendments and revisions to 10 CFR Part 40, Appendix A so that appropriate regulatory requirements minimizing or eliminating dual or overlapping jurisdiction could be made applicable to ISR uranium recovery facilities. While the rulemaking was ongoing, the Commission instructed staff is to pursue completion of a Memorandum of Understanding through which NRC would agree to exercise enforcement discretion to permit current ISR uranium recovery licensees to meet state standards until license amendments revising appropriate license conditions for groundwater can be prepared, submitted, and approved. (March 24, 2006 STAFF REQUIREMENTS - COMJSM-06-0001 – REGULATION OF GROUNDWATER PROTECTION AT *IN SITU* LEACH URANIUM EXTRACTION FACILITIES)

In 2010, EPA informed NRC that it would undertake its own rulemaking effort to issue generally applicable standards for ISR mines. As such, NRC deferred its ongoing ISR rulemaking effort, prior to the publication of a proposed rule, in anticipation of the need to conform its implementing regulations to the generally applicable standards to be issued by the EPA.

In 2015, EPA formally proposed its “Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings.” On January 29, 2017, EPA announced that it was proposing a new version of these regulations. Based on the significant concerns raised in comments on the proposal, EPA concluded that it had serious questions concerning whether it had the legal authority under UMTRCA to issue the regulations as proposed in 2017. Additionally, EPA determined that the existing regulatory framework was sufficient to ensure the protection of public health and the environment at existing ISR mines. As a result, EPA withdrew the 2017 proposal on October 30, 2018.

This release of RIS *NRC REGULATORY ISSUE SUMMARY 2009-05 URANIUM RECOVERY POLICY REGARDING: (1) THE PROCESS FOR SCHEDULING LICENSING REVIEWS OF APPLICATIONS FOR NEW URANIUM RECOVERY FACILITIES AND (2) THE RESTORATION OF GROUNDWATER AT LICENSED URANIUM IN SITU RECOVERY FACILITIES* amounted to regulation via a RIS and did not involve either public notice or comment. The WMA protested this decision in a letter dated June 3, 2009 entitled Wyoming *Mining Association - Comments on NRC REGULATORY ISSUE SUMMARY 2009-05 URANIUM RECOVERY POLICY REGARDING: (1) THE PROCESS FOR SCHEDULING LICENSING REVIEWS OF APPLICATIONS FOR NEW URANIUM RECOVERY FACILITIES AND (2) THE RESTORATION OF GROUNDWATER AT LICENSED URANIUM IN SITU RECOVERY FACILITIES* dated Wednesday, April 29, 2009. (Please see Appendix 1).

This letter stated:

> *WMA believes that this Regulatory Issues Summary (RIS) is far more than merely informational and that it contains a major regulatory change that should have been noticed in the Federal Register and made available for public comment prior to implementation. While the portions of the RIS that deal with the process for scheduling licensing reviews are administrative in nature, the application of 10 CFR Part 40 Appendix A standards as currently written to groundwater restoration at in situ uranium recovery facilities is a significant change that should be subject to the rulemaking process.*

The National Mining Association (NMA) protested NRC RIS 2009-05 as well, stating that it was in violation of the Administrative Procedures Act (APA) because it was not merely informational but contained a major regulatory change and should have been noticed for comment in the Federal Register. (Please see Appendix 2)

The NMA letter stated:

> ***NRC Violated the APA in Failing to Publish the RIS for Comment***
>
> *Under the APA, rules are defined as "the whole or a part of an agency statement of general or particular applicability and future effect designed to implement, interpret, or prescribe law or policy or describing the organization, procedure, or practice requirements of an agency." APA section 551(4).*
>
> *Both section 552(a)(1) and section 553 of the APA govern procedures for agency rulemaking. Section 552(a)(1) provides in relevant part as follows:*
>
> *(a) Each agency shall make available to the public information as follows:*
> *(1) Each agency shall separately state and currently publish in the Federal Register for the guidance of the public— . . .*
> *(D) substantive rules of general applicability adopted as authorized by law, and statements of general policy or interpretations of general applicability formulated and adopted by the agency; and*
> *(E) each amendment, revision, or repeal of the foregoing.*
>
> *Section 553 sets forth guidance as to when notice and comment procedures are required and specific procedures for conducting notice and comment rule making. According to these sections of the APA, "rules" must be published for notice and comment. Agencies cannot substitute guidance documents in lieu of rules to impose new substantive requirements. The issue of when guidance needs to be published for comment was addressed directly by the U.S. Court of Appeals for the District of Columbia Circuit in Appalachian Power Co. v. EPA, wherein the court found that an Environmental Protection Agency guidance document relating to emissions monitoring imposed new substantive requirements on facilities that necessitated notice and comment rulemaking. The court concluded that "it is well-established that an agency may not escape the notice and comment requirements .. . by labeling a major substantive legal addition to a rule a mere interpretation." Appalachian Power Co. v. EPA, 208 F.3d 1015, (D.C. Cir. 2000). If they wish to impose new substantive requirements, agencies must follow section 553 of the APA.*
>
> *Croplife America v. EPA, 329 F.3d 876 (D.C. Cir. 2003).*
>
> *Considerations for determining whether a "guidance" document should be published as a rule include whether the agency acts as if the document is controlling and whether the document would lead parties to believe the agency will disapprove permit applications unless they comply with terms of the document. See generally, Appalachian Power. As discussed in detail below, NRC indicates that the RIS' conclusion about the applicability of Appendix A to ISR facilities is controlling, even in the face of existing NRC policy and guidance to the contrary. Furthermore, prospective licensees have been informed by NRC that for their applications to be approved, the application must "demonstrate that the applicant will be able to return the groundwater quality to the NRC required restoration standard of baseline water quality or the standards listed in Criterion 5B(5)(b) of Appendix A to 10 CFR Part 40." (See Request for Additional Information, Moore Ranch Uranium Project) Source Material License Application at p. 13, ADAMS accession number ML081340113.) Given these considerations, NRC violated the APA by failing to publish the RIS for comment.*

The Nuclear Regulatory Commission (NRC) never responded to either the NMA's or WMA's letters.

The Regulatory Issues Summary also conflicted with the already existing *NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications* provides in *SECTION 6.0 GROUND-WATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING* which stated:

"The applicant may therefore propose returning the water quality to its pre-operational class of use (e.g., drinking water, livestock, agricultural, or limited use) as a secondary restoration standard."

The Regulatory Issues Summary recognized this conflict in stating:

The staff recognizes that NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications," provides guidance that is not consistent with the requirements in Criterion 5B of Appendix A discussed above. In particular, the NUREG-1569 discussion of groundwater restoration to "pre-operational class of use" as being a secondary standard is not accurate, and is not an appropriate standard to use in evaluating license applications. Criterion 5B contains the appropriate standards that will be applied to groundwater restoration at ISR facilities

Thus, the existing guidance on groundwater restoration at in-situ uranium recovery operations is repudiated by the RIS.

Little direction or guidance is provided on preparing Alternate Concentration Limit (ACL) applications. 10 CFR Part 40 Appendix A Criterion 5 was written to address groundwater plumes related to tailings impoundments and not to address in-situ uranium recovery wellfields.

Additional guidance is provided in *NUREG-1620 - Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title **II** of the Uranium Mill Tailings Radiation Control Act of 1978 Final Report* however it is limited to the three (3) pages of Appendix K. Please note that *NUREG-1620 - Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978 Final Report* was published in June 2003, six (6) years prior to the publication of *NRC RIS 2009-05 URANIUM RECOVERY POLICY REGARDING: (1) THE PROCESS FOR SCHEDULING LICENSING REVIEWS OF APPLICATIONS FOR NEW URANIUM RECOVERY FACILITIES AND (2) THE RESTORATION OF GROUNDWATER AT LICENSED URANIUM IN SITU RECOVERY FACILITIES* that extended Alternate Concentration Limits (ACLs) to depleted in-situ uranium recovery wellfields. NUREG-1620 was written for uranium mill tailings sites and their associated groundwater plumes and not for ISR.

Thus, the current scheme for regulating groundwater protection and restoration at in-situ uranium recovery facilities grew out of a Commission decision and two (2) RISs; none of which have been subject to public notice or comment. The 2009 RIS inappropriately applied standards for groundwater plumes related to uranium mill tailings impoundments to in-situ uranium recovery wellfields.

This issue was raised in the June 3, 2009 letter from the WMA that stated:

> *This appendix was initially added on October 16, 1985 (50 Federal Register 41862) in response to the passage by Congress of the Uranium Mill Tailings Radiation Control Act (UMTRCA). The purpose of UMTRCA, which was passed by Congress in November 1978, is clear. It is stated in the preamble of the Act (§ 7901. Congressional findings and purposes) as follows:*
>
> *(a) The Congress finds that uranium mill tailings located at active and inactive mill operations may pose a potential and significant radiation health hazard to the public, and that the protection of the public health, safety, and welfare and the regulation of interstate commerce require that every reasonable effort be made to provide for the stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings.*
>
> *(b) The purposes of this chapter are to provide-*
>
> *(1) in cooperation with the interested States, Indian tribes, and the persons who own or control inactive mill tailings sites, a program of assessment and remedial action at such sites, including, where appropriate, the reprocessing of tailings to extract residual uranium and other mineral values where practicable, in order to stabilize and control such tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public, and*
>
> *(2) a program to regulate mill tailings during uranium or thorium are processing at active mill operations and after termination of such operations in order to stabilize and control such tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public.*

The June 1, 2009 letter from the NMA also raised this issue as well stating:

> *...clearly the current 5B criterion POC language is not designed for ISL facilities. First, Criterion 5B states:*
>
> > *Uranium and thorium byproduct materials must be managed to conform to the following secondary ground-water protection standard:*
> >
> > *Hazardous constituents entering the ground water from a licensed site must not exceed the specified concentration limits in the uppermost aquifer beyond the point of compliance during the compliance period.*
>
> *ISR activities generally do not occur in the uppermost aquifer but are generally mined in a given aquifer with other aquifers above and below the one being mined. The ISR SRP, NUREG-1569 recognizes this fact as it requires monitoring of overlying and underlying aquifers. Furthermore, Criterion 5B indicates "the point of compliance must be selected to provide prompt indication of ground-water contamination on the hydraulically downgradient edge of the disposal area." Again, this language cannot be applied directly to ISR operations since they do not have disposal areas.*

Please identify any issues that should be addressed to protect groundwater at ISR facilities, in either this rulemaking or through the development of guidance documents.

The key issue that should be recognized and addressed in any rulemaking effort is risk, specifically the very low risk to groundwater posed by in-situ uranium recovery operations or any in-situ recovery operation to recover any metal.

The key to the low risk is that in-situ recovery operations can only take place within exempt portions of an Underground Source of Drinking Water (USDW). These exempt areas are created under 40 CFR Part 146 which states:

§ 146.4 Criteria for exempted aquifers.

- *An aquifer or a portion thereof which meets the criteria for an "underground source of drinking water" in § 146.3 may be determined under § 144.7 of this chapter to be an "exempted aquifer" for Class I-V wells if it meets the criteria in paragraphs (a) through (c) of this section. Class VI wells must meet the criteria under paragraph (d) of this section:*

(a) *It does not currently serve as a source of drinking water; and*

(b) *It cannot now and will not in the future serve as a source of drinking water because:*

(1) *It is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible.*

(2) *It is situated at a depth or location which makes recovery of water for drinking water purposes economically or technologically impractical;*

(3) *It is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption; or*

(4) *It is located over a Class III well mining area subject to subsidence or catastrophic collapse; or*

(c) *The total dissolved solids content of the ground water is more than 3,000 and less than 10,000 mg/l and it is not reasonably expected to supply a public water system.*

No aquifer exemption has ever been rescinded. Once a portion of an USDW is exempted it remains exempt.

This fact must be recognized in any future rulemaking. It was clearly recognized in *NUREG-1569 Standard Review Plan for In Situ Leach Uranium Extraction License Applications* when it states in Section 6.0:

> *In addition to the NRC license, the EPA Authorized States issue underground injection control permits for in situ leaching operations, after the EPA grants an exemption from ground-water protection provisions for the portion of the aquifer undergoing uranium extraction (the exploited ore zone in an aquifer). The EPA aquifer exemption effectively removes that portion of the aquifer from any future consideration for ground-water protection;...*

The low risk to groundwater is well documented by the NRC itself in its report entitled *DATA ON GROUNDWATER IMPACTS AT THE EXISTING ISR FACILITIES - NRC-075* - Submitted: June 20, 2014 - ADAMS Accession Number: ML14172A092 states:

> *Based on a review of historical licensing documentation, data from the regional monitoring at all existing ISR facilities indicate that no impacts attributable to an ISR facility were observed at the regional monitoring locations. In addition, the staff is unaware of any situation indicating that: (1) the quality of groundwater at a nearby water supply well has been degraded; (2) the use of a water supply well has been discontinued; or, (3) a well has been relocated because of environmental impacts attributed to an ISR facility.* (Page 5)

This document was prepared because the Commission directed the NRC staff to provide it with the data it had in hand that assessed environmental impacts to the groundwater from previously licensed ISR facilities (Staff Requirements Memorandum dated January 8, 2009, SRM M081211). The Staff Requirements Memorandum (SRM) was issued following a December 11, 2008, NRC briefing on the status of uranium recovery facilities during which the staff briefed the Commissioners on the status of uranium recovery applications, ISR facilities generic environmental impact statement (GEIS), rulemaking for groundwater protection at ISR facilities, and Native American outreach.

An agreement state (Texas) reached a similar conclusion when the Texas Commission on Environmental Quality, which has regulated in-situ uranium recovery for over three decades, also noted in a May 24, 2012, letter to the NRC that, "*there has not been one instance of documented off-site pollution of a USDW from in situ uranium mining activities.*"

NUREG-1910 - Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities confirms the low risk involved in in-situ uranium recovery facilities when it:

- indicates the majority of potential impacts are "small;"
- explains that all groundwater in an ISR uranium recovery zone is exempted from consideration as a source of drinking water by the EPA because it is unsuitable for human consumption as a drinking water source both before and after uranium recovery operations occur;
- describes the groundwater restoration that is required to protect adjacent non-exempt waters; and
- explains that in ISR mining, non-toxic leaching agents, such as oxygen with sodium carbonate, are injected through wells into the ore body to dissolve the uranium.

Please identify any issues that should be addressed to enhance public or occupational safety at ISR facilities, in either this rulemaking or through the development of guidance documents.

The fact that uranium in and of itself poses a low risk should be addressed, as well as that the real safety issues at any in-situ uranium recovery operation are in essence the same as at any other industrial operation in that they are almost entirely confined to physical risks posed by such things as working at heights, trips and fall, unplanned release of energy, contact with electricity and working around heavy equipment and machinery. In fact, the greatest risk to in-situ uranium recovery workers may well be their daily commute to and from the job site.

Licensed recovery of source material is part of the nuclear fuel cycle. The NRC's objectives regarding fuel cycle facilities are as follows:

> *For fuel cycle facilities, make continuous improvement in licensing and oversight, and risk inform new regulations as needed, while performing existing risk-informed functions.*

Source: *Fuel Cycle Sub-Arena* **-** https://www.nrc.gov/about-nrc/regulatory/risk- informed/rpp/materials-safety-fuel-cycle.html

Thus, any new regulations that flow from this rulemaking effort should be risk informed.

There are a number of epidemiological studies and other medical studies that attest to the low risks posed by uranium that can be provided and will probably be provided as this rulemaking effort proceeds.

They are listed below:

> *TOXICOLOGICAL PROFILE FOR URANIUM* **-** *U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES - Agency for Toxic Substances and Disease Registry - February 2013* initially (*PUBLIC HEALTH STATEMENT*)
>
> *Cancer and Noncancer Mortality in Populations Living Near Uranium and Vanadium Mining and Milling Operations in Montrose County, Colorado, 1950-2000, Boice, J.D. et al 2007 Radial. Res. 167.711-726*
>
> *Cancer mortality in a Texas county with prior uranium mining and milling activities, 1950–2001 Boice,J.D., et al 2003 J. Radiological . Protection 23 (2003) 247–262*

The low risks posed by uranium and uranium recovery operations are also shown in studies of workers, veterans and others, specifically:

> *A cohort study of uranium millers and miners of Grants, New Mexico, 1979–2005 Boice, J.D., et al,2008 JOURNAL OF RADIOLOGICAL PROTECTION*
>
> *Mortality among a cohort of uranium mill workers: an update Pinkerton, L.E., et al 2003 Occupational and Environmental Medicine 2004;61:57–64*
>
> *Grand Rounds: Nephrotoxicity in a Young Child Exposed to Uranium from Contaminated Well Water* -H. Sonali Magdo et al (August 2007)
>
> *ACUTE CHEMICAL TOXICITY OF URANIUM* by Ronald L. Kathren and Richard K. Burklin (Health Physics Society 2008).
>
> *URANIUM DEPOSITION AND RETENTION IN A USTUR WHOLE BODY CASE* J. J. Russell and R. L. Kathren (October 2003)
>
> *The U.S. Department of Veterans' Affairs depleted uranium exposed cohort at 25 Years: Longitudinal surveillance results* Melissa A. McDiarmid et al (October 2016)

The low risks posed by in-situ uranium recovery in the long term are enhanced in part due to the natural attenuation of groundwater contaminants related to in-situ recovery over time. This effect is documented as follows:

- In a Journal of Environmental Monitoring 2012 paper entitled *Determination of Contaminant Levels and Remediation Efficacy In Groundwater at a Former In-Situ Recovery Uranium Mine* by Thomas Borch, Nicholas Roche and Thomas E. Johnson of Colorado State University (CSU) in Fort Collins, Colorado, the following conclusions are presented:

- *The groundwater quality pre-mining was designated as Wyoming Class of Use (Commercial-Mineral) due to the elevated concentrations of dissolved radium. The water was found to be unsuitable for domestic, irrigation, or livestock purposes. The concentrations of contaminants were generally elevated at the end of restoration, with uranium, arsenic, iron, manganese, and selenium having levels increased by at least a factor of five times from their baseline concentration levels* and;

- *Although the concentration levels post-restoration were higher than baseline concentration, the water "Class of Use" standards established by the WYDEQ deemed to have been met. Also, 30 of 35 parameters had concentrations post-restoration below limits for any Class of Use (See Table 2).*

- It also concludes:

  - *The very low concentrations of target species (U, Ra) at the two monitoring wells indicate that natural attenuation is likely to play a major role at immobilizing residual (after remediation) concentrations of U(VI) species thus preventing them from moving outside the mined area. There is a potential for natural attenuation in this system, since the conditions were originally reduced (low redox potential) especially if sulfate reducing conditions can be re-established. Undisturbed soil outside the mining area is also conducive to precipitation, complexation and immobilization of uranium due to the existing reducing conditions.*

- The Department of Energy (DOE) employs natural flushing/natural attenuation at some Title I uranium mill tailings sites as discussed in *DOE Remediation of Uranium Mills: A Progress Report* which may be found at: http://www.swhydro.arizona.edu/archive/V7_N6/feature5.pdf

- The paper entitled *Experience with restoration of ore-bearing aquifers after in situ leach uranium mining* (V.G. Yazikov, V.U. Zabaznov NAC Kazatomprom, Almaty, Kazakhstan - https://inis.iaea.org/collection/NCLCollectionStore/_Public/33/032/33032936.pdf) discusses natural attenuation at the Irkol Deposit which was subjected to a two and a half year full scale in-situ sulphuric acid leach test. The paper states:

  - *Over 13 years, almost complete natural attenuation of the residual ISL solutions took place. This include sulphate ion (Fig. 1), nitrate ion (Fig.2), total contents of the other salts including iron, aluminium, magnesium and the heavy metals (Fig. 3) and also radionuclides of the uranium and radium group (Fig. 4) took place. Over this period, the pH of the medium increased to 7.5-8.0 (Fig. 5) and the oxidation-reduction potential decreased to the background value - 120 mV. As a result, the area of the leach-field aquifer of approximately 20 000 m2 nearly returned to the baseline hydrogeochemical state which existed prior to mining.*

  - The paper is attached in Appendix 3.

- *NUREG/CR-3136 Aquifer Restoration at In-Situ Leach Uranium Mines: Evidence for Natural Restoration Processes* dated April 1983 discuses natural restoration processes. It concludes:

  - *The results of the laboratory experiments must be verified by field studies; however, we can tentatively recommend that natural processes be included as an important mechanism of aquifer restoration when restoration criteria are established for certain ground-water constituents. Completed experiments show that the list of dissolved constituents affected by natural restoration processes includes uranium and carbonate, and possibly redoxsensitive trace metals (e.g., As, Se, and Mo).*

  - This NUREG may be found at the link below:

    - *https://www.osti.gov/servlets/purl/6192987*

In addition, current groundwater restoration methods involve the creation of substantial volumes of wastewater that is subsequently disposed in Class I deep disposal wells or through evaporation in ponds. This approach is a consumptive use of groundwater that should be analyzed from a cost and benefit standpoint. Use of natural flushing would minimize such consumptive use of groundwater.

Please identify any issues that should be addressed to establish a relatively uniform set of requirements for ISR facilities nationwide (both in Agreement States and in non-Agreement States).

The following issues should be addressed:

- **Aquifer exemptions**
    - The fact that any type of in-situ recovery regardless of the mineral (e.g., uranium or copper) can only occur within a portion of an Underground Source of Drinking Water (USDW) that has been exempted in accordance with 40 CFR 146.4 under the criteria cited above.
    - No aquifer exemption has ever been rescinded.
    - This fact was clearly recognized in *NUREG-1569 Standard Review Plan for In Situ Leach Uranium Extraction License Applications* when it states in Section 6.0:

    " In addition to the NRC license, the EPA Authorized States issue underground injection control permits for in situ leaching operations, after the EPA grants an exemption from ground-water protection provisions for the portion of the aquifer undergoing uranium extraction (the exploited ore zone in an aquifer). The EPA aquifer exemption effectively removes that portion of the aquifer from any future consideration for ground-water protection;..."

    - 10 CFR Part 40 Appendix A Criterion 5 does not recognize this fact and as such is unsuitable for use in regulation of groundwater restoration at in-situ uranium recovery operations.
    - The direct issue is not groundwater protection within a depleted wellfield which is exempted from protection under EPA regulations but rather the protection of the groundwater outside of the aquifer exemption boundary.
    - Returning water quality to its pre-operational class of use should be allowed as a potential restoration standard. This is discussed in NUREG-1569 *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* that states:
        - *The applicant may therefore propose returning the water quality to its pre-operational class of use (e.g., drinking water, livestock, agricultural, or limited use) as a secondary restoration standard.*

- **Regulatory parity with other types of in-situ mineral extraction operations**
    - Copper will be mined via in-situ recovery in Arizona. Excelsior Mining Corporation (https://www.excelsiormining.com/) has obtained an aquifer exemption and UIC permit to perform in-situ copper recovery. Please see the page entitled *Excelsior Mining Arizona Inc. Gunnison Copper Project Class III UIC Area Permit and Aquifer Exemption* at https://www.epa.gov/uic/excelsior-mining-arizona-inc-gunnison-copper-project-class-iii-uic-area-permit-and-aquifer
    - Copper and uranium are both metals and both will be extracted via in-situ recovery. There should be parity between how both are treated in regard to groundwater restoration.
    - The groundwater restoration requirements for the Gunnison Copper Project are quite simple and are as follows:

- *After copper recoveries drop below the economic cutoff, ISR in each production block will be deemed complete and the block will be rinsed using fresh groundwater until applicable water quality standards are met. A three-step rinsing process will be implemented as follows:*
    - *1. Rinse three (3) pore volumes (based on a 3% fracture porosity of the orebody);*
    - *2. Rest for one (1) year; and*
    - *3. Rinse two (2) pore volumes.*
- **Source:** *Underground Injection Control Program AREA PERMIT Class III In-Situ Production of Copper Permit No. R9UIC-AZ3-FY16-1 Gunnison Copper Project Cochise County, Arizona - https://www.epa.gov/sites/production/files/2018-06/documents/r9uic-az3-fy16-1-excelsior_permit-2018-06-22.pdf*

Conclusions

The Wyoming Mining Association (WMA) has made the following conclusions regarding this Request for Comment on *Ground Water Protection at Uranium In Situ Recovery Facilities:*

- A rulemaking is required to replace the current ad hoc regulatory scheme for groundwater restoration at in-situ uranium recovery facilities that is based upon a Commission decision and two (2) RISs that were published without any public notice or opportunity for public comment.
- The rulemaking should incorporate and address the following items:
    - In-situ uranium recovery occurs within the exempted portion of an USDW and no aquifer exemption has never been rescinded.
    - Groundwater restoration requirements should not be specifically directed to restoration within the exempted portion of the aquifer but rather directed at protecting the groundwater outside of the aquifer exemption boundary such that its class of use is not degraded.
    - The risks posed by in-situ uranium recovery are documented to be very low.
    - The risks posed by uranium itself to populations and to individuals is very low.
    - The Toxicological Profile for Uranium does not classify natural uranium as a carcinogen but rather as a nephrotoxin. Thus, uranium is treated as any other heavy metal.
    - Passive restoration and natural attenuation should be considered as further reducing long term risks.
    - Regulatory parity with regulations governing the extraction of other metals (primarily copper) by the in-situ method within exempted aquifers should be considered in any proposed rules.
- Rulemaking costs
    - No discussion has been provided regarding how the cost of this proposed rulemaking will be covered. The in-situ uranium recovery industry in the United States is in poor financial condition and cannot afford to cover the cost of such a rulemaking, especially since all but one uranium in-situ recovery operation in the United States are in agreement states (Texas and Wyoming). The WMA will only support this rulemaking effort if a non-industry source of funding is used.

The Wyoming Mining Association (WMA) appreciates the opportunity to comment on this Federal Register Notice. If you have any questions please do not hesitate to contact me.

Best regards,

Travis Deti
Executive Director

CC: Katie Sweeney, National Mining Association

Appendix 1

WYOMING MINING ASSOCIATION

June 3, 2009

Chairman Jaczko
Commissioner Lyons
Commissioner Klein
Commissioner Svinicki

In care of:

Annette L. Vietti-Cook
Secretary of the Commission
U.S. Nuclear Regulatory Commission
Mail Stop O-16G4
Washington, DC 20555-0001

Dear Chairman Jaczko:

Subject: **Wyoming Mining Association - Comments on *NRC REGULATORY ISSUE SUMMARY 2009-05 URANIUM RECOVERY POLICY REGARDING: (1) THE PROCESS FOR SCHEDULING LICENSING REVIEWS OF APPLICATIONS FOR NEW URANIUM RECOVERY FACILITIES AND (2) THE RESTORATION OF GROUNDWATER AT LICENSED URANIUM IN SITU RECOVERY FACILITIES* dated Wednesday, April 29, 2009**

The Wyoming Mining Association (WMA) is an industry association representing mining companies, contractors, vendors, suppliers and consultants in the State of Wyoming. Among its mining industry members are uranium recovery licensees, including in-situ and conventional uranium recovery operators, several companies planning new uranium recovery operations and at least two (2) companies conducting final reclamation/restoration operations. WMA has reviewed the April 29, 2009 Regulatory Issues Summary (RIS) and has the following comments on it and specifically on the application of 10 CFR Part 40 Appendix A criterion 5B to uranium in-situ recovery operations:

Major Regulatory Change and the Need for Public Comment

The use of 10 CFR Part 40 Appendix A Criterion 5B, as a standard applicable to groundwater restoration at in-situ uranium recovery facilities is a major regulatory change. The Regulatory Issues Summary (RIS) states:

> *A notice of opportunity for public comment on this RIS was not published in the Federal Register because this RIS is informational and does not represent a departure from current regulatory requirements. This RIS pertains in part to an administrative aspect of the regulatory process that involves the voluntary submission of information on the part of addressees.*

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E-mail wma@vcn.com Web page www.wma-minelife.com

WMA believes that this Regulatory Issues Summary (RIS) is far more than merely *informational* and that it contains a major regulatory change that should have been noticed in the Federal Register and made available for public comment prior to implementation. While the portions of the RIS that deal with the process for scheduling licensing reviews are administrative in nature, the application of 10 CFR Part 40 Appendix A standards as currently written to groundwater restoration at in situ uranium recovery facilities is a significant change that should be subject to the rulemaking process. In fact, the Staff is currently working on a rulemaking that would revise 10 CFR Part 40 Appendix A to include groundwater restoration at in situ uranium recovery facilities. The RIS states that "*...the NRC, in consultation with the Environmental Protection Agency (EPA), is in the process of revising the regulations in 10 CFR Part 40, Appendix A, to clarify the groundwater restoration standards for ISR facilities. In the interim, pending issuance of the proposed ISR rule for public comment, this RIS provides clarification of NRC's existing groundwater restoration standards in Appendix A. However, it should be recognized that the ongoing rulemaking process and consultation with EPA may lead to changes in requirements that could be inconsistent with the Appendix A clarifications that are discussed...*" in the RIS. Staff states in the RIS that they expect that a draft of the proposed revisions to Appendix A will be published for public comment in 2010, which is a further delay from the previously announced rulemaking schedule. Furthermore, as discussed below, WMA believes that the RIS does not provide "*clarification*" of how Appendix A as currently written should apply to ISR groundwater restoration.

It is deeply disturbing to the uranium recovery industry that they are not being included in the decision making process. The industry has been included in the process on previous policy changes.

The NRC Staff itself admits that this change is inconsistent with existing guidance stating:

> *The staff recognizes that NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications," provides guidance that is not consistent with the requirements in Criterion 5B of Appendix A discussed above. In particular, the NUREG-1569 discussion of groundwater restoration to "pre-operational class of use" as being a secondary standard is not accurate, and is not an appropriate standard to use in evaluating license applications. Criterion 5B contains the appropriate standards that will be applied to groundwater restoration at ISR facilities.*

The existing guidance, NUREG-1569, was only finalized after acceptance and review of public comments. Staff states in the RIS that "*NUREG-1569 will be revised to correctly identify the standards for groundwater restoration at ISR facilities and to address the new requirements codified by the rulemaking.*" Any change to NUREG-1569 should also require a public comment period and consideration of public input. In the interim, the RIS fails to provide any guidance related to applying the current Appendix A requirements to ISR groundwater restoration.

Distribution of a Regulatory Issues Summary (RIS) related to in-situ uranium recovery operations for public comment has been previously proposed by Staff and accepted by a vote of the Commission. In *STAFF REQUIREMENTS - SECY-03-0186 - OPTIONS AND RECOMMENDATIONS FOR NRC DEFERRING ACTIVE REGULATION OF GROUND-WATER PROTECTION AT IN SITU LEACH URANIUM EXTRACTION FACILITIES* the Commission states:

> *The Commission has approved the staff's recommendation in Option 2a. The staff should proceed with development of a Regulatory Issue Summary to inform the public about this proposal and then proceed to develop a memorandum of understanding with each appropriate State.*

Option 2a of *SECY-03-0186* states in part,

> "*If the Commission approves this approach to Option 2, the staff would issue a RIS for comment...*"

Clearly if the Commission planned to make the RIS related to deferring active regulation of ground water protection at in-situ uranium recovery operations available for public comment prior to final release, then this document should, given the fact that its content is related, have been released for public comment as well.

Use of the current 10 CFR Part 40 Appendix A as a Standard Applicable to Groundwater Restoration at In-Situ Uranium Recovery Facilities

Original Intent and Purpose of 10 CFR Part 40 Appendix A

10 CFR Part 40 Appendix A which is entitled *Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content* was intended solely for the regulation of conventional uranium mills, mill tailings and tailings impoundments. It was not intended for the regulation of in-situ uranium recovery operations. The introduction clearly states:

> *Every applicant for a license to possess and use source material in conjunction with uranium or thorium milling, or byproduct material at sites formerly associated with such milling, is required by the provisions of § 40.31(h) to include in a license application proposed specifications relating to milling operations and the disposition of tailings or wastes resulting from such milling activities. This appendix establishes technical, financial, ownership, and long-term site surveillance criteria relating to the siting, operation, decontamination, decommissioning, and reclamation of mills and tailings or waste systems and sites at which such mills and systems are located.*

This appendix was initially added on October 16, 1985 (50 Federal Register 41862) in response to the passage by Congress of the Uranium Mill Tailings Radiation Control Act (UMTRCA). The purpose of UMTRCA, which was passed by Congress in November 1978, is clear. It is stated in the preamble of the Act (§ 7901. Congressional findings and purposes) as follows:

> *(a) The Congress finds that uranium mill tailings located at active and inactive mill operations may pose a potential and significant radiation health hazard to the public, and that the protection of the public health, safety, and welfare and the regulation of interstate commerce require that every reasonable effort be made to provide for the stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings.*
> *(b) The purposes of this chapter are to provide—*
> *(1) in cooperation with the interested States, Indian tribes, and the persons who own or control inactive mill tailings sites, a program of assessment and remedial action at such sites, including, where appropriate, the reprocessing of tailings to extract residual uranium and other mineral values where practicable, in order to stabilize and control such tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public, and*
> *(2) a program to regulate mill tailings during uranium or thorium ore processing at active mill operations and after termination of such operations in order to stabilize and control such tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public.*

The above history is succinctly summarized *in Recommendations for a Coordinated Approach to Regulating the Uranium Recovery Industry: A White Paper Presented By the National Mining Association* as follows:

> *First, the AEA, as amended by UMTRCA, establishes a pervasive federal scheme for the regulation of uranium mill tailings and related wastes. No less than three federal agencies play an active role in regulating mill tailings. Pursuant to section 274 of UMTRCA, the U.S. Environmental Protection Agency (EPA) has issued detailed, generally applicable standards to address both radiological and non-radiological hazards (i.e., groundwater) associated with mill tailings that are closely modeled after its Resource Conservation and Recovery Act (RCRA) regulations. In turn, NRC has incorporated these regulations into its criteria for the management and closure of mill tailings sites, set forth at 10 C.F.R. Part 40, Appendix A. In addition, NRC plays the key role in overseeing closure of active uranium mill tailings sites and final disposal of the tailings themselves. Finally, the Department of Energy (DOE) completes the circle of federal oversight of uranium mill tailings by acting as the permanent custodian and perpetual licensee of sites used for the disposal of tailings under Title II of UMTRCA, as well as exercising primary responsibility for selecting and overseeing the remediation of inactive uranium mill tailings sites under Title I of UMTRCA.*

Based on the legislative intent of UMTRCA and the subsequent intent of the regulations promulgated to carry out its intent it is clear that 10 CFR Part 40 Appendix A was not intended or designed to regulate in-situ uranium recovery operations as written.

The applicability of 10 CFR Part 40 to in-situ uranium recovery was discussed in *COMJSM-06-0001 REGULATION OF GROUNDWATER PROTECTION AT IN SITU LEACH URANIUM EXTRACTION FACILITIES.* In it, Commissioner Merrifield stated the following regarding regulation of in-situ uranium recovery:

It is my belief that the manner in which the NRC currently regulates this group of licensees is both complex and unmanageable. While the staff has done its best to regulate ISL licensees through the generally applicable requirements in Part 40 and imposition of license conditions, our failure to promulgate specific regulations for ISLs has resulted in an inconsistent and ineffective regulatory program. We have been attempting to force a square peg into a round hole for years, and I believe we should finally remedy this situation through notice and comment rulemaking. In developing a proposed rule, the staff should formulate a regulatory framework that is tailored specifically to this unique group of licensees.

Unfortunately the Commission has now imposed new requirements without notice or the opportunity for comment.

Specific Language in 10 CFR Part 40 Appendix A and Criterion 5B that is Inapplicable to In-situ Uranium Recovery Operations, Applicable only to Conventional Uranium Mill Tailings Sites and/or conflicts with Existing Regulations and/or Guidance

10 CFR Part 40 Appendix A could be used to regulate in-situ uranium recovery with modifications through rulemaking. As noted, Staff is currently in the process of working with EPA on a rulemaking to revise Appendix A to apply to in situ uranium recovery. However, specific language currently in Appendix A as described below is inapplicable to in-situ uranium recovery and the RIS fails to provide any guidance to industry on the acceptable application of Appendix A to groundwater protection at these facilities.

10 CFR Part 40 Appendix A defines point of compliance as follows:

> Point of compliance *is the site specific location in the uppermost aquifer where the ground-water protection standard must be met.*

Criterion 5B states that the point of compliance will be determined as follows:

> "*...The Commission will also establish the point of compliance and compliance period on a site specific basis through license conditions and orders. The objective in selecting the point of compliance is to provide the earliest practicable warning that the impoundment is releasing hazardous constituents to the ground water. The point of compliance must be selected to provide prompt indication of ground-water contamination on the hydraulically downgradient edge of the disposal area.*

40 CFR 192.02 defines point of compliance as follows:

> *(4) Point of compliance: The point of compliance is the location at which the groundwater concentration limits of paragraph (c)(3) of this section apply. The point of compliance is the intersection of a vertical plane with the uppermost aquifer underlying the site, located at the hydraulically downgradient limit of the disposal area plus the area taken up by any liner, dike, or other barrier designed to contain the residual radioactive material.*

In order to use Criterion 5B for the regulation of in-situ uranium recovery wellfields, it must be made clear that the applicable points of compliance are the monitor wells surrounding the wellfield. This is not clear in Criterion 5B or in the Regulatory Issues Summary (RIS). The reason that it is not clear in Criterion 5B is of course the fact that Criterion 5B was written for uranium mill tailings impoundments.

The point of compliance as defined above is at the "*hydraulically downgradient limit of the disposal area*" If Alternate Concentration Limits (ACLs) are to be applied to in-situ uranium recovery operations and the point of compliance is the monitor well ring, then it should be made clear that licensees would be allowed in their Alternate Concentration Limit (ACL) application for release following groundwater restoration, to move the point of compliance up to 500 meters outside of the monitor well ring. This is based on 40 CFR Part 192.32(a) 2(iv) which states:

(iv) The regulatory agency may establish alternate concentration limits (to be satisfied at the point of compliance specified under §264.95) under the criteria of §264.94(b), provided that, after considering practicable corrective actions, these limits are as low as reasonably achievable, and that, in any case, the standards of §264.94(a) are satisfied at all points at a greater distance than 500 meters from the edge of the disposal area and/or outside the site boundary...

The following is specific language in Criterion 5B that is clearly inapplicable to in-situ uranium recovery operations:

5B(1)--Uranium and thorium byproduct materials must be managed to conform to the following secondary ground-water protection standard: Hazardous constituents entering the ground water from a licensed site must not exceed the specified concentration limits in the uppermost aquifer beyond the point of compliance during the compliance period. Hazardous constituents are those constituents identified by the Commission pursuant to paragraph 5B(2) of this criterion.

Again, this criterion applies only to the "*uppermost aquifer*". In-situ uranium recovery does not generally occur in the uppermost aquifer. In-situ uranium recovery operations generally mine in a given aquifer with other aquifers above and below the one being mined. This is why *NUREG-1569 Standard Review Plan for In Situ Leach Uranium Extraction License Applications* states:

NUREG/CR–6733 (NRC, 2001, Section 4.3.3) established that significant risks for vertical excursions may exist if monitor wells are randomly located, given the typical criteria for spacing of vertical excursion monitor wells at licensed in situ leach facilities {e.g., one well per 1.6 ha [4 acres] for overlying aquifers; one well per 3.2 ha [8 acres] for underlying aquifers}. Thus, location of vertical excursion monitor wells within the well field should be such that the likelihood of detecting a vertical excursion is maximized.

Clearly Criterion 5B cannot be applied to in-situ uranium recovery facilities since it only applies to the "*uppermost aquifer*" when in-situ uranium recovery operations operate in deeper aquifers, which is why monitoring of overlying and underlying aquifers is currently required.

5B(1) continued: *The Commission will also establish the point of compliance and compliance period on a site specific basis through license conditions and orders. The objective in selecting the point of compliance is to provide the earliest practicable warning that the impoundment is releasing hazardous constituents to the ground water. The point of compliance must be selected to provide prompt indication of ground-water contamination on the hydraulically downgradient edge of the disposal area.*

This language applies to disposal areas (tailings impoundments) and not to in-situ uranium recovery wellfields. Tailings impoundments are designed to contain 11(e).2-byproduct material. This language is meant to address downgradient contamination from impoundments holding 11(e).2-byproduct material. This criterion cannot apply to in-situ uranium recovery wellfields since "*Underground ore bodies depleted by such solution extraction operations do not constitute "byproduct material" within this definition." (10 CFR Part 40.4 – Definitions)* Given this fact Criterion 5B should not be used to regulate them.

The language in Criterion 5B also establishes regulation "*on a site-specific basis through license conditions and orders*". This approach flies in the face of current and accepted regulatory policy specifically the development of *NUREG-1910 - Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities – Draft Report for Comment.* The regulatory approach taken by the Commission to date is exemplified by NUREG-1910, that being to take a generic approach to licensing of in-situ uranium recovery facilities given their overall similarities.

Outdated Requirements in 10 CFR Part 40 Appendix A

10 CFR Part 40 Appendix A was last updated on April 12, 1999, over a decade ago. Criterion 5B references drinking water limits in paragraph 5C stating, "*...the drinking water limits in paragraph 5C state acceptable hazards...*" These limits, which are based on Maximum Concentration Limits (MCLs) promulgated by EPA as primary drinking water standards, are not current. Specifically the following limits are not current:

- Arsenic is listed as 0.05 milligrams per liter. The current standard is 0.010 milligrams per liter as of 01/23/06.
- Barium is listed as 1.0 milligrams per liter. The current standard is 2.0 milligrams per liter.
- Cadmium is listed as 0.01 milligrams per liter. The current standard is 0.005 milligrams per liter.

- Chromium is listed as 0.05 milligrams per liter. The current standard is 0.1 milligrams per liter.
- Lead is listed as 0.05 milligrams per liter. The action level for lead (based on the treatment technique) is 0.015 milligrams per liter.
- Selenium is listed as 0.01 milligrams per liter. The current standard is 0.05 milligrams per liter
- Lindane is listed as 0.004 milligrams per liter. The current standard is 0.0002 milligrams per liter.
- Methoxychlor is listed as 0.1milligrams per liter. The current standard is 0.04 milligrams per liter.
- Toxaphene is listed as 0.005 milligrams per liter. The current standard is 0.003 milligrams per liter.
- In addition, lindane, methoxychlor and toxaphene are not used in in-situ uranium recovery operations and do not apply to them. A number of the substances listed in 10 CFR Part 40 Appendix A are related to solvent extraction circuits at conventional uranium mills. In-situ uranium recovery operations do not contain solvent extraction circuits.

It is poor regulatory practice to reference standards that are not current. In addition, in situ uranium recovery facilities are currently required to restore groundwater based on an extensive list of parameters based primarily on Wyoming Guideline 8. There are no provisions in Appendix A as currently written for restoration of these additional chemical constituents.

Conflicts with *COMSECY-07-0015 – PATH FORWARD FOR RULEMAKING ON GROUNDWATER PROTECTION AT IN SITU LEACH URANIUM EXTRACTION FACILITIES* and Associated Staff Requirements Memorandum (SRM)

COMSECY-07-0015 (Staff Requirements) states in part,

> *The staff should actively engage interested stakeholders through public workshops and work closely and cooperatively with the Environmental Protection Agency (EPA).*
>
> *The staff should remain diligent in working with EPA and appropriate States to establish appropriate standards to protect public health and safety and the environment and at the same time reduce, and preferably eliminate, dual regulation.*

The issuance of this RIS without opportunity for public comment fails to meet the Commission's requirement that the "*...staff should actively engage interested stakeholders...*"

COMSECY-07-0015 states in part: "*However, based on discussions with EPA, the regulations will conform to the standards in 40 CFR Part 192, and may contain relevant elements of the EPA's SDWA-based UIC program. The codification of standards for groundwater protection at ISLs will address industry's preference for predictability and stability in the regulatory process.*"

The issuance of this RIS without the opportunity for public comment fails to yield "*predictability and stability in the regulatory process*" and fails to meet the goals of COMSECY-07-0015. Staff explicitly recognized this by stating in the RIS that "*...it should be recognized that the ongoing rulemaking process and consultation with EPA may lead to changes in requirements that could be inconsistent with the Appendix A clarifications that are discussed...*" in the RIS.

Conflicts with *NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications*

As previously noted, the staff recognizes that NUREG-1569 provides guidance that is not consistent with the requirements in Criterion 5B of Appendix A and the RIS constitutes a major change in regulation for in-situ uranium recovery. NUREG-1569 was prepared in coordination with the State UIC programs that govern in situ uranium recovery and implemented acceptance criteria that complimented the UIC programs. Section 6.1.3 of NUREG-1569 discusses this coordination of NRC and State standards:

> *Secondary Restoration Standards—In situ leach operations may cause permanent changes in water quality within the exploited production zone, because the in situ leach extraction process relies on changing the chemistry in the production zone to remove the uranium. The applicant may therefore propose returning the water quality to its pre-operational class of use (e.g., drinking water, livestock, agricultural, or limited use) as a secondary restoration standard. Applications should state the principal goal of the restoration program and that secondary standards will not be applied so long as restoration continues to result in significant improvement in ground-water quality. The applicant must first attempt to return ground-water quality to primary restoration standards before falling back on secondary restoration standards. License conditions should be set up such that a license amendment is necessary before the*

applicant can revert to secondary goals. The applicant must commit to use reasonable efforts to reach primary restoration standards.

The RIS unilaterally changes this criterion to one that uses 1) background concentrations, which pose no incremental hazards and are the principal goal under NUREG-1569, 2) the drinking water limits in paragraph 5C, which as previously noted are outdated and incomplete when compared with the standards in NUREG-1569, or 3) Alternate Concentration Limits (ACLs). ACLs are discussed in 10 CFR Part 40 Appendix A criterion 5B which states:

Alternate Concentration Limits that present no significant hazard may be proposed by licensees for Commission consideration. Licensees must provide the basis for any proposed limits including consideration of practicable corrective actions, that limits are as low as reasonably achievable, and information on the factors the Commission must consider. The Commission will establish a site specific alternate concentration limit for a hazardous constituent as provided in paragraph 5B(5) of this criterion if it finds that the proposed limit is as low as reasonably achievable, after considering practicable corrective actions, and that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the alternate concentration limit is not exceeded.

This change to groundwater restoration standards needs to be consistent with existing state standards, at least in the State of Wyoming. The current Wyoming CHAPTER 11 NONCOAL IN SITU MINING regulations require that *"...operators returning all affected groundwater to the pre-mining class of use or better using Best Practicable Technology..."*

The State of Wyoming Environmental Quality Act Chapter 11 Article 1 (General Provisions) states in the definitions:

"Groundwater restoration" means the condition achieved when the quality of all groundwater affected by the injection of recovery fluids is returned to a quality of use equal to or better than, and consistent with the uses for which the water was suitable prior to the operation by employing the best practicable technology;

This RIS creates conflicts the State of Wyoming Environmental Quality Act and existing State regulations. These conflicts could have been avoided if Staff had sought public comment for this RIS or maintained the current regulatory approach until the Part 40 rulemaking process is complete.

Impacts to Existing Licenses and to Pending Applications

A change of this magnitude may require substantial revisions to pending license applications submitted by WMA member companies and currently under review by NRC Staff, creating further delays in licensing, particularly since the Staff has provided no guidance on the acceptable application of these requirements to in situ uranium recovery. It will also require changes to existing licenses since the RIS states that these new requirements will apply to current operating licensees. Furthermore, Staff has not discussed how this RIS should apply at Agreement States with in situ uranium recovery licensees, such as Texas.

Conclusions

The following are WMA conclusions concerning this RIS:

The changes to groundwater restoration standards for in-situ uranium recovery operations described in this RIS constitute a major regulatory change that should have been subject to public notice and comment.

The use of 10 CFR Part 40 Appendix A criterion 5B as currently written is inappropriate for groundwater restoration at in-situ uranium recovery operations. The Uranium Mill Tailings Radiation Control Act (UMTRCA) and 10 CFR Part 40 Appendix A which was promulgated to implement UMTRCA were not originally intended to regulate in-situ uranium recovery. 10 CFR Part 40 Appendix A should not be used to regulate groundwater restoration at in situ uranium recovery licensees until the rulemaking process is complete. Many specific provisions of Appendix A cannot be applied to ISR facilities until revised.

The document is inconsistent with existing State of Wyoming regulations and the State's Environmental Quality Act as well as creates the potential for conflicts with current Underground Injection Control (UIC) regulations. These potential conflicts could have been avoided by following the public comment or rulemaking process.

The RIS is not in conformance with *COMSECY-07-0015 – PATH FORWARD FOR RULEMAKING ON GROUNDWATER PROTECTION AT IN SITU LEACH URANIUM EXTRACTION FACILITIES* and the associated Staff Requirements Memorandum (SRM).

Based on the problems enumerated above, WMA believes at a minimum that the RIS should be rescinded and interim guidance provided following public notice and an appropriate period for public comment. WMA prefers that the current regulatory approach of implementing generally applicable Part 40 Appendix A requirements through existing guidance and license condition be maintained until the Part 40 rulemaking process has run its course.

WMA appreciates the opportunity to comment on this Regulatory Issues Summary (RIS). If you have any questions please do not hesitate to contact me.

Sincerely yours,
WYOMING MINING ASSOCIATION

Marion Loomis

Marion Loomis
Executive Director

Cc: Bill Von Till – NRC/DWME
Katie Sweeney – National Mining Association

Appendix 2

June 1, 2009

U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, Maryland 20852

Re: NRC Regulatory Issue Summary 2009-05

Dear Sir:

The National Mining Association (NMA) submits these comments on the Nuclear Regulatory Commission's (NRC) Regulatory Issue Summary (RIS) 2009-05, specifically as it pertains to the restoration of groundwater at licensed uranium *in situ* recovery (ISR) facilities. NMA represents producers of most of America's coal, metals, industrial and agricultural minerals; manufacturers of mining and mineral processing machinery and supplies; transporters; financial and engineering firms; and other businesses related to coal and hardrock mining. These comments are submitted by NMA on behalf of its member companies who are NRC licensees or prospective licensees, including the owners and operators or prospective operators of uranium mills and mill tailings sites and ISR production facilities.

NMA strongly disagrees with NRC's conclusion that the RIS is informational and does not represent a departure from current regulatory requirements. The RIS clearly imposes new requirements on licensees and therefore, NRC violated the Administrative Procedures Act (APA) by failing to publish the RIS for public comment. NRC, thus, should rescind the RIS immediately. Furthermore, NMA disputes the RIS' conclusion that the standards contained in Criterion 5B of 10 CFR Part 40, Appendix A apply currently to the restoration of groundwater at ISR facilities. This conclusion is contrary to NRC's long-standing interpretation, guidance and policy regarding applicability of Appendix A criteria to ISR facilities and NRC cannot rely upon this conclusion to delay pending license applications. As NRC correctly notes, when the Appendix A requirements were established in 1985, uranium ore was recovered and processed predominantly at conventional mills and, as such, Appendix A focused primarily on operations and closure at conventional mill sites as opposed to ISR facilities. The RIS then entirely ignores this history, leaps forward 15 years to the NRC's determination that waste water generated during ISR operations is classified as 11e.(2) byproduct material and illogically determines that 1) since ISR wastes are byproduct material, and 2) since Appendix A is designed to regulate byproduct material, Appendix A must apply directly at written to ISR facilities.

NRC Violated the APA in Failing to Publish the RIS for Comment

Under the APA, rules are defined as "the whole or a part of an agency statement of general or particular applicability and future effect designed to implement, interpret, or prescribe law or policy or describing the organization, procedure, or practice requirements of an agency." APA section 551(4).

Both section 552(a)(1) and section 553 of the APA govern procedures for agency rulemaking. Section 552(a)(1) provides in relevant part as follows:

> (a) Each agency shall make available to the public information as follows:
>
> > (1) Each agency shall separately state and currently publish in the Federal Register for the guidance of the public— . . .
> >
> > > (D) substantive rules of general applicability adopted as authorized by law, and statements of general policy or interpretations of general applicability formulated and adopted by the agency; and
> > >
> > > (E) each amendment, revision, or repeal of the foregoing.

Section 553 sets forth guidance as to when notice and comment procedures are required and specific procedures for conducting notice and comment rule making. According to these sections of the APA, "rules" must be published for notice and comment. Agencies cannot substitute guidance documents in lieu of rules to impose new substantive requirements. The issue of when guidance needs to be published for comment was addressed directly by the U.S. Court of Appeals for the District of Columbia Circuit in *Appalachian Power Co. v. EPA*, wherein the court found that an Environmental Protection Agency guidance document relating to emissions monitoring imposed new substantive requirements on facilities that necessitated notice and comment rulemaking. The court concluded that "it is well-established that an agency may not escape the notice and comment requirements . . . by labeling a major substantive legal addition to a rule a mere interpretation." *Appalachian Power Co. v. EPA,* 208 F.3d 1015, (D.C. Cir. 2000). If they wish to impose new substantive requirements, agencies must follow section 553 of the APA. *Croplife America v. EPA*, 329 F.3d 876 (D.C. Cir. 2003).

Considerations for determining whether a "guidance" document should be published as a rule include whether the agency acts as if the document is controlling and whether the document would lead parties to believe the agency will disapprove permit applications unless they comply with terms of the document. *See generally, Appalachian Power.* As discussed in detail below, NRC indicates that the RIS' conclusion about the applicability of Appendix A to ISR facilities is controlling, even in the face of existing NRC policy and guidance to the contrary. Furthermore, prospective licensees have been informed by NRC that for their applications to be approved, the application must "demonstrate that the applicant will be able to return the groundwater quality to the NRC required restoration standard of baseline water quality or the standards listed in Criterion 5B(5)(b) of Appendix A to 10 CFR Part 40." (See Request for Additional Information, Moore Ranch Uranium Project

Source Material License Application at p. 13, ADAMS accession number ML081340113.) Given these considerations, NRC violated the APA by failing to publish the RIS for comment.

NRC Long-standing Interpretation of Applicability of Appendix A Conflicts with the RIS Conclusion

As early as 1997, NRC raised the idea of creation of a new part 41 or new appendices to part 40 because "there are no requirements in 10 CFR Part 40 for ISL facilities that cover the protection of groundwater or establish standards for assuring that the water quality in the impacted aquifers is restored after uranium extraction operations are completed." NRC prepared a draft rulemaking plan indicating that

> Currently, NRC uses the generally applicable requirements in 10 CFR Part 40, Appendix A, to regulate ISLs. Ground-water cleanup standards, however, are written in a manner that makes them applicable to only uranium mill tailing impoundments. Because of this . . ., the staff has regulated the ground water at ISL facilities by using generically applicable requirements in 10 CFR Part 40 and by drawing on applicable groundwater standards from the U.S. Environmental Protection Agency (EPA) or States, mainly through license conditions.

Draft Rulemaking Plan: Domestic Licensing of Uranium and Thorium Recovery Facilities - 10 CFR Part 41, p. 12.

NRC was particularly interested in new regulations for ISR facilities due to the fact that ISR facilities, as opposed to mills, had become, and were expected to continue to be, the primary source of U.S. uranium production. NRC obtained assistance from the Center for Nuclear Waste Regulatory Analyses (Center) to determine ways to risk-inform ISR regulations. The Center analysis confirms the NRC's contemporaneous assessment that Appendix A was not directly applicable to ISR facilities:

> While the entire milling process is governed by 10 CFR Part 40, Appendix A, the ISL is not covered by this part of the Code of Federal Regulation for those aspects of the ISL that are not in common with the uranium mill. Rather, ISL facilities are regulated to protect the health and environment through a set of requirements that are known as license conditions. These license conditions are subject to legal challenges, imply economic and operational risk to the ISL owners, and may not be uniformly applied across licensees. To remedy this situation NRC has contemplated the development of a new rule, 10 CFR 41.

"Risk Informing the Materials and Waste Arenas: Integration of Case Studies and Related Risk Assessments -- Volume 2: Case Study Plan and Case Study

Reports" -- December 2001, Revised February 2002. Case Study on the Risk Informing Uranium Recovery, Volume 2: Appendix E, p. 20.

The planned ISR rulemaking was put on hold in 2001 due to the depressed financial state of the uranium recovery industry. As the recovering uranium production industry began to once again seek to expand ISR facility production and submit new applications, NRC determined to resurrect the rulemaking. Once again, the concern was raised that

> Both 10 CFR Part 40, Appendix A and 40 CFR Part 192 focus primarily on conventional mills, with little reference to ISL uranium facilities. As a result, NRC has been regulating groundwater protection at ISLs primarily through license conditions.

COMSECY 07-0015: Path Forward for Rulemaking on Groundwater Protection at *In Situ* Leach Uranium Extraction Facilities, p. 2.

NRC Guidance Conflicts with the RIS Conclusion

The conclusion that Appendix A criterion 5B is directly applicable to ISR facilities conflicts entirely with the primary NRC guidance for review of ISR applications, NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications." Specifically, the review plan is intended to provide guidance on what is to be reviewed, the basis for the review, how the staff review is to be accomplished, what the staff will find acceptable in a demonstration of compliance with the regulations, and the conclusions that are sought regarding the applicable sections in 10 CFR Part 40, Appendix A. Yet, the RIS explicitly acknowledges that the SRP provides guidance that is not consistent with the requirements in Criterion 5B of Appendix A: "In particular, the NUREG-1569 discussion of groundwater restoration to "pre-operational class of use" as being a secondary standard is not accurate, and is not an appropriate standard to use in evaluating license applications. Criterion 5B contains the appropriate standards that will be applied to groundwater restoration at ISR facilities."

NRC Must Continue Current Policy until NRC Rulemaking is Concluded

As discussed in the RIS, NRC currently is proceeding with a rulemaking to revise the regulations in 10 CFR Part 40, Appendix A, to clarify the groundwater restoration standards for ISR facilities. The primary purpose of the rulemaking is to codify and make directly applicable the requirements of 10 CFR Part 40, Appendix A, Criterion 5(b)(6) to ISR facilities. Logically, the rulemaking would be unnecessary if the requirements are already directly applicable to ISR facilities. Furthermore, since NRC fails to provide any reasoned analyses of its change in its long-standing interpretation, it needs to comply with the notice and comment provisions of the APA prior to changing its policy. *See*, *Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 42 (1983)("an agency changing its

course by rescinding a rule is obligated to supply a reasoned analysis for the change.”)

Criterion 5B Point of Compliance Cannot Be Directly Applied to ISR Facilities

While the location of the point of compliance at ISR facilities is not directly addressed in the RIS, clearly the current 5B criterion POC language is not designed for ISL facilities. First, Criterion 5B states:

> Uranium and thorium byproduct materials must be managed to conform to the following secondary ground-water protection standard: Hazardous constituents entering the ground water from a licensed site must not exceed the specified concentration limits in the uppermost aquifer beyond the point of compliance during the compliance period.

ISR activities generally do not occur in the uppermost aquifer but are generally mined in a given aquifer with other aquifers above and below the one being mined. The ISR SRP, NUREG-1569 recognizes this fact as it requires monitoring of overlying and underlying aquifers. Furthermore, Criterion 5B indicates “the point of compliance must be selected to provide prompt indication of ground-water contamination on the hydraulically downgradient edge of the disposal area.” Again, this language cannot be applied directly to ISR operations since they do not have disposal areas. Rather, the current approach for to groundwater monitoring at ISR facilities, in which the POC is located at the wellfield monitor wells, is consistent with the purpose of the Criterion. The stated objective in selecting the point of compliance *is to provide the earliest practicable warning* that the impoundment is releasing hazardous constituents to the ground water."

NRC’s draft Generic Environmental Impact Statement (DGEIS) for ISR facilities, NUREG-1910, accurately describes the current approach to groundwater monitoring programs and excursions at ISR facilities. As stated in the DGEIS, "[l]icensees must maintain groundwater monitoring programs...to detect both vertical and horizontal excursions and must have operating procedures to analyze an excursion and determine how to remediate it." DGEIS at 2-18. As part of this mandatory groundwater monitoring program, NRC requires that licensees establish upper control limits *at monitor wells* that, similar to a POC, are designed to "provide early warning if leaching solutions are moving away from the well fields." Similar to a conventional uranium mill, an ISR operator is also required to select "excursion indicators" that are "easily measurable parameters that are found in higher concentrations during ISR operations than in natural waters." After constructing its wellfield and commencing uranium recovery operations in that wellfield, a licensee is required to sample monitor wells on a pre-determined schedule to ensure that such indicators have not been impermissibly exceeded. In the event that site excursion indicators are impermissibly exceeded, NRC classifies such an exceedance as an "excursion." An "excursion" is defined in the DGEIS as "when two or more excursion indicators in a monitoring well exceed their UCLs." When an excursion is detected, NRC requires that a licensee "take...several steps to notify NRC and

confirm the excursion through additional and more frequent sampling" and recover the excursion. As a result, the monitor wells at an ISR site serve as the equivalent of a POC. Any attempt by NRC's attempt to require that the POC at any location other than monitor wells would be wholly inconsistent with Appendix A Criteria and current practices at ISR project sites.

Conclusion

As discussed above, the conclusion NRC reaches about the current applicability of the standards contained in Criterion 5B of 10 CFR Part 40, Appendix A to the restoration of groundwater at ISR facilities is legally faulty. The RIS clearly represents a departure from current regulatory requirements and imposes new requirements on licensees. Therefore, NRC violated the APA by failing to publish the RIS for public comment and should immediately rescind the RIS.

Please contact me at ksweeney@nma.org or (202)463-2627 if you have any questions regarding NMA's position on the RIS.

Sincerely,

General Counsel, National Mining Association

Appendix 3

IAEA-SM-362/43

Experience with restoration of ore-bearing aquifers after in situ leach uranium mining

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NAC Kazatomprom, Almaty, Kazakhstan

Abstract. In many cases the most important environmental issue for in situ leach uranium mining technology is the impact on groundwater. Usually the greatest issue is the chemical condition of the ore bearing aquifer following the completion of leaching. Based on experience gained during post leach monitoring, it has been found that in properly selected sites the impact following leaching is greatly reduced because of the process of self restoration, otherwise known as natural attenuation. This paper provides ground water monitoring data from 1985 to 1997 following completion of leaching at the Irkol uranium deposit, Kazakhstan. It shows the evolution of the pH, and other chemical parameters over this period. The monitoring results demonstrate that at this site the process of natural attenuation appears to have effectively reduced the impact on groundwater at the site, as well as to keep contaminated leaching fluids from moving more than a few hundreds of metres from the wellfield.

For objective reasons, a contradictory situation has been long formed in the world commercial production of non-ferrous metals in which the supply of metals grows while the primary production goes down. The ore used in the production of non-ferrous metals is becoming lower grade. Therefore, in order to maintain and increase an appropriate level of the metal output, ores have to be mined in larger quantities.

Mining equipment for ore production is increasing in capacity, and more toxic agents are being used for ore dressing and concentrate production. A large quantity of fuel and flux is also used in metallurgical plants to produce increasing volumes of concentrates. This results in a growing negative impact on the environment. One way of reversing this situation may be the comprehensive use of geotechnical methods for mineral production and processing.

The geotechnology is a complex of processes and operations with a minimal impact on the environment. The geo-technology, in situ leach (ISL) mining may be considered to be the safest mining method with regards to the environment. The environment is a large system which is formed as a result of interaction of its three subsystems, namely, ecology, man and technology. It is difficult to underestimate the role of in situ uranium leaching in the solution of a large social problems by freeing people from working in radioactive dusty mines and open pits.

In situ metals leaching is a mining method using selective transfer of the useful component into the liquid phase within the ore followed by processing of the pregnant (production) solution. This method enables one to apply one of the basic hydrometallurgical process – **percolation** taking place within the ore occurrence. It should be noted that this method uses only natural processes. They are intensified due to the oxidation-reduction in the hydrochemical environment caused by the action of reagents – sulphuric acid in sulphuric acid leaching, and either ammonium or sodium bicarbonate in carbonate leaching.

Recently, as a result of the development of metal mining by ISL at ore deposits located in aquifers, the question of groundwater restoration after completing mining has become of increasing interest.

The environmental disturbance of ISL mining is characterized as the following:

— All operations are conducted within ore occurrence without any substantial site development. The ISL mining does not cause any significant mechanical disturbance of the surface and

subsoil (as compared to conventional mining). When mining roll front type (bed infiltration) deposits using a system of wells, such disturbances do not take place.

— During leaching of roll front type deposits the ISL process is performed as a closed cycle based on the balance of the volume of injected and recovered solutions. Pumping to recover the solution develops a cone of the depression in the groundwater in the vicinity of recovery wells. During this process a closed hydraulic contour is formed in the ISL leaching area. This prevents any migration of solutions outside of the leach area. Along the border of the leach field is formed a strong acid-alkaline barrier beyond which any substantial flow of the acid ISL solution is prevented.

— ISL processes (both acid and carbonate) cause substantial changes in the ground-water chemistry in ISL leach fields. They may increase the concentration of the total dissolved solids by up to ten times. These components include aluminium, iron, nitrates, heavy metals, microelements and also radionuclides.

Such increases in total dissolved solids are relatively short-lived and strictly limited in area. Nevertheless, under the current environmental law, special water users – such as ISL project – must provide continuous monitoring of the water resources (aquifers) and take measures to ensure the water quality of the aquifers return almost to the pre-mining baseline conditions after the completion of mining.

At present, there are two main restoration methods in the technology of groundwater treatment from man-caused contamination. The first method utilizes physiochemical and biological treatment of the contaminated aquifers and groundwater, with or without pumping the water to the surface. The second method includes treating the water mainly in place. These technological processes are difficult to carry out. They are rather costly and not very efficient and both ultimately require the construction and maintenance of radioactive waste storage site. Costs of the above water treatment methods are high amounting to 20-50% of the final ISL product (i.e. uranium cost).

When choosing optimal methods for the ground-water restoration, first of all, we should define whether we understand the impact of the ISL process on the environment. The authors, who have a large experience in ISL production, contend that mining of the roll front type uranium deposits affects only the aquifer hydrogeochemistry by changing its oxidation-reduction state. Quantities of sulphates, (during acid leach) or carbonates, (during alkaline leach) introduced during the ISL process are very small compared to their natural quantities in the water and rocks involved in the ISL process.

Following the impact caused during leaching, reduction of the natural reduction-oxidation aquifer conditions start, and this is followed by demineralization of the groundwater.

To better understand this process, from mid-1980s, a group of scientists and experts in uranium production conducted theoretical and experimental studies of the behaviour of the residual ISL solution after the completion of mining. The major conclusion of the studies is that the ore-hosting epigenetic zoned hydrochemical medium is resistant to intensive ISL impact. The groundwater system tends to return to pre-mining condition by self-neutralization, or "natural attenuation", once the introduction of leaching solution is suspended. It has been demonstrated at several test sites that a slow but irreversible neutralization of ISL leaching solutions takes place in aquifers containing residual solution plumes after leaching is stopped. This process is based both on the action of natural geochemical barriers, which are an integral factor of the epigenetic chemical zoning of such uranium deposits, and barriers that result from the mining itself.

At the **neutralization** (alkaline) barrier it has been observed that pH increases from 2.0-2.5 to 7.5-8.5 mV due to a reduction in the content of potential acidifiers (iron disulphides and other), and an increase in the content of neutralizers (carbonates, chlorides, alkali earth, chips of feldspar grains,

montmorillonite and hydromica clays and other). In this zone, the formation of insoluble cement and gypsum take place, accompanied by isomorphic absorption of strontium, barium, radium and other heavy metals. At the same time, the precipitation of aluminium and iron hydroxides take place. These precipitates also absorb light and heavy metals. Bicarbonates are neutralized to carbonates forming almost insoluble calcium and magnesium dolomites. Ferrous iron is hydrolysed to ferric iron, which forms a strong reduction barrier.

The **reduction** barrier is characterized by a decrease of the oxidation-reduction potential from 350-450 to 0-150 mV. In this zone, the carbon substances, pyrite sulphur, bitumen, organic substances, hydrogen and hydrogen sulphide in the unoxidized rocks precipitate uranium, radionuclides, molybdenum, arsenic, selenium and tellurium. When the content of carbonaceous matter and phosphates increases, a **sorption** barrier is formed which also absorbs a number of microelements and radionuclides. Therefore, both reduction and sorption barriers develop near the limit of the ISL field.

A special role in purification of the groundwater from sulphate and nitrate enrichment belongs to spore forming bacteria. Such bacteria spores occur in unoxidized sands of host aquifers. With a pH value of 6-7, mineralization of the groundwater is close to the nutrient medium for the bacteria reproduction. In the presence of soluble organic carbon the vital activity of bacteria becomes more intensive.

Both laboratory and field tests in the wells of Severny and Yuzhny (i.e. North and South) Karamurun deposits have demonstrated that sulphate reducing bacteria adapted to sulphate media (pH 3.7 to 5) decrease the content of sulphates in the ore solutions from 10 to 0.5 g/l. At these sites the content of sulphates is halved from 5.4 to 2.7 grams/litre over a few months.

On the basis of these theoretical conclusions monitoring was conducted at test and commercial production sites in the CIS republics (Uzbekistan, Kazakhstan, Ukraine) and in the U.S.A. The largest scale and most detailed studies of the natural hydrochemical processes and self-purification (i.e. natural attenuation) of the stratal water contaminated by the products of sulphuric acid uranium ISL were carried out at the Irkol deposit in Kazakhstan and Yuzhny Bukinay deposit in Uzbekistan. Similar surveys have been conducted at the Yuzhny Karamurun and Uvanas deposits in Kazakhstan.

Based on the results of the long term monitoring, it was established that mineralization of the residual solution is reduced due to hydraulic dispersion, molecular diffusion, physical and chemical reactions with host rocks, mechanical sorption and monatomic ion exchange. The rate and efficiency of the process, first of all, depends on the sorption properties of the aquifer host rocks. The presence of residual carbonates significantly accelerates the process of natural attenuation following sulphuric acid ISL The other positive factors are a low thickness of the ore-hosting horizon and increased depths of deposit, where increased temperature and pressure help catalyse and accelerate the process.

The results of 13 years of monitoring of the self-purification process at the Irkol deposit supports the authors conclusion. The Irkol deposit is located in Kzyl-ordinskaia oblast in Mining Group Number 6. The detailed exploration was finished in 1985. Ore occurs in sands of Cretaceous age, at a depth ranging from 390 to 700 m. The average depth is 400-450 m. The reserves are 21 800 t U with an average uranium content of 0.042%. The ore is non-calcareous with a CO_2 content of 0.2%.

Here, over two and a half years, a full-scale in-situ sulphuric acid leach test was carried out at the depth of 450 meters. 65 tons of uranium were mined at the site with a recovery of 80%. Following completion of leaching from 1985 to 1997, systematic sampling of the remaining residual leach solutions was done using recovery and monitor wells. The monitoring was carried out every half year to determine the concentration of a large number of components remaining in the solutions.

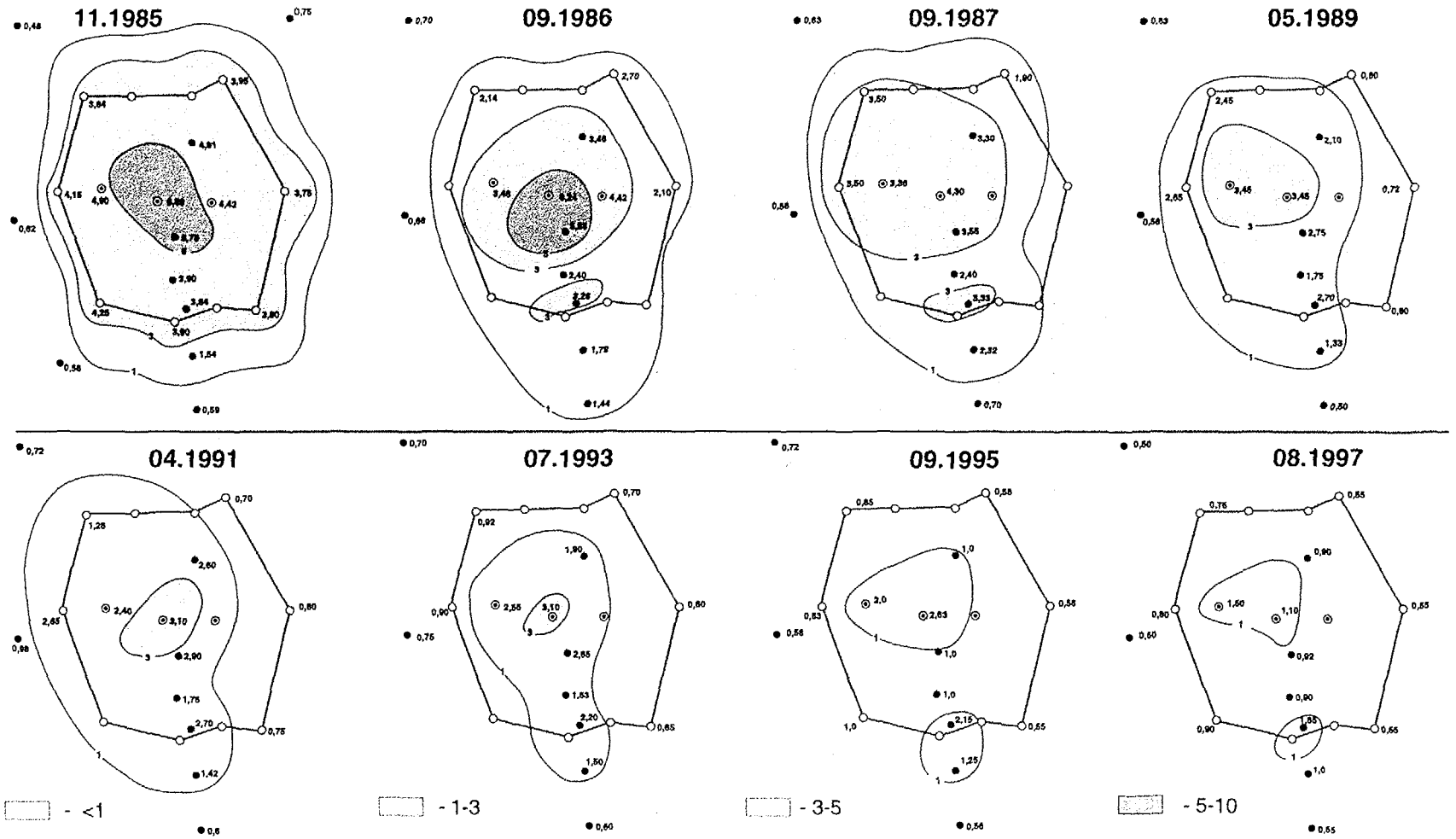

FIG. 1. Sulphate concentration (SO_4^{-2} grams/litre, (g/l)) in residual leach solution at the Irkol, Kazakhstan ISL wellfield following completion of injection of leach solutions in 1985.

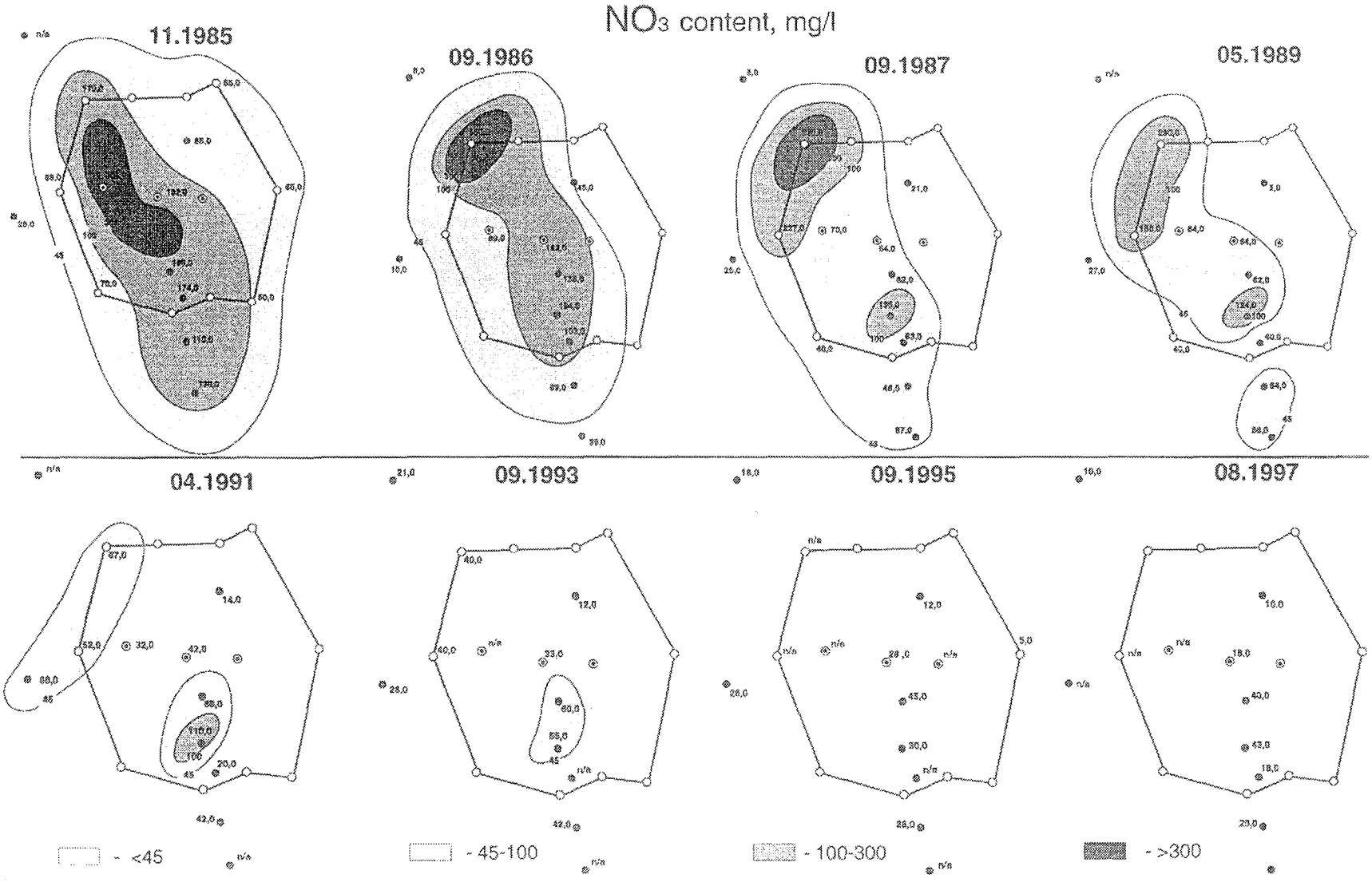

FIG. 2. Nitrate concentration (NO_3, milligrams/litre) at the Irkol, Kazakhstan ISL wellfield following completion of injection of leach solutions in 1985.

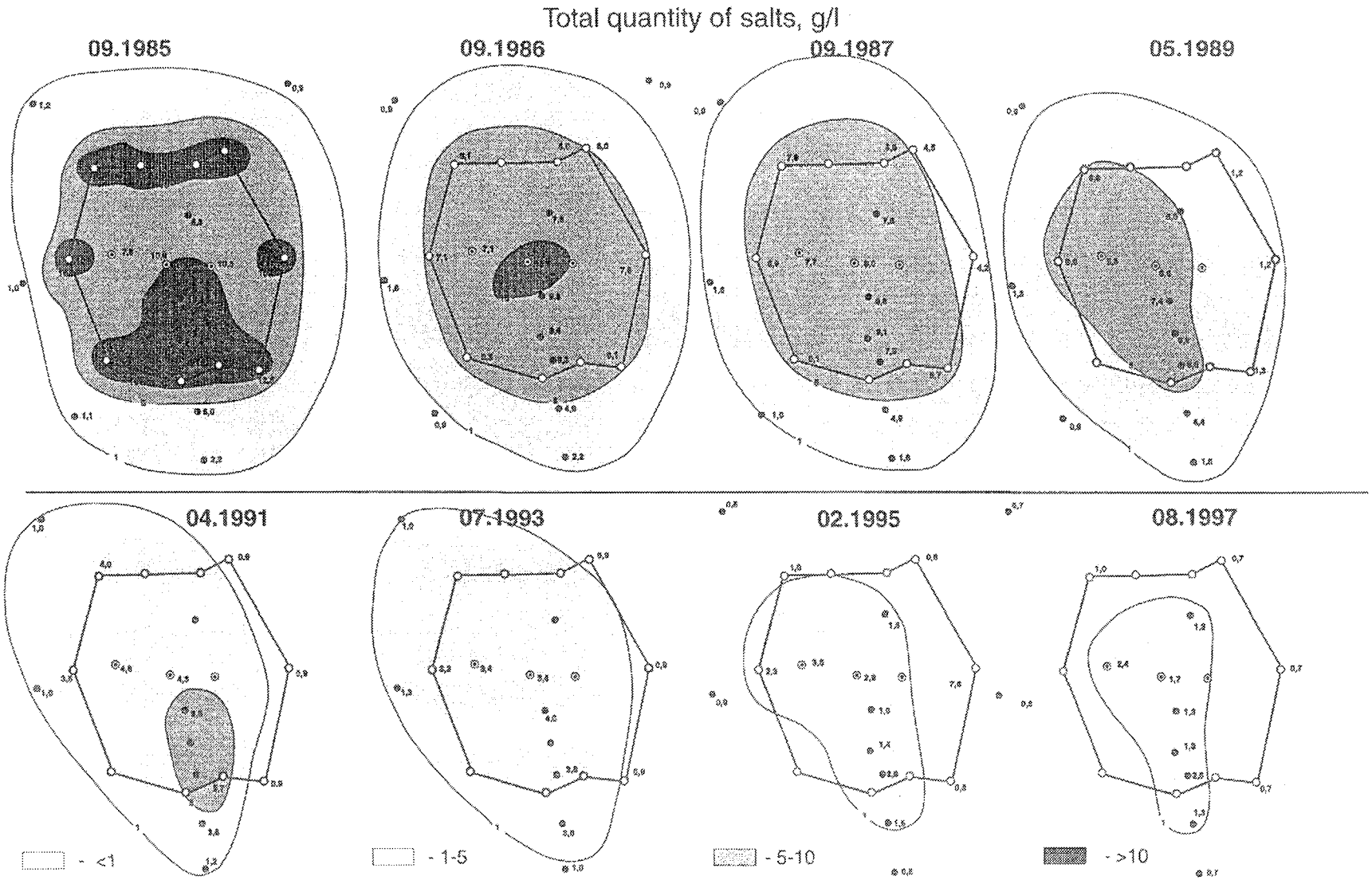

FIG. 3. Concentration of Total Dissolved Solids (TDS, g/l) at the Irkol, Kazakhstan ISL wellfield following completion in injection of leach solutions in 1985.

It was decided that it would be sufficient to demonstrate the behaviour over time of the main and long-lived products of leaching and the pH in the former leach area. The concentration of uranium was also monitored. At the completion of mining, the following values were observed:

pH – 2.5;
Sulphates – 6.9 g/l;
Nitrates – 360 mg/l;
U – 57 mg/l;
Total mineralization – 15.3 g/l.

Over 13 years, almost complete natural attenuation of the residual ISL solutions took place. This include sulphate ion (Fig. 1), nitrate ion (Fig.2), total contents of the other salts including iron, aluminium, magnesium and the heavy metals (Fig. 3) and also radionuclides of the uranium and radium group (Fig. 4) took place. Over this period, the pH of the medium increased to 7.5-8.0 (Fig. 5) and the oxidation-reduction potential decreased to the background value – 120 mV. As a result the area of the leach-field aquifer of approximately 20 000 m^2 nearly returned to the baseline hydrogeochemical state which existed prior to mining.

At the Yuzhny (South) Bukinai deposit (Uzbekistan) similar monitoring was conducted for 11 years after the ISL mining had stopped. Over this period, 50-60 % of the process of self-purification of the residual solutions took place.

The collected data demonstrate that the natural hydrogeochemical neutralization of the residual solutions after in-situ sulphuric acid uranium leach is **a method of restoration of the groundwater** of ore-bearing horizons. The costs are mainly incurred by installation of a monitor well system and carrying out a regime of hydrochemical monitoring until complete demineralization of the residual solutions to the required level. In comparison with active restoration using the pump and treat method and/or chemical precipitation, natural restoration of groundwater is 10 to 100 times less expensive.

The sole, but rather significant negative aspect of the self-restoration method is that this method is slow. Tens of years are required for returning to the baseline chemical condition of the groundwater. This factor caused us to organize a test to intensify this process at the Yuzhny (South), Bukinai and Severny (North) Karamurun deposits using forced filtration of ISL residual solutions outside of the area of their initial location of the ISL field.

To promote the transfer of the contaminants in the residual solution from the liquid to a solid phase, the solution was pumped from the ISL well-field area to an adjacent area of unoxidized rocks. The fluids were allowed to flow through the unoxidized rocks. For this purpose, a system of special monitor and injection/production wells was installed adjacent to the leach field. The distance from the mined deposit to the recovery wells was determined by calculations based on concentration of the dissolved contaminants, the reduction and sorption properties of rocks in the demineralization area and the contrasting level of natural geochemical barriers. Formation water from the opposite side of the plume, or a part of the plume were simultaneously injected.

The main result of these experiments resulted in the conclusion that percolating the residual ISL solutions through rocks unaffected by ISL returned the concentration of the dissolved elements back to the background level. Water circulation through unoxidized rocks has been determined as the most effective method of natural attenuation.

The method ensures total ground-water restoration within a relatively short period of time (i.e. from a few months to two or three years, subject to the size of the site to be cleaned). The costs are mainly related to the drilling of wells, pumping and chemical monitoring. This method of restoration of ore-bearing horizons following acid ISL uranium mining has been patented by a group of research workers that developed the technology.

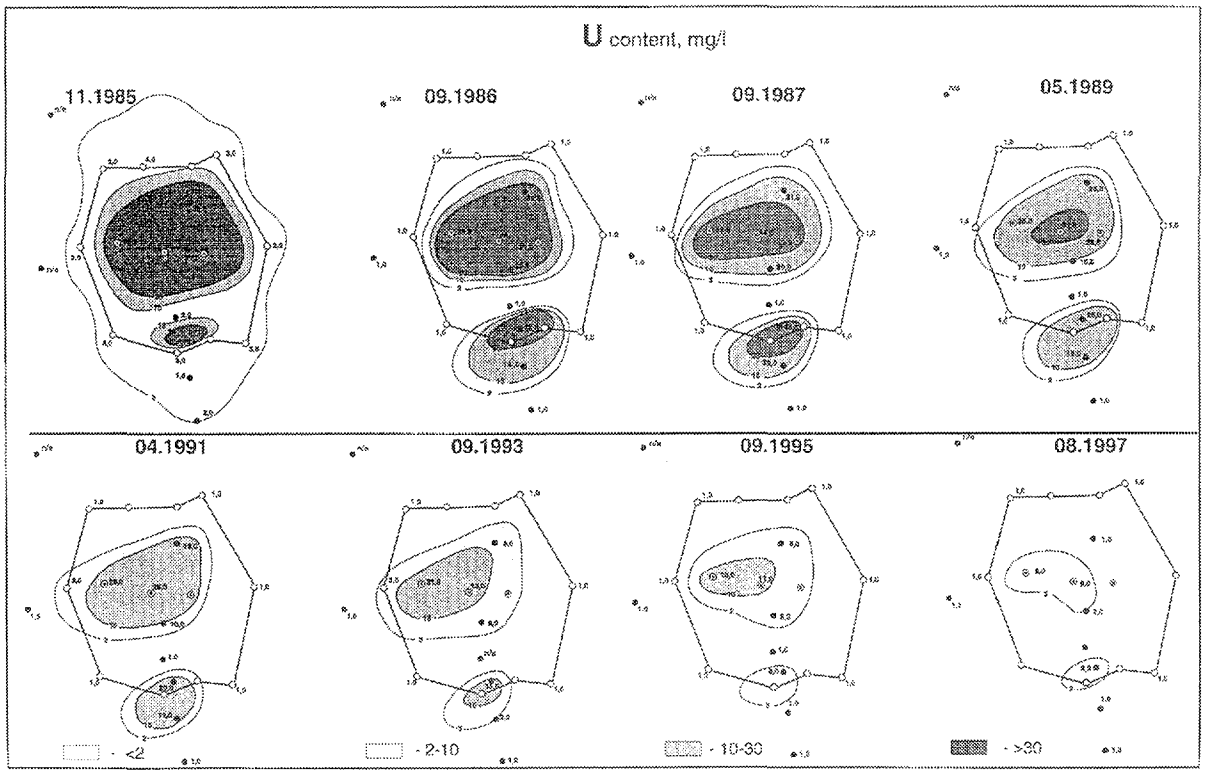

FIG. 4. Uranium concentration (U, g/l) at the Irkol, Kazakhstan ISL wellfield following completion of injection of leach solutions in 1985.

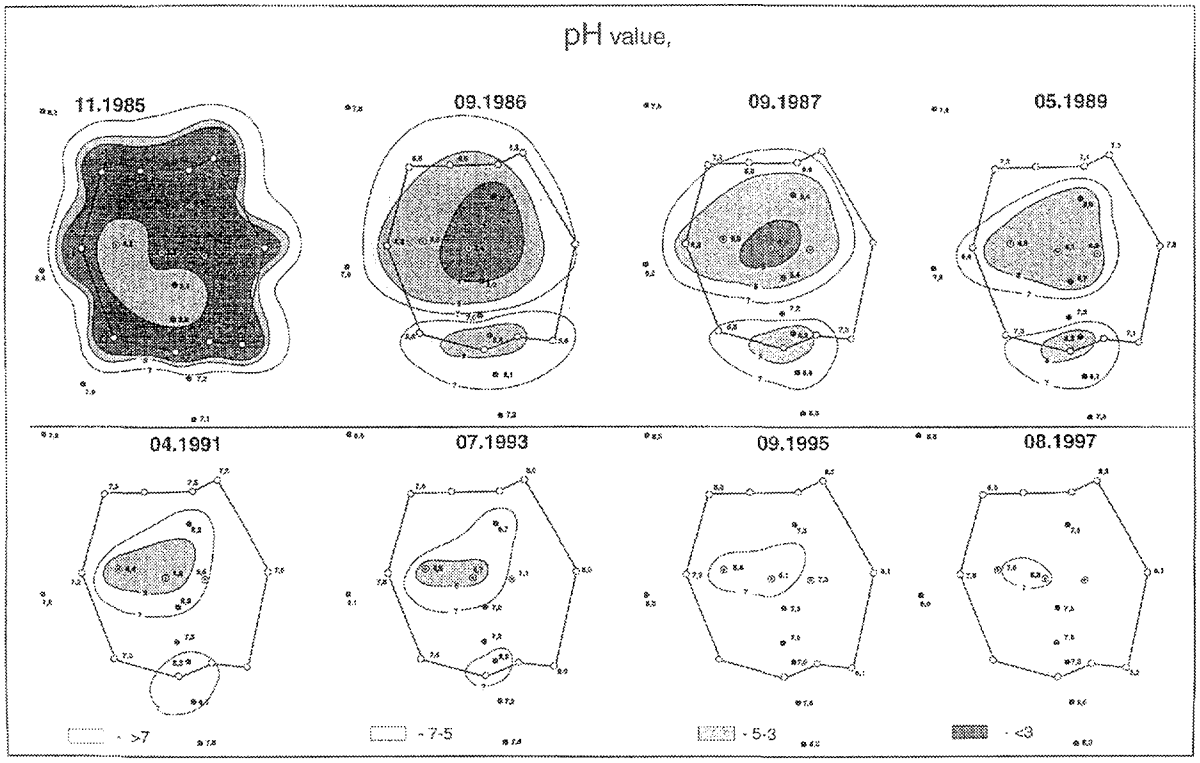

FIG. 5. Value of pH of residual leach solution at the Irkol, Kazakhstan ISL wellfield following completion of injection of leach solutions in 1985.