UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE PRESIDING OFFICER

In the Matter of	)	
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HYDRO RESOURCES, INC.	)	Docket No. 40-8968-ML
P.O. Box 777	)	
Crownpoint, NM 87313	)	

NRC STAFF'S RESPONSE TO INTERVENORS' PRESENTATION ON RADIOLOGICAL AIR EMISSIONS

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August 5, 2005

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INTRODUCTION

On June 13, 2005, lead intervenors Eastern Navajo Diné Against Uranium Mining (ENDAUM), and Southwest Research and Information Center (SRIC) (referred to collectively as the "Intervenors"), submitted a written presentation on their areas of concern[1] pertaining to radiological air emissions at the Church Rock Section 17 site. *See* "[Intervenors'] Written Presentation in Opposition to Hydro Resources, Inc.'s Application for a Materials License With Respect to: Radiological Air Emissions for Church Rock Section 17" (June 13 Brief). Among the exhibits attached to the June 13 Brief are declarations of Melinda Ronca-Battista and Bernd Franke, marked as Exhibits K and L, respectively.

For the reasons discussed herein, the Presiding Officer should reject the Intervenors' air emission concerns. In summary, the concerns set forth in the June 13 Brief are outside the scope of this proceeding. These concerns are primarily based on emissions produced by materials associated with the old and abandoned uranium mine on Church Rock Section 17. This mine, and the unrefined and unprocessed uranium ore left behind, constitute materials which are exempt from United States Nuclear Regulatory Commission (NRC) licensing

[1] This proceeding is governed by the former 10 C.F.R. Part 2, Subpart L hearing procedures (cited throughout this filing), under which "areas of concern" rather than contentions are litigated.

requirements. To the extent that the June 13 Brief may be viewed as stating concerns about radiological safety arising from the abandoned uranium mine, and the surface materials associated with it, such concerns are outside the scope of the Atomic Energy Act (AEA), and thus seek a remedy which the NRC lacks regulatory authority to grant. Additionally, as discussed in the attached affidavits of Christepher McKenney and Richard Weller (Staff Exhibits 1 and 2, respectively), the Intervenors' air emission concerns lack an adequate technical basis.

BACKGROUND

The following information is relevant to the Intervenors' present air emission concerns. On November 14, 1994, the notice of opportunity to request a hearing on the proposal of Hydro Resources, Inc. (HRI) to conduct *in situ* leach (ISL) uranium mining was published. The notice stated in pertinent part that those requesting a hearing were required to submit a detailed description of their areas of concern "about the licensing activity that is the subject matter of the proceeding." 59 Fed. Reg. 56557, at 56558 col. 2 (Nov. 14, 1994). By letter dated December 14, 1994 (a copy of which is attached hereto as Staff Exhibit 3), intervenors Grace Sam and Marilyn Sam (now Marilyn Morris) requested a hearing. One of their stated concerns was that HRI's proposal (as described in NUREG-1508, the October 1994 "Draft Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project" (DEIS))[2] "does not address how existing contamination of the area on and

[2] Excerpts of the DEIS are attached to the June 13 Brief as Exhibit M. The "Final Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project" (FEIS) was published in February 1997.

around the Church Rock site" would be remediated, thus delaying "progress in cleaning up existing contamination" at the Church Rock site.[3] Staff Exhibit 3, at 2.

On August 15, 1997, the lead intervenors submitted "Petitioners ENDAUM and SRIC's Second Amended Request for Hearing, Petition to Intervene, and Statement of Concerns" (ENDAUM/SRIC Petition to Amend), which included as an area of concern the claim that HRI had not shown it could adequately control air emissions produced by its proposed ISL mining operations. *See* ENDAUM/SRIC Petition to Amend, pages 109-115, attached hereto as Staff Exhibit 4. This concern, unlike the Sams' concern discussed above, made no mention of existing contamination on and around HRI's Church Rock site.

HRI's 10 C.F.R. Part 40 license was issued in January 1998. In LBP-98-9, as part of his ruling on all of the hearing requests submitted, the Presiding Officer ruled on the Sams' 1994 hearing request. The Presiding Officer admitted the Sams' as parties based on their concern about truck transportation of radioactive materials produced by the proposed ISL mining. *See* LBP-98-9, 47 NRC 261, 283 (1998); *see also* Staff Exhibit 3, at 1-2. However, after noting that pursuant to 10 C.F.R. § 2.1205(h) an area of concern must be "germane to the subject matter of the proceeding," the Presiding Officer ruled that the Sams' concern about existing contamination at the Church Rock site was "not germane to this proceeding." LBP-98-9, 47 NRC at 268 and 283. "Unless there is some project-related reason, a licensee is not required to clean up problems that it did not create." *Id.*, at 283. At the same time, the Presiding Officer found that the ENDAUM and SRIC air emission concern was germane, and he

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[3] Then as now, HRI's "Church Rock site" included contiguous portions of Sections 8 and 17. However, in 1994, the Presiding Officer had not yet split this adjudicatory proceeding into phases, whereby areas of concern pertaining to Church Rock Sections 8 and 17 would be separately considered and decided. This action was not taken until after LBP-98-9 (ruling on hearing requests and admitting areas of concern) had been issued. *See* unpublished orders (dated September 22, 1998 and October 13, 1998).

admitted it into this proceeding. *Id.*, at 282 and n.59, *citing* pages 109-115 of the ENDAUM/SRIC Petition to Amend.

By motion dated June 5, 1998, Marilyn Morris sought reconsideration of the Presiding Officer's refusal to admit her concern about existing contamination at the Church Rock site. The NRC Staff opposed the motion, stating that contamination "from previous mining activities is not redressible in this proceeding" because the Presiding Officer's jurisdiction is limited by the action as described in the *Federal Register* notice of opportunity for hearing. "NRC Staff Opposition to Marilyn Morris Motion for Reconsideration," dated June 22, 1998, at 3. The Presiding Officer denied the motion for reconsideration.[4]

On November 5, 2004, the Presiding Officer issued an order setting the schedule for phase two of this litigation, in which written presentations on the areas of concern for the Section 17, Unit 1 and Crownpoint sites would be considered and ruled upon. "Order (Schedule for Written Presentations)," dated November 5, 2004 (unpublished) (November 5 Order), at 1. Subsequently, the Presiding Officer revised the schedule for written presentations based on the Intervenors' decision not to pursue certain areas of concern. "Order (Revised Schedule for Written Presentations)," dated February 3, 2005 (unpublished) (February 3 Order), at 1. This order left intact Parts 2 and 3 of the November 5 Order relating to the format and content of the written presentations. *Id.*, at 3. The Intervenors' remaining concerns for the Section 17, Unit 1 and Crownpoint sites have now been submitted in the following order: (1) groundwater protection, groundwater restoration, and surety estimates; (2) preservation of cultural resources; (3) radiological air emissions; and (4) adequacy of the FEIS, culminating with the June 24, 2005 submission of "[Intervenors'] Written Presentation in Opposition to Hydro

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[4] *See* "Memorandum and Order (Marilyn Morris' Motion for Reconsideration)," dated June 23, 1998 (unpublished) (June 23 Order).

Resources, Inc.'s Application for a Materials License With Respect to: NEPA Issues for Church Rock Section 17, Unit 1 and Crownpoint" (June 24 Brief).

On July 29, 2005, HRI submitted its response to the June 13 Brief. *See* "[HRI's] Response in Opposition to Intervenors' Written Presentation Regarding Air Emissions" (HRI's Response). Included as exhibits to HRI's Response were affidavits of Mark Pelizza, Douglas Chambers, and Salvador Chavez, marked as Exhibits A, B and C, respectively.

DISCUSSION

I. Preliminary Issues Related to Air Emission Area of Concern

A. Radiological Releases from Existing Contamination Outside Scope of Admitted Air Emission Concern

As indicated above, the 1994 notice of opportunity for hearing in this proceeding pertained to HRI's request for the NRC Staff's approval to conduct ISL uranium mining on its New Mexico sites, and the notice required that areas of concern be limited to this proposed licensing activity. *See* 59 Fed. Reg. *supra*, 56557 *et seq.* Areas of concern in Subpart L proceedings are limited to "the licensing activity that is the subject matter of the proceeding" pursuant to 10 C.F.R. § 2.1205(e)(3). This provision requires that an area of concern be relevant, *i.e.*, germane, to the licensing action at issue. *See Sequoyah Fuels Corp.* (Gore, Oklahoma Site Decommissioning), CLI-01-2, 53 NRC 9, 16 (2001). Additionally, presiding officers lack the power to explore issues which are outside of the notice of opportunity for hearing. *See Portland General Electric Co.* (Trojan Nuclear Plant), ALAB-534, 9 NRC 287, 289-90 n.6 (1979).

Air emission concerns based on existing levels of radon and gamma radiation on and around HRI's Church Rock Section 17 site – levels unrelated to ISL mining – are not germane, and thus are not properly subject to litigation here. *See* LBP-98-9, *supra*, 47 NRC at 283. Contrary to LBP-98-9 and the denial of the Sams' motion for reconsideration, the Intervenors'

legal argument supporting their air emission concerns represents an elaboration upon the earlier concerns which the Sams unsuccessfully sought to have admitted into this proceeding. This is perhaps most clearly shown by examining Staff Exhibit 4 – the Intervenors' area of concern on air emissions admitted into this proceeding by the Presiding Officer in LBP-98-9. This concern focused on the adequacy of emission controls on the equipment HRI would use to conduct ISL mining, and did not discuss doses from any existing contamination. *See* Staff Exhibit 4. As stated in the Background Section above, the Intervenors' air emissions concern set forth in Staff Exhibit 4 contains no indication that any existing contamination was part of that concern. By contrast, as shown below, the Intervenors' present argument supporting their air emission concerns relies primarily upon claims of existing contamination in and around HRI's Church Rock Section 17 site. Such concerns are not germane to the licensing action at issue, and thus do not form a valid basis for requesting that HRI's license "be revoked or amended with respect to Section 17." June 13 Brief, at 2. This request should therefore be denied.

The Intervenors now state that underground sources of radiation at HRI's Church Rock Section 17 site "such as the old mine workings" located there, "as well as material left on the site such as soil contaminated by previous mining and evaporation pond sludge," must be a component of HRI's total effective dose equivalent (TEDE)[5] calculations for Section 17 because "HRI is responsible" for the material left behind by the previous mining activities. June 13 Brief, at 16. The Intervenors further state that "the material in the underground mine" is byproduct material. *Id.*, at 16-17 (*quoting* 10 C.F.R. § 40.4 definition of byproduct material). Pursuing this argument, the Intervenors state that "the prior occupant of Section 17 owned and operated an underground uranium mine" there; that "some of the ore remains in the underground mine

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[5] TEDE is one of the defined terms set forth in 10 C.F.R. § 20.1003, and means "the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures)."

workings;" and that "radiation from that remaining ore" must be included in HRI's TEDE calculations. June 13 Brief, at 17. Because the existing levels of radiation at Section 17 are also said to come from source material – which is allegedly producing doses above the 100 millirem annual limit for a member of the public (*see* 10 C.F.R. § 20.1301) – the Intervenors claim that any emissions from HRI's Section 17 operations "would therefore cause radiation levels to climb further above" the already high level. June 13 Brief, at 18. As confirmatory evidence that the existing levels of radiation at a boundary of HRI's Section 17 restricted area produce dose limits above those set by 10 C.F.R. § 20.1301, the Intervenors cite gamma radiation measurements (taken by their proffered expert, Ms. Ronca-Battista), which are said to equate with an annual dose of 1100 millirem to a hypothetical individual located at the boundary of HRI's Section 17 restricted area. *See* June 13 Brief, at 19. The Intervenors further cite to Ms. Ronca-Battista's conclusion – based on a statistical analysis of data she recently collected – that "the elevated gamma levels on and near Section 17 could only be the result of either past mining" there, or be the result of "ore haulage from Section 17," or a combination of both. *Id.*, at 20, *citing* Intervenors' Exhibit K, at ¶¶ 31-35.

Similarly, with respect to allegedly elevated levels of radon now present at Section 17, this condition is said to be "very likely caused by extant source material and byproduct material from previous mining at Section 17." June 13 Brief, at 21, *citing* Intervenors' Exhibit K, at ¶¶ 31-35,[6] and Intervenors' Exhibit L (Mr. Franke's declaration), at ¶ 18. The Intervenors state that in calculating the TEDE for Larry King and his family (who reside on land adjacent to HRI's Church Rock Section 17 ISL mining site), HRI must "account for existing elevated levels of radon and gamma radiation at Section 17 and include them in its TEDE calculation." June 13

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[6] As discussed by Mr. McKenney in Staff Exhibit 1, Ms. Ronca-Battista's declaration only addresses gamma survey results, and does not discuss the potential sources of the ambient radon levels in the area.

Brief, at 21 (footnote omitted). In summarizing its primary argument, the Intervenors state that "upholding HRI's License for Section 17 would completely ignore the impacts of past uranium mining." *Id.*, at 23.

As indicated by the above summary, the Intervenors' present air emission concerns are based on existing contamination unrelated to HRI's proposed ISL uranium mining. Concerns based on such contamination are outside the scope of admitted concerns in this proceeding. *See* LBP-98-9, and June 23 Order, *supra*. Accordingly, the Presiding Officer should reject the Intervenors' air emission concerns to the extent that they are based on existing levels of radon and gamma radiation on and in the vicinity of HRI's Church Rock Section 17 ISL mining site.

B. Law of the Case Doctrine

As stated in the NRC Staff's recent filing responding to the Intervenors' groundwater concerns (*see* "NRC Staff's Written Presentation on Groundwater Protection, Groundwater Restoration, and Surety Estimates" (April 29, 2005), at 6-7), the doctrines of res judicata, collateral estoppel, law of the case, and laches are generally applicable in NRC adjudicatory proceedings, signifying adherence to the fundamental precept of common law adjudication that once an issue is determined in a proceeding, that issue is conclusively resolved.[7] The law of the case doctrine provides that when a court decides upon a rule of law or makes a factual determination, that decision should continue to govern the same issues in subsequent stages of the same case. *Safir v. Dole*, 718 F.2d 475, 480-81 (D.C. Cir. 1983). The doctrine encompasses the court's explicit decision, as well as those issues decided by necessary

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[7] *See e.g., Alabama Power Co.* (Joseph M. Farley Nuclear Plant, Units 1 and 2), CLI-74-12, 7 AEC 203, 203-204 (1974) (res judicata and collateral estoppel); *Safety Light Corp.* (Bloomsburg Site Decontamination), CLI-92-9, 35 NRC 156, 159-160 (1992) (law of the case); *Houston Light and Power Co.* (South Texas Project, Units 1 and 2), CLI-77-13, 5 NRC 1303, 1321 (1977) (laches).

implication. *Williamsburg Wax Museum, Inc. v. Historic Figures, Inc.*, 810 F.2d 243, 249 (D.C. Cir. 1987).

However, the doctrine is not applicable to dicta, *i.e.*, statements that are not necessary to the decision or conclusion reached. *See e.g., Bull HN Information Systems, Inc. v. Hutson*, 229 F.3d 321, 326 n3 (1st Cir. 2000) (doctrine not applicable to dicta); *see also*, 18B Wright, Miller & Cooper, § 4478 (describing how the discretionary law of the case doctrine does not reach a matter stated in dicta that was not presented for decision and was not decided). Moreover, the doctrine of the law of the case is not an ironclad rule; its application is a matter of discretion. *See Public Service Company of Indiana* (Marble Hill Nuclear Generating Station, Units 1 and 2), ALAB-493, 8 NRC 253, 260 (1978). Where a court is convinced that its declared law is wrong and would work an injustice, it retains the power to apply a different rule of law in the interests of settling the case before it correctly. *Id.*

The Presiding Officer's July 20, 2005 partial initial decision on the Intervenors' groundwater concerns discussed the law of the case doctrine, and stated in part as follows:

> It bears emphasizing, however, that the law of the case doctrine merely guides a tribunal's discretion; it does not limit a tribunal's power ... and it "should not be applied woodenly in a way inconsistent with substantial justice" .... Thus, an adjudicative body should, in a proper exercise of discretion, refrain from applying law of the case doctrine where "changed circumstances or public interest factors dictate." ... Changed circumstances include a situation where, for example, intervening controlling authority makes reconsideration appropriate, or substantially different evidence is adduced at a subsequent stage of the proceeding.

LBP-05-17, 62 NRC ___(slip op.), at 11 (citations omitted).

For those air emission areas of concern which fall within the scope of the relevant findings and rulings previously made by the Presiding Officer (discussed further in Section I.C below), the Presiding Officer should reject the Intervenors' present concerns to the extent that they are contrary to those prior determinations.

C. Previous Air Emission Rulings in this Proceeding

Air emission concerns based on existing levels of radon and gamma radiation on and around HRI's Church Rock Section 17 site – levels unrelated to ISL mining – are not germane, and thus are not properly subject to litigation here. *See* LBP-98-9, *supra*, 47 NRC at 283. *See also* June 23 Order. The Presiding Officer should apply this law of the case here, and reject the air emission concerns set forth in the June 13 Brief.

In LBP-99-19, 49 NRC 421 (1999), *pet. for rev. denied,* CLI-00-12, 52 NRC 1 (2000), the former Presiding Officer (Peter Bloch) addressed the Intervenors' previous air emission concerns – *i.e.*, that HRI's operations would violate 10 C.F.R. Part 20 requirements – but he did not address the Intervenors' related claims pertaining to alleged violations of the National Environmental Policy Act (NEPA). *See* LBP-99-19, 49 NRC at 422. His analysis focused on "potential radiation exposure resulting from operations at Church Rock Section 8." *Id.*, at 424. Judge Bloch summarized the Intervenors' concern as whether HRI's operations at Church Rock Section 8 will cause the TEDE "to the individual likely to receive the highest dose from the licensed operation to exceed the annual dose limit." *Id.*, at 425 (emphasis added). He set forth there the applicable TEDE provision, which states in pertinent part as follows:

> Each licensee shall conduct operations so that ---
>
> (1) the [TEDE] to individual members of the public from the licensed operation does not exceed 0.1 rem (1 millisievert) in a year, exclusive of the dose contributions from background radiation.

10 C.F.R. § 20.1301(a)(1). Judge Bloch correctly noted that the 10 C.F.R. § 20.1003 definition of "background radiation" is a key to properly applying 10 C.F.R. § 20.1301(a)(1). *See* LBP-99-19, 49 NRC at 425.

While the Intervenors focus on Judge Bloch's interpretation of the background radiation definition (*see* June 13 Brief, at 12-14), he nevertheless disagreed with the Intervenors "concerning the calculation of offsite doses." LBP-99-19, 49 NRC at 426. Judge Bloch

evaluated the Staff's (Mr. McKenney's) worst-case dose calculation, and found that radon doses "released from operations at the Church Rock site" would not exceed the dose limits "to a hypothetical individual 100 meters off site." *Id.* Mr. McKenney had also evaluated radiation generated by source material on the surface of Church Rock Section 8, and concluded that the annual TEDE exposure to the nearest resident attributable to such material would be a small fraction of one millirem. *Id.* Judge Bloch agreed, finding "there is no substantial risk attributable to radium from source materials on Section 8." *Id.*, at 427.

Significantly (for purposes of determining how the Intervenors' present Section 17 air emission concerns should be viewed), Judge Bloch then made the following statements:

> Though there may be a risk associated with radium from source material on HRI's Church Rock Section 17, that question may be held in abeyance and not addressed in this portion of the proceedings. In bypassing the issue of proper calculation of background radiation from Section 17, it has not yet been determined whether radiation released from the underground mine on Section 17 may be excluded from background.

Id., at 427 (footnote omitted) (emphasis added).[8] On the basis of these statements, the Staff submits that Judge Bloch's construction of the term "background radiation" is dicta, because it was not necessary to any of his Section 8 decisions or conclusions. With respect to the Section 17 background radiation issue, Judge Bloch's construction is thus not law of the case that the Presiding Officer is obligated to follow here.

Additionally, Judge Bloch's interpretation of the "background radiation" definition is incorrect, because it acts to extend the NRC's regulatory authority over all source material. But the NRC's jurisdiction over source material only begins after source material is removed "from its place of deposit in nature." AEA Section 62, 42 U.S.C. § 2092. *See also* 10 C.F.R.

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[8] By thus indicating that further information was needed before a decision on background radiation on Section 17 could be reached, Judge Bloch implicitly recognized that his construction of the term "background radiation" was subject to further refinement in this Section 17 phase of the proceeding.

§ 40.13(b).[9] As discussed further below, implementing Judge Bloch's interpretation would also create an internal conflict in how the definition's provisions are applied.

The 10 C.F.R. § 20.1003 definition at issue states that "background radiation" means:

> Radiation from cosmic sources; naturally occurring radioactive material, including radon (except as a decay product of source or special nuclear material); and global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the licensee. "*Background radiation*" does not include radiation from source, by-product, or special nuclear materials regulated by the Commission.

10 C.F.R. § 20.1003. In Judge Bloch's view, the concluding phrase "regulated by the Commission" applies only to "special nuclear materials," and not to source or by-product materials.[10] LBP-99-19, 49 NRC at 426. Thus, for example, under this interpretation of the above-quoted definition's second sentence, all radiation from any source material – whether or not such material was regulated by the Commission – would not be part of "background radiation," and all such radiation would therefore have to be considered as part of the licensee's required TEDE calculations. *Id.*[11]

The result reached by Judge Bloch conflicts with the first sentence of the definition, under which radiation from "naturally occurring radioactive material" (NORM) is part of

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[9] AEA Section 62 (42 U.S.C. § 2092) and 10 C.F.R. § 40.13(b) are discussed further in Section II, below.

[10] Judge Bloch misapplied his announced rule of regulatory construction to the definition of background radiation. He interpreted the subordinate clause "regulated by the Commission" to apply only to the "last noun in the series, 'special nuclear materials.'" LBP-99-19, 49 NRC at 426. Judge Bloch reasoned that application of the subordinate clause to "each of the antecedent nouns" is not proper English grammar, and further stated that to hold otherwise would be to find that the regulation contains a drafting error. *Id.* However, there is but a single antecedent noun, *i.e.*, "materials", and that noun has three precedent adjectives: source, byproduct, and special nuclear. Thus, application of Judge Bloch's rule (apply the subordinate clause to the last noun) leads to the conclusion that "regulated by the Commission" qualifies the noun "materials," and thus applies to source material, byproduct material, and special nuclear material.

[11] The full quote from LBP-99-19 on which the Intervenors rely is set forth at page 12 of the June 13 Brief.

background. As discussed in Section II.C below, NORM and the subset of NORM known as technologically enhanced naturally occurring radioactive material (TENORM) are materials over which the NRC lacks regulatory authority. NORM includes uranium left undisturbed in nature – *e.g.*, uranium ore in an outcropping of rock – and the NRC does not regulate this type of source material. Radiation from this type of source material is not part of the required TEDE calculation under the first sentence of the definition, because this would be radiation generated by NORM. Yet under Judge Bloch's interpretation of the definition's second sentence, such radiation would be part of the required TEDE calculation because it would be radiation generated by source material.[12] Under the proper interpretation of the definition's second sentence, radiation from uranium ore in an outcropping of rock would not be part of the required TEDE calculation because it would not be radiation generated by source material regulated by the Commission. Moreover, neither Judge Bloch nor the Intervenors identify any rationale explaining why radiation from special nuclear materials should be treated differently than radiation from either source material or byproduct material for purposes of making 10 C.F.R. Part 20 TEDE calculations.

Accordingly, Judge Bloch's interpretation of the "background radiation" definition should not be considered as limiting the Presiding Officer here under the "law of the case."

The Intervenors' argument that Judge Bloch's interpretation of the 10 C.F.R. § 20.1003 definition of "background radiation" is now settled law because "the Commission did not accept Intervenors' petition for review" (June 13 Brief at 13) is disingenuous. In denying review, the Commission was only addressing issues raised by the Intervenors, and not issues raised by the

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[12] In other words, source material cannot logically be both "naturally occurring" and therefore part of the background radiation excluded from TEDE calculations under the definition's first sentence, and yet also be source material included in TEDE calculations under Judge Bloch's interpretation of the definition's second sentence.

Staff.[13] The Commission's refusal to entertain a discretionary appeal is no indication of its views on the merits, nor does such action by the Commission cut off the Presiding Officer's right to reconsider a question which is still pending. *See Marble Hill, supra*, 8 NRC at 260. Accordingly, the Staff may still raise the background radiation issue because the Commission never addressed the portion of LBP-99-19 discussing the definition of background radiation.

The other previous Presiding Officer decision in this proceeding which is relevant to the Intervenors' present air emission concerns is LBP-04-23, 60 NRC 441, 456-58 (2004), which ruled on radiological air emission issues in the context of considering whether a supplement to the FEIS was required to consider a housing development which might be built to the southwest of Section 17. HRI and the Staff argued that the FEIS properly evaluated the radiological dose estimates for Church Rock's restricted site boundaries as well as the nearest downwind residence, and found them to be within the applicable 10 C.F.R. Part 20 limits. The Presiding Officer found that the Intervenors' argument with respect to the airborne emissions of HRI's ISL mining operations "is without merit," and refused to order that the FEIS be supplemented. LBP-04-23, 60 NRC at 457. This decision is further discussed in Staff Exhibit 1, at ¶ 27.

II. The Intervenors' Arguments Are Based on Erroneous Premises

Even if the Presiding Officer should find that the Intervenors' air emission concerns set forth in the June 13 Brief are germane to this proceeding, these concerns should be rejected because they lack an adequate legal and technical basis. The Intervenors' argument (as summarized above in Section I.A) erroneously assumes that any uranium ores and old uranium mine spoils located on or under Section 17 are either source or byproduct material

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[13] Certainly, it would be premature to seek Commission review of Presiding Officer dicta simply because an erroneous interpretation of a definition could at some future point possibly lead to a different judgment. *See e.g., California v. Rooney*, 483 U.S. 307, 311-314 (1987) (declining, as premature, to accept a petition for review of a favorable lower court decision based on concerns that dicta might create adverse law of the case).

subject to regulation by the NRC. But as discussed below in the following Sections, the Intervenors' argument (A) fails to address Section 62 of the AEA and the related regulatory exemption in 10 C.F.R. Part 40; (B) misconstrues the definition of byproduct material; and (C) misapplies the TEDE requirements in 10 C.F.R. Part 20. The Intervenors' policy argument – addressed in Section D below – is similarly shown to be without merit.

A. Material Associated with UNC Uranium Mine on Section 17 Is Unrefined and Unprocessed Ore Exempt from NRC Regulation

The analysis here starts with Section 62 of the AEA, which states as follows:

> Unless authorized by a general or specific license issued by the Commission, which the Commission is hereby authorized to issue, no person may transfer or receive in interstate commerce, transfer, deliver, receive possession of or title to, or import into or export from the United States any source material after removal from its place of deposit in nature, except that licenses shall not be required for quantities of source material which, in the opinion of the Commission, are unimportant.

AEA Section 62, 42 U.S.C. § 2092 (emphasis added). Requiring that HRI's TEDE calculations include radiation from un-mined uranium ore within the abandoned Section 17 uranium mine formerly operated by United Nuclear Corporation (UNC)[14] – and placing limitations on HRI's license as a result of such TEDE calculations – would be inconsistent with this AEA provision. As stated, the NRC's jurisdiction over source material only begins after source material is removed "from its place of deposit in nature." AEA Section 62, 42 U.S.C. § 2092.

The NRC (then the Atomic Energy Commission) implemented its AEA Section 62 authority by promulgating 10 C.F.R. § 40.13, "Unimportant quantities of source material," which states in pertinent part as follows:

> Any person is exempt from the regulations in this part and from the requirements for a license set forth in section 62 of the [AEA] to the extent that such person receives, possesses, uses, or transfers unrefined and unprocessed ore

[14] The locations of two UNC uranium mines and the UNC mill which processed the uranium ore are discussed in Mr. Weller's Affidavit (Staff Exhibit 2).

> containing source material; provided, that, except as authorized in a specific license, such person shall not refine or process such ore.

10 C.F.R. § 40.13(b) (emphases added).[15] In promulgating 10 C.F.R. § 40.13(b), the Atomic Energy Commission stated in pertinent part as follows:

> The [Atomic Energy] Act does not ... require a license for the mining of source material, and the proposed regulations, as in the case of the current regulations, do not require a license for the conduct of mining activities. Under the present regulation, miners are required to have a license to transfer the source material after it is mined. Under the proposed regulation ..., the possession and transfer of unrefined and unprocessed ores containing source material would be exempted.

25 Fed. Reg. 8619, col. 2 (Sept. 7, 1960).

The 10 C.F.R. § 40.13(b) exemption provision contains two defined terms which are relevant here. "Unrefined and unprocessed ore" is a term defined in 10 C.F.R. § 40.4 as meaning "ore in its natural form prior to any processing, such as grinding, roasting or beneficiating, or refining." "Source material" is also a defined term in 10 C.F.R. § 40.4 and means:

> (1) Uranium or thorium, or any combination thereof, in any physical or chemical form or (2) ores which contain by weight one-twentieth of one percent (0.05%) or more of: (i) Uranium, (ii) thorium or (iii) any combination thereof. Source material does not include special nuclear material.[16]

Pursuant to the above-quoted provisions and statements, the uranium in the UNC underground mine on Section 17 is not regulated by the NRC because this material has not

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[15] Note that pursuant to the latter proviso of 10 C.F.R. § 40.13(b), any presently unrefined and unprocessed ores on Section 17 that HRI intends to subject to ISL mining are not exempt from licensing requirements. This is because HRI's ISL mining operation will process uranium ore through chemical treatment underground.

[16] The two-part definition of "Source material" may be viewed as drawing a distinction between low-level source material (*i.e.*, ores which contain by weight one-twentieth of one percent or less of uranium/thorium), and source material made up of ores containing by weight one-twentieth of one percent or more of uranium/thorium. Because the 10 C.F.R. § 40.13(b) exemption does not draw such a distinction, the question of the type of source material present on and under the Section 17 site may be viewed as being not relevant here. Nevertheless, the Staff (Mr. McKenney) has reviewed the hearing record and finds no evidence that any of the existing mine waste on Section 17 exceeds the one-twentieth of one percent threshold. *See* Staff Exhibit 1, at ¶¶ 7-11.

been removed from its place of deposit in nature. Further, the existing UNC uranium mine spoils on and under Section 17 are "unrefined and unprocessed ore" – *i.e.*, "ore in its natural form prior to any processing, such as grinding, roasting or beneficiating, or refining." Thus, even though HRI may be said to possess unrefined and unprocessed ore stemming from the presence of the old UNC uranium mine and its spoils on Section 17 – and even though such ore is source material – such material is exempt from the 10 C.F.R. Part 40 licensing requirements pursuant to 10 C.F.R. § 40.13(b).

By the Intervenors' own admissions, any existing levels of radon and gamma radiation on and in the vicinity of HRI's Church Rock Section 17 ISL mining site arise from the UNC uranium mine located there. *See* June 13 Brief, at 16-23. The Intervenors' present air emission concerns are thus based on the presence of unrefined and unprocessed uranium ore on and under HRI's Church Rock Section 17 site. But as shown above, such material is exempt from NRC regulation under the AEA.

The Intervenors' technical basis for their present air emission concerns also does not support the relief they request. The Staff has reviewed the declarations of Ms. Ronca-Battista (Intervenors' Exhibit K) and Mr. Franke (Intervenors' Exhibit L), and finds that they provide no evidence showing that the exposure rates measured around Section 17 are caused either by source material exceeding 0.05 percent by weight uranium/thorium, or by by-product material. *See* Staff Exhibit 1, at ¶ 11. This finding applies to the concerns regarding elevated gamma rates as well as to the concerns regarding elevated ambient radon levels. Neither Ms. Ronca-Battista nor Mr. Franke discuss TENORM, nor do they discuss how the exposure rates measured as part of the Church Rock Uranium Monitoring Project (CRUMP) are consistent or inconsistent with the presence of TENORM. The Staff discusses the CRUMP survey results, and concludes that the gamma exposure rates produced by natural soils and surface mine

waste (as measured by Ms. Ronca-Battista) do not need to be included in HRI's TEDE calculations. *See* Staff Exhibit 1, at ¶¶ 12-16.

Accordingly, based on the legal analysis set forth above, and the technical evaluation in Staff Exhibit 1, the Presiding Officer should find that any radiological hazards arising from source material associated with the UNC uranium mine on HRI's Church Rock Section 17 site are not subject to regulation by the NRC. The Presiding Officer should therefore reject the Intervenors' air emission concerns to the extent they are based on any existing levels of radon and gamma radiation on and in the vicinity of HRI's Church Rock Section 17 site.

B. Material Associated with UNC Uranium Mine on Section 17 Is Not Byproduct Material

Insofar as non-ISL uranium mine waste is concerned, 10 C.F.R. § 40.4 defines "byproduct material" in pertinent part as meaning "the tailings or wastes produced by the extraction or concentration of uranium ... from any ore processed primarily for its source material content" (emphasis added). The Intervenors' argument (as summarized above in Section I.A) misconstrues what byproduct material is by ignoring this processing component of the definition. Uranium ore must first be processed, and it is only the waste produced by such processing which constitutes byproduct material. Because no uranium ore mined from the old UNC mine on Section 17 was processed on Section 17, the unprocessed uranium mine spoils left behind are not "byproduct material" under the 10 C.F.R. § 40.4 definition. Rather, as discussed above in Section II.A., the existing uranium ores and uranium mine spoils on and under Section 17 are unrefined and unprocessed ore, and such source material is exempt from the 10 C.F.R. Part 40 licensing requirements.

Moreover, as discussed in Mr. Weller's Affidavit (Staff Exhibit 2), the Intervenors have produced no evidence that Section 17 ever contained any byproduct material. *See* Staff Exhibit 2, at ¶ 9. The uranium mine waste materials on Section 17 are not uranium mill tailings.

The UNC uranium mill which received and processed the ore from UNC's Section 17 mine was located more than three miles to the northeast of the mine. *See* Staff Exhibit 2, at ¶ 4.

The regulatory distinction between the type of uranium mine waste typically left behind at non-ISL uranium mining sites, as opposed to the mill tailings which result from uranium milling operations, is discussed in NUREG-0706, the NRC's "Final Generic Environmental Impact Statement on Uranium Milling" published in 1980 following enactment of the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). Excerpts from NUREG-0706 are attached hereto as Staff Exhibit 5. The Staff's response to a comment that the impacts of uranium mining and uranium milling should be considered together includes the following statement:

> Because the NRC has no jurisdictional authority over uranium mining, the inclusion of a detailed evaluation of the impacts of uranium mining associated with uranium milling would be essentially fruitless with respect to providing needed regulatory control.

Staff Exhibit 5, at A-11. For similar reasons, NUREG-0706 did not focus on the impacts of uranium mining, such as those relating to the transport of uranium ore from the mine to the mill. *See* Staff Exhibit 5, at A-15.

The distinction between non-ISL uranium mining and uranium milling is also reflected in guidance the Staff published in 1995 as to what constitutes 11e.(2) byproduct material under the AEA (as amended by UMTRCA). The Staff's "Final Position and Guidance on the Use of Uranium Mill Feed Material Other Than Natural Ores" sets forth three criteria governing whether uranium mill licensee requests to process material will be approved, the first of which states as follows:

> For the tailings and wastes from the proposed processing to qualify as 11e.(2) byproduct material, the feed material must qualify as "ore." In determining whether the feed material is ore, the following definition of ore must be used:

> Ore is a natural or native matter that may be mined and treated for the extraction of any of its constituents or any other matter from which source material is extracted in a licensed uranium or thorium mill.

60 Fed. Reg. 49296, col. 3 (Sept. 22, 1995). The third criterion governing whether uranium mill licensee requests to process material will be approved states in pertinent part as follows:

> For the tailings and waste from the proposed processing to qualify as 11e.(2) byproduct material, the ore must be processed primarily for its source material content.

Id., at 49297, col. 1. These criteria reflect the fact that after uranium ore is mined, it must be milled to extract and refine its uranium content, and that the milling stage is the point where NRC licensing requirements become applicable.

Accordingly, for the reasons set forth above and in Staff Exhibit 2, the Presiding Officer should find that HRI's Section 17 site does not contain – and never has contained – byproduct material, and that NRC licensing requirements do not apply to non-ISL uranium mine waste.

C. Dose Contributions from Any Existing Contamination Are Not Part of Required 10 C.F.R. Part 20 TEDE Calculations

The Intervenor arguments pertaining to the TEDE calculations HRI should be required to make (*see* June 13 Brief, at 16-22) should be rejected by the Presiding Officer. As stated above in Section I.C, 10 C.F.R. § 20.1301 sets radiological dose limits for individual members of the public that NRC licensees must meet. This regulation states in pertinent part that a licensee shall conduct operations so that the TEDE "to individual members of the public from the licensed operation" does not exceed 0.1 rem in a year, "exclusive of the dose contributions from background radiation." 10 C.F.R. § 20.1301(a)(1) (emphases added). The phrase "from the licensed operation" serves as a limitation on what makes up the TEDE – a limitation that the Intervenors do not address – and its inclusion in 10 C.F.R. § 20.1301(a)(1) is consistent with the discussion in Section I.A, *supra* (*i.e.*, to be germane, radiological safety issues in NRC adjudications must arise from NRC-licensed operations). A further limitation on what makes up

the TEDE is that this total dose measurement does not include "the dose contributions from background radiation." As shown below, any existing contamination on and in the vicinity of Section 17 is background radiation unrelated to any NRC-licensed activity, and any doses produced by such contamination are excluded from the TEDE pursuant to the terms of 10 C.F.R. § 20.1301(a)(1). *See also* 10 C.F.R. § 20.1002 (the 10 C.F.R. Part 20 limits do not apply to doses due to background radiation).

As discussed above in Section I.C, to properly apply the 10 C.F.R. § 20.1301(a)(1) TEDE provisions, one must first understand what constitutes "background radiation." Pursuant to the 10 C.F.R. § 20.1003 definition, such radiation includes radiation from NORM.

The Staff discusses NORM in SECY-01-0057, a copy of which is attached hereto as Staff Exhibit 6. In SECY-01-0057, the Staff was responding to Commission requests on whether changes to the AEA should be proposed which would extend the NRC's statutory authority to regulate NORM and TENORM. *See* Staff Exhibit 6, at 1-2.[17] NORM includes primordial material such as uranium which has been left undisturbed in nature, and the NRC lacks regulatory authority over such material. *Id.*, at 2. The NRC similarly lacks regulatory authority over the subset of NORM known as TENORM, which the Staff described generally as including primordial material whose radioactivity has been increased or concentrated as a result of human intervention. *Id.*, at 3. In the June 2000 report to Congress referenced by the Staff in SECY-01-0057, the United States Environmental Protection Agency (EPA) described TENORM in somewhat greater detail as follows:

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[17] Attachment 9 to SECY-01-0057 ("Staff's Earlier Work From the Periods 1976-78; 1984; 1987-88; and 1992") discusses work extending back nearly 30 years on whether the AEA should be changed to bring naturally occurring and accelerator-produced radioactive material (NARM) under the NRC's statutory authority. A copy of Attachment 9 is attached hereto as Staff Exhibit 7. As reflected in Staff Exhibit 7, these past efforts have not resulted in changes to the AEA, or to NRC regulations, with respect to unprocessed uranium ores.

> TENORM is material containing radionuclides that are present naturally in rocks, soils, water, and minerals and that have become concentrated and/or exposed to the accessible environment as a result of human activities such as manufacturing, water treatment, or mining operations.

EPA 402-R-00-01, "Evaluation of EPA's Guidelines for [TENORM]," at 2. A copy of EPA 402-R-00-01 is attached hereto as Staff Exhibit 8.[18] The Staff notes that non-ISL uranium mining produced large quantities of TENORM which generate relatively low specific radioactivity. *See* Staff Exhibit 6, at 3 and Table 2 therein (titled "Sources, Quantities, and Concentrations of TENORM").

Congress has not amended the AEA to include within the scope of the NRC's regulatory authority either (1) NORM left in place underground within abandoned uranium mines or (2) TENORM in the form of uranium ore left on the surface of abandoned uranium mine sites. Thus, the doses from NORM and TENORM on which the Intervenors implicitly rely do not form a basis supporting their air emission concerns, because such doses arise from "background radiation" as defined in 10 C.F.R. § 20.1003, and as used in 10 C.F.R. § 20.1301(a)(1). Moreover, as discussed above in Section II.A, while the material associated with the UNC uranium mine on HRI's Church Rock Section 17 site is source material,[19] it falls within the "unimportant quantities of source material" exemption, because it is "unrefined and unprocessed ore." *See* 10 C.F.R. § 40.13 (b).

Accordingly, the Presiding Officer should find that any doses produced by NORM or TENORM in, on and around HRI's Church Rock Section 17 site are part of background radiation, and are therefore excluded from the required TEDE calculations.

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[18] More recently, the EPA notes that TENORM wastes are not regulated by the EPA or the NRC, and that as a result the responsibility for regulating TENORM has fallen to the States. *See* Frequently Asked Questions regarding TENORM, at http://www.epa.gov/radiation/tenorm/index.html.

[19] The Staff notes that native rock in the vicinity of Section 17 may simultaneously be classified as both NORM *and* source material. Similarly, TENORM in the form of uranium mine spoils or overburden may be both TENORM *and* source material.

D. Intervenors' Policy Argument Lacks Merit

The Intervenors argue that HRI's license should be revoked for policy reasons. *See* June 13 Brief, at 22-24. In this regard, they claim that focusing on emissions from HRI's proposed ISL operation at its Church Rock site effectively condemns "communities to be radiation sacrifice areas." *Id.*, at 23. As reflected in the Staff's discussions set forth above, and in Staff Exhibits 1 and 2, the evidence submitted by the Intervenors does not support this type of rhetoric.

Additionally, as HRI asserts, it cannot rightfully be held responsible for the past actions of previous non-ISL uranium mining operators who were not subject to NRC licensing requirements. *See* HRI's Response, at 30. This point is supported by Judge Bloch's early ruling in this proceeding that HRI "is not required to clean up problems that it did not create." LBP-98-9, *supra*, 47 NRC at 283. The Presiding Officer should therefore reject the Intervenors' policy argument.

III. Requests to Keep Record Open Should Be Denied

As part of their air emission concerns, and as an alternative to the requested suspension or revocation of HRI's license, the Intervenors make several requests that they be given an opportunity in the future to challenge various sets of data that HRI might later have to submit. *See* June 13 Brief, at 16, 21-22, 28, 30, 35 and 41. These requests are similar to their previous groundwater argument that with respect to HRI's later establishment of groundwater baseline values and related upper control limits, a hearing would then be necessary in which the Intervenors could evaluate such data. In rejecting this argument, the Presiding Officer stated as follows:

> This argument, if accepted, would effectively transmogrify license proceedings into open-ended enforcement actions: that is, licensing boards would be required to keep license proceedings open for the entire life of the license so intervenors would have a continuing, unrestricted opportunity to raise charges of

> non-compliance. Neither the AEA nor NRC regulations contemplate, much less compel, such an outcome.

LBP-05-17, *supra*, slip op. at 20 (citation omitted). For these same reasons, the Presiding Officer should now reject these alternate requests for relief with respect to the Intervenors' air emission concerns.

IV. Radon from HRI's Church Rock Operations Will Be Within Part 20 Limits[20]

The Intervenors renew their Section 8 air emission concerns, basing their arguments that HRI's ISL mining operations will emit unacceptable levels of radon on the opinions of Mr. Franke. *See* June 13 Brief, at 24-35. The Staff evaluates the potential radon releases from HRI's proposed Church Rock operations, and finds that the Intervenors have submitted no evidence affecting the FEIS conclusion that the Church Rock operations will produce only a small fraction of the 10 C.F.R. Part 20 TEDE limits. *See* Staff Exhibit 1, at ¶¶ 18-26. As did Judge Bloch in LBP-99-19, the Presiding Officer should reject this set of air emission concerns.

The Intervenors argue that HRI's license should be revoked because "the information HRI submitted with respect to radioactive air emissions at Section 17" provided an insufficient basis on which to make health and safety findings on the proposed ISL operations. June 13 Brief, at 24. More specifically, the Intervenors argue that the source term used is inadequate; that the meteorological data is inadequate, thereby causing allegedly high radon doses at the King family residences to be overlooked; and that HRI failed to provide detailed information on the satellite processing facility's pressurized system. The Staff addresses each of these three arguments below.

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[20] The Staff's Section IV addresses the arguments made on pages 24-35 (Section IV.B) of the June 13 Brief.

A. Source Term is Acceptable

The Intervenors assert that the "projected doses to individuals exposed to radon" from the ion exchange columns and pressure relief valves on wellfield trunk lines are improperly based on only one source of data: dissolved radon concentrations in Unit 1 groundwater. June 13 Brief, at 25. However, conservative assumptions regarding the volume of radon to be released from the processing facility's ion exchange columns and a "very conservative" assumed radon evolution of 95% provide assurances that the actual releases will be well within the 10 C.F.R. Part 20 limits. *See* FEIS, at 4-83. The air release calculations assume that the trunk lines operate continuously at the maximum proposed flow rate. *Id.* In arguing that the Staff's models are inadequate, the Intervenor's expert, Mr. Franke, fails to provide any basis for his assumption that the radon concentration in the groundwater at Section 17 will be twelve times the Unit 1 average. *See* Staff Exhibit 1, at ¶ 21. The Intervenors have failed to show that the Staff's conservative FEIS analyses are faulty.

As part of their argument on this point, the Intervenors assert that the Staff failed to include "airborne radiation releases from liquid waste disposal in the TEDE calculations for the Church Rock site" and instead "chose to refer to doses calculated from land application of restoration wastewater at Section 12 north of Crownpoint" in support of a finding that wastewater disposal at Church Rock "would add less than 1 mrem per year to the TEDE." June 13 Brief, at 26-27. As noted by HRI, the Intervenors should not be permitted to raise liquid waste disposal issues here. *See* HRI's Response, at 32 n.13. Such issues were pursued during the Section 8 phase of this proceeding, but are among the ones "which Intervenors waived their right to litigate" during this phase of the proceeding. June 24 Brief, at 20. Moreover, as the Commission previously found, HRI must submit a license amendment request and obtain Staff approval prior to conducting any waste disposal through land application,

pursuant to License Condition 11.8. *See* CLI-01-04, 53 NRC 31, 50-51 (2001). Accordingly, the Presiding Officer should not consider this part of the Intervenors' argument.

For the reasons stated above and in Staff Exhibit 1, the Presiding Officer should reject the Intervenors' source term arguments.

B. Use of Gallup, NM Weather Data Is Acceptable

The Intervenors argue that HRI should have included site-specific weather data as part of its license application, and that its failure to do so caused the Staff to overlook high radon doses that the King family residences will be exposed to. *See* June 13 Brief, at 28-31. As Mr. McKenney notes, the topographical features at Church Rock Section 17 exhibit a general southwest-northeast trend similar to the prevailing wind direction. Staff Exhibit 1, at ¶ 24. But, even assuming an east-west wind direction at Section 17, the King family residences are not in the predominate downwind radon exposure pathway of the satellite processing facility on Section 8. The calculated dose to the residence northeast of the Section 8 facility (CRR 4) bounds any possible doses the King family residences could be exposed to, and the bounding dose calculated for CRR 4 is well below the 10 C.F.R. Part 20 limits. *See* Staff Exhibit 1, at ¶ 25. The Presiding Officer should accordingly reject the Intervenors' meteorological and related arguments.

C. The Processing Facility's Pressurized System Is Based on Proven Technology

The Intervenors argue that to minimize radon releases from its satellite processing facility on Section 8, HRI will rely on an unproven pressurized wellfield and ion exchange system, about which HRI has provided no technical information. *See* June 13 Brief, at 31-35. However, the Intervenors ignore (1) the June 25, 2004 affidavit of Ron C. Linton (discussing the successful use of similar technology at an ISL facility in Wyoming); (2) additional evidence presented in 2004 by HRI; and (3) the Presiding Officer's ruling on this concern in LBP-04-23,

supra, 60 NRC at 457-58. Moreover, the airborne concentrations of radon and its daughters are below the 10 C.F.R. Part 20 limits *with or without* the pressurized effluent control system. *See* FEIS, at 4-85; *see also* Staff Exhibit 1, at ¶¶ 27-29. For all of these reasons the Presiding Officer should reject the Intervenors' unproven technology claim.

V. Summary of Previous Evidence and Decisions Involving Radioactive Air Emissions

A. Summary of Staff Evidence on Radioactive Air Emissions

The NRC Staff has submitted four previous filings related to radiological air emissions: (1) "NRC Staff's Response to Intervenors' Presentation on Air Emissions Issues" (February 18, 1999) (LL9902220030) and the attached affidavit of Christepher A. McKenney (February 18, 1999) (LL9902220038); (2) Letter to Judges Bloch and Murphy in Response to Questions from the Presiding Officer (April 7, 1999) and the attached affidavit of Christepher A. McKenney (April 7, 1999) (LL9904080108); (3) "NRC Staff's Response to Intervenors' Air Emissions Answers" (April 21, 1999) (LL9904230028) and the attached affidavit of Christepher A. McKenney (April 21, 1999) (LL9904230032); and (4) "NRC Staff's Answer to Intervenors' Motions to Supplement FEIS" (June 25, 2004) and the attached affidavits of Ron C. Linton and Richard A. Weller (ML041810325).

B. Summary of Presiding Officer Decisions on Radioactive Air Emissions

In LBP-98-9, the Presiding Officer ruled that the Sams' concern about existing contamination at the Church Rock site was "not germane to this proceeding." LBP-98-9, *supra*, 47 NRC at 283. At the same time, the Presiding Officer found that ENDAUM and SRIC's 1997 air emission concern – which did not reference existing contamination – was germane. *Id.*, at 282 and n.59, *citing* pages 109-115 of the ENDAUM/SRIC Petition to Amend.

In LBP-99-19, the Presiding Officer issued a partial initial decision on radioactive air emissions. The Presiding Officer agreed with the Intervenors that radiation from source materials on the site should not be considered background radiation. *See* LBP-99-19, *supra*,

49 NRC at 426. However, after reviewing the Intervenors' arguments regarding doses to members of the public, the Presiding Officer agreed with Mr. McKenney and held that doses from radon released from licensed operations at Church Rock Section 8 will not exceed the Part 20 dose limits to members of the public. *Id.* The Presiding Officer explicitly left open the question of whether the radon released from the abandoned UNC mine on Section 17 must be considered as part of the TEDE calculations. *Id.*, at 427.

In LBP-04-23, the Presiding Officer denied the Intervenors' request that the FEIS be supplemented based on a proposed housing development project. In doing so, the Presiding Officer rejected the Intervenors' arguments that the efficacy of the satellite processing facility's pressurized system was unproven. LBP-04-23, *supra*, 60 NRC at 457-58.

C. Summary of Commission Decision on Radioactive Air Emissions

The Commission denied the Intervenors' petition to review LBP-99-19, finding in relevant part that the technical issues pertaining to radioactive air emissions had been properly decided. *See* CLI-00-12, *supra*, 52 NRC at 3.

D. Comparison of Section 8 to Section 17, Unit 1 and Crownpoint

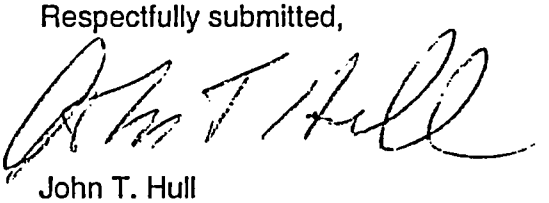
In their June 13 Brief, the Intervenors focused on their air emission concerns with respect to Section 17 only. Accordingly, no such concerns with respect to Unit 1 or Crownpoint are at issue, and these sites need not be addressed here. With respect to the differences between Section 8 and Section 17, the primary differences are the presence of the UNC uranium mine on Section 17, and the presence of the satellite processing facility on Section 8. *See* Staff Exhibit 1, at ¶ 17; *see also, infra*, Section II.A and II.B. Also, unlike Section 8, there is no indication that any material on the Section 17 ground surface has a uranium content that exceeds 0.05% by weight. *See* Staff Exhibit 1, at ¶ 10. Regardless, because Section 8 and Section 17 are contiguous, the Staff has consistently treated them as one area for purposes of making dose calculations. *See e.g.*, April 7, 1999 McKenney Affidavit, at ¶ 3 and n.1. Since

the projected dose from licensed operations at both sites is a small fraction of the 10 C.F.R. Part 20 limits, the differences between the two sites do not warrant the relief requested by the Intervenors.

CONCLUSION

For the reasons set forth above, and in Staff Exhibits 1 and 2, the Staff requests that the Presiding Officer reject the Intervenors' radiological air emission areas of concern.

Respectfully submitted,



John T. Hull
Tyson R. Smith
Counsel for NRC Staff

Dated at Rockville, Maryland
this 5th day of August, 2005

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE PRESIDING OFFICER

In the Matter of	)	
	)	Docket No. 40-8968-ML
HYDRO RESOURCES, INC.	)	
P.O. Box 777	)	
Crownpoint, NM 87313	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF'S RESPONSE TO INTERVENORS' PRESENTATION ON RADIOLOGICAL AIR EMISSIONS" in the above-captioned proceeding have been served on the following persons, by electronic mail, and by deposit in the United States mail, first class, or as indicated by an asterisk (*) through deposit in the Nuclear Regulatory Commission's internal distribution system, on this 5th day of August, 2005.

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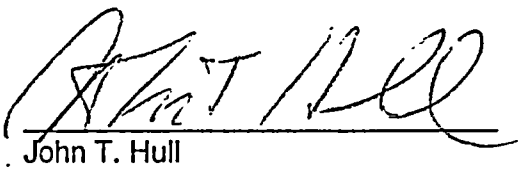

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE PRESIDING OFFICER

In the Matter of	)	
	)	
HYDRO RESOURCES, INC.	)	Docket No. 40-8968-ML
P.O. Box 777	)	
Crownpoint, NM 87313	)	

NRC STAFF'S RESPONSE TO INTERVENORS' PRESENTATION ON RADIOLOGICAL AIR EMISSIONS

STAFF EXHIBITS AND ATTACHMENTS

John T. Hull
Tyson R. Smith

August 5, 2005

Exhibit List

Staff Exhibit 1 — Affidavit of Christepher A. McKenney

- McKenney Attachment 1 — Statement of Professional Qualifications
- McKenney Attachment 2 — HRI Table 2.9-1 (from HRI's revised 1993 environmental report)
- McKenney Attachment 3 — HRI Figure 2.9-1 "Gamma Survey Map" (May 1987)

Staff Exhibit 2 — Affidavit of Richard A. Weller

- Weller Attachment 1 — HRI Figure 2.7-1 (from HRI's 1988 environmental report)
- Weller Attachment 2 — UNC's Tailings Sand Backfill Cleanup Verification Report (April 1989)
- Weller Attachment 3 — NRC Memorandum "Cleanup of Tailings at the Northeast Church Rock Mine" (October 1989)
- Weller Attachment 4 — UNC Figure 2 - "Site Layout and Performance Monitoring Well Locations" (December 2004)

Staff Exhibit 3 — Letter to U.S. Nuclear Regulatory Commission from Grace Sam, dated December 14, 1994

Staff Exhibit 4 — Pages 109-115 of Intervenors' Statement of Concerns, dated August 15, 1997

Staff Exhibit 5 — Excerpts from NUREG-0706 - "Final Generic Environmental Impact Statement on Uranium Milling" (September 1980)

Staff Exhibit 6 — SECY-01-0057 "Expansion of NRC Statutory Authority Over Medical Use of Naturally Occurring and Accelerator-Produced Radioactive Material (NARM)" (March 2001)

Staff Exhibit 7 — Attachment 9 to SECY-01-0057

Staff Exhibit 8 — "Evaluation of EPA's Guidelines for Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM)" (June 2000)

Staff Exhibit 1

Affidavit of Christopher A. McKenney

Staff Exhibit 1

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE PRESIDING OFFICER

In the Matter of	)	
	)	
HYDRO RESOURCES, INC.	)	Docket No. 40-8968-ML
P.O. Box 777	)	
Crownpoint, NM 87313	)	

AFFIDAVIT OF CHRISTEPHER A. MCKENNEY

I, Christepher A. McKenney, being duly sworn, declare as follows:

1. I am competent to make this affidavit, and the opinions expressed herein are based on my best professional judgement. I am employed by the U.S. Nuclear Regulatory Commission (NRC) in the Office of Nuclear Material Safety and Safeguards. As part of my duties, I worked on reviewing the Hydro Resources, Inc. (HRI) license application from 1995 until the license authorizing *in situ* leach (ISL) uranium mining was issued in 1998. I reviewed the HRI submittals in the areas of health physics, operations, and radiological impacts from potential land application. In 1996, I performed a site visit of HRI's Church Rock site on Sections 8 and 17. I also submitted several affidavits on air emissions issues during the Section 8 phase of this proceeding. My resume, attached hereto as Attachment 1, describes my general background, training, and other qualifications to express the opinions stated herein.

2. Below, I evaluate some of the comments and conclusions of (1) Melinda Ronca-Battista, set forth in her declaration dated June 10, 2005; and (2) Bernd Franke, set forth in his declaration dated June 12, 2005.

3. Among the materials I reviewed in preparing this affidavit (in addition to reviewing the above declarations and the legal argument to which they were attached) are the following items (listed in chronological order from most recent to oldest):

A. Affidavit of Richard Weller dated August 5, 2005.

B. LBP-04-23, 60 NRC 441, issued October 22, 2004.

C. Affidavit of Ron Linton, dated June 25, 2004 (attached as Staff Exhibit 1 to Staff's June 25, 2004 filing).

D. LBP-99-19, 49 NRC 421, issued May 13, 1999.

E. Staff's April 21, 1999 filing, to which my affidavit of that date was attached as Staff Exhibit 1.

F. ENDAUM's and SRIC's filing dated April 7, 1999, including supporting Declaration of Bernd Franke.

G. Staff's April 7, 1999 filing, which includes my affidavit of that date.

H. LBP-99-15, 49 NRC 261, issued March 18, 1999.

I. Staff's February 18, 1999 filing, which includes my affidavit of that date.

J. ENDAUM's and SRIC's filing dated January 11, 1999, including supporting Declaration of Bernd Franke.

K. Franke and Associates. Crownpoint Uranium Solution Mining Project: Review of Outdoor Radon Levels and External Gamma Radiation, dated January 5, 1999 (Exhibit 2 to Franke 1999 Declaration).

L. U.S. Nuclear Regulatory Commission, Safety Evaluation Report, Hydro Resources, Inc., License Application for Crownpoint Uranium Solution Mining Project, McKinley County, New Mexico (SER). Washington, D.C., December 5, 1997 (ACN 9712310298, NB 10.4).

M. U.S. Nuclear Regulatory Commission. NUREG-1508, "Final Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico" (FEIS) February 1997 (ACN 9703200270, NB 10).

N. U.S. Nuclear Regulatory Commission. NUREG-1508, "Draft Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico" (DEIS) October 1994 (ACN 9411160064, NB 7).

O. Eggleston Holmes and Associates. Church Rock MILDOS, August 30, 1993 (ACN 9311170249, NB 6.6).

P. Hydro Resources, Inc. Churchrock Project Revised Environmental Report. March 16, 1993 (ACN 9304130421, NB 6.1).

Q. U.S. NRC Regulatory Guide 4.14, Revision1. "Radiological Effluent and Environmental Monitoring at Uranium Mills" April 1980 (Regulatory Guide 4.14).

4. As discussed in more detail in the staff's legal brief, the primary issue raised by the Intervenors is which sources of radiation must be included in any assessment of whether HRI can comply with the annual total effective dose equivalent (TEDE) limit of 10 CFR § 20.1301(a)(1). The Intervenors are concerned that the presence of the United Nuclear Corporation (UNC) underground uranium mine, and related UNC mine spoils on the surface of Section 17, are causing elevated radiation levels there compared with other areas in the vicinity that were not affected by previous uranium mining. The Intervenors have also raised other issues regarding the adequacy of the dose modeling assessment.

5. There are three existing sources of external radiation and radon on Section 17. These are (1) natural surface soils, (2) surface mine waste and debris from the operations of the UNC mine, and (3) material underground in the UNC mine. A fourth potential source of external radiation and radon on Section 17 is releases from HRI's planned ISL mining operations. Each of these four sources needs to be evaluated in terms of whether the radiation it generates is either from source or byproduct material regulated by the NRC (and, therefore, radiation to be included in the TEDE calculation), or is from naturally occurring radioactive material (NORM) that is excluded from the TEDE calculation as being part of "background radiation."

6. As discussed in Mr. Weller's current affidavit, no milling of the uranium mined by UNC took place at the Section 17 site. Accordingly, any surface remnants of the mined uranium/thorium ore, or overburden material left behind at the Section 17 site are not "byproduct material." Therefore, I evaluate each of the four above-described sources of

external radiation in terms of whether it is source material regulated by the NRC, or whether it is NORM. In doing so, I use the following definitions of terms:

"Source material" is defined in 10 CFR Parts 20 and 40 as follows:

> (1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or (2) Ores that contain, by weight, one-twentieth of 1 percent (0.05 percent), or more of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material.

"Background radiation" is defined in 10 CFR Part 20 as meaning:

> Radiation from cosmic sources; naturally occurring radioactive material [NORM], including radon (except as a decay product of source or special nuclear material); and global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the licensee. "*Background radiation*" does not include radiation from source, by-product, or special nuclear materials regulated by the Commission.

"Unrefined and unprocessed ore" is a term defined in 10 CFR § 40.4 as meaning "ore in its natural form prior to any processing, such as grinding, roasting or beneficiating, or refining." As discussed in the staff's legal brief, pursuant to the 10 CFR § 40.13(b) exemption, unrefined and unprocessed uranium ore -- even though such ore contains source material -- is not regulated by the NRC. As also discussed in the staff's legal brief, and as set forth in its Exhibit 6, NORM includes primordial material such as uranium which has been left undisturbed in nature, and the NRC lacks regulatory authority over such material. A subset of NORM is technologically-enhanced naturally occurring radioactive material (TENORM), and the NRC similarly lacks regulatory authority over TENORM. As set forth in Staff Exhibit 8, the United States Environmental Protection Agency (EPA) describes TENORM as follows:

> TENORM is material containing radionuclides that are present naturally in rocks, soils, water, and minerals and that have become concentrated and/or exposed to the accessible environment as a result of human activities such as manufacturing, water treatment, or mining operations.

Summary of My Opinions

7. Ms. Ronca-Battista and Mr. Franke are incorrect in their base assumption that all the radiation from residual radioactivity in and on Section 17 associated with the UNC mine there must be included as part of HRI's TEDE calculations. They do not properly take into account the definitions of terms, and the regulatory exemption set forth in ¶ 6 above. Nor do they establish that materials associated with the UNC mine on Section 17 fall outside the EPA's TENORM description. Ms. Ronca-Battista and Mr. Franke provide no evidence indicating that the exposure rates and radon measured around Section 17 are caused by source material regulated by the NRC, or by byproduct material. All of the elevated radiation and radon measurements cited by Ms. Ronca-Battista and Mr. Franke are caused by TENORM.

8. All soils and rocks include some level of uranium and thorium. Most of these materials, however, are generally considered to be NORM, as they are neither the result of processing uranium/thorium, nor do they contain ore of sufficient weight percent (*i.e.*, 0.05 percent), to ever be regulated by the NRC as source material. The 0.05 weight percent threshold used in the definition of source material is equivalent to material having uranium concentrated in it at a value of 500 parts per million (ppm).

Natural Surface Soils and Surface Mine Waste

9. The first two existing sources of external radiation and radon on Section 17 have to be grouped together in my evaluation because there is no practical way to differentiate from the available data whether an elevated radiation measurement is due to native soils or mine waste. But as indicated above in ¶ 6, neither radiation from native soils nor radiation from mine waste would be part of a required TEDE calculation unless: (1) such soil or waste had uranium concentrated in it at a value of 500 ppm or more; and (2) such soil or waste had been refined or processed for its source material content. Moreover, radiation from mine waste would not be part of a required TEDE calculation because mine waste is TENORM.

10. As part of my present evaluation, I reviewed data from HRI's March 1993 revised environmental report (Section 2.9, Table 2.9-1 and Figure 2.9-1), and compared it with the gamma survey data provided by Ms. Ronca-Battista. HRI's Table 2.9-1 (a copy of which is attached hereto as Attachment 2) reports the results of soil samples taken across Section 8 and Section 17. HRI's Figure 2.9-1, dated May 1987 and titled "Gamma Survey Map" – a copy of which (reduced in size to 8.5 by 11 inches, and converted into two pages) is attached hereto as Attachment 3 – shows the corresponding sampling locations and concurrent gamma survey results. Soil samples 8S-21, 8S-25, and 8S-26 listed in Attachment 2 were all taken in areas with gamma rates exceeding those measured by Ms. Ronca-Battista's survey. The highest concentration measured by HRI is 420 ppm, with a corresponding gamma rate of 350 μR/hr. This is more than two times the highest gamma rate measured by Ms. Ronca-Battista. Based on my review of this HRI data, I re-affirm the accuracy of my April 7, 1999, affidavit statements that there are apparently no materials present on the ground surface of Section 17 exceeding the 500 ppm uranium threshold. Therefore, in my opinion, no source material of the type regulated by the NRC is present on the surface of Section 17.

11. I disagree with Ms. Ronca-Battista's conclusion (Exhibit K, ¶ 35) that elevated radiation measurements from native soils or mine waste on Section 17 must be included as part of HRI's TEDE calculations. I also disagree with Mr. Franke's related statements that elevated gamma rates (Exhibit L, ¶ 15) and elevated ambient radon levels generated by UNC's Section 17 mining activities (Exhibit L, ¶ 16) are not part of NORM and therefore must be included in HRI's TEDE calculations. Exhibit L, ¶ 18. As no refining or processing of ore ever took place on Section 17, none of the residual source material or mine waste is subject to the NRC's radiological safety requirements. Thus, any radiation from these materials would not be part of HRI's required TEDE calculations. Moreover, Ms. Ronca-Battista and Mr. Franke provide no evidence showing that the exposure rates measured around Section 17 are caused

either by source material which exceeds 0.05 percent by weight, or by by-product material. They do not address the applicable regulatory provisions and the description of TENORM discussed above in ¶ 6, nor do they discuss how the exposure rates measured as part of the Church Rock Uranium Monitoring Project (CRUMP) are consistent or inconsistent with those definitions and the presence of TENORM. Furthermore, while Ms. Ronca-Battista's data shows elevated gamma rates over areas unaffected by mining, these gamma rates do not exceed those set forth in Attachments 2 and 3. I note that her declaration only describes the process and results of gamma survey results, and does not indicate that soil sampling was performed to characterize the source of the gamma exposure rate. Because her survey did not perform soil sampling, no direct determination can be made regarding the concentration of the material causing the exposure rates she measured. However, she gives no indication that the material on which her gamma rates are based is different from the material previously evaluated by HRI as part of its March 1993 revised environmental report.

12. Ms. Ronca-Battista's declaration describes the process and approach used by her as part of the CRUMP to survey areas near but outside of the HRI lease areas. She has used an approach similar to those described in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), which is used by the NRC for surveys of potentially contaminated sites. The CRUMP survey results are consistent with the gamma survey data described in DEIS Section 3.7.1 (Intervenors' Exhibit M), and HRI's March 1993 revised environmental report (*see* Attachments 2 and 3). Actually, the exposure rates listed in these documents have higher ranges than those measured by the CRUMP survey.

13. The CRUMP survey found the higher elevated exposure rates in proximity to the old mine road and State Route 566 (Table 1 of Exhibit K). This would be consistent with past use of the road, which was probably contaminated by the act of hauling ore from the Section 17 UNC mine to the UNC mill. Possible sources of contamination are the use of mine spoils in

creating the road, and fugitive dust or rock lost from the haul trucks. None of this is new information. DEIS Section 3.7.1 stated that portions of Section 8 and Section 17 have elevated radiation levels that appear to be the result of previous mining activities.

14. Table 2 of Exhibit K compares various sampling locations on Section 17 to one of the background reference areas, Chapter House. This comparison is inappropriate for two reasons. First, the comparison should be made between comparable measures of exposure rates. In this case, the mean for the elevated area should be compared to the mean for the background readings, rather than the maximum reading being compared to the mean of the background readings. If the means are compared, the fourth column of Table 2 would show factors between 2 and 3 (e.g., for Location 2-3 and 2-4, the mean was 28 μR/hr and dividing by Church Rock Chapter House's 11 μR/hr, one gets approximately 2.5 rather than 16.4). Second, Ms. Ronca-Battista states that "there is no statistical difference between the background reference areas' [Church Rock Chapter House and Springstead] gamma emission rates," and that she therefore "determined that background reference area gamma emission rates for the CRUMP study area range up to 15 μR/hr." Exhibit K, ¶ 24. In the comparison, she uses the mean from Church Rock of 11 μR/hr, instead of using the above-referenced 15 μR/hr figure. Dividing the Section 17 means by 11 μR/hr, rather 15 μR/hr, artificially inflates the difference between the measured means and the assumed unaffected areas.

15. Table 2 of Exhibit K shows relatively consistent mean exposure rates at all four sampling locations, with areas 2-5 and 2-6 which are farther from the HRI Lease areas showing slightly higher means. From this, I infer that the gamma exposure is being caused by a large diffuse area source rather than from a specific source on the HRI Lease area. If it were caused by a specific source on the HRI Lease area, the survey should show that the exposure rate drops with distance away from the source.

16. For all of the above reasons, I conclude that the gamma exposure rates produced by natural soils and surface mine waste (as measured by Ms. Ronca-Battista) do not need to be included in HRI's TEDE calculations.

Material in UNC Mine

17. The third existing source of external radiation on Section 17 to be considered is the UNC underground mine, from which radon releases may be occurring. As discussed in my April 7, 1999 affidavit, a non-ISL underground uranium mine can increase radon release into the environment by providing preferential 'fast' pathways for radon gas to reach the atmosphere through the mine's various shafts and conduits. An abandoned or not fully remediated mine (i.e., those mines with shafts and vents not closed off) can remain a long-term source of TENORM emissions. Any such TENORM emissions that may be occurring from the UNC mine on Section 17 (*e.g.*, radon released from the ore there) are part of "background radiation" under the terms of the definition set forth above in ¶ 6, because TENORM is a subset of NORM. I further note that the ore in the UNC mine is not source material regulated by the NRC, because it has not been removed from its place of deposit in nature. For all of these reasons I conclude that any radon that may be escaping from the UNC underground mine does not need to be included in HRI's TEDE calculations.

Potential Releases From HRI's ISL Mining Activities

18. In contrast to the three existing sources of external radiation and radon on Section 17 discussed above, releases from HRI's proposed ISL operations must be included in the TEDE evaluation.

19. The FEIS considered two potential radon release scenarios for operations at Church Rock: (1) releases if the pressurized downflow ion exchange system operates as planned by HRI and (2) releases if the pressurized system does not operate properly. *See* FEIS Table 4.24 (at page 4-85). Based on the assumed wind rose, both scenarios show that

radon concentrations at (1) the boundary of the HRI Lease areas and (2) a hypothetical nearest residence directly downwind, would be a fraction of the annual concentration limits set forth in 10 CFR Part 20, Appendix B. The analyzed scenarios include radon releases from both the satellite processing facility on Section 8, and releases from the operating ISL wellfields.

20. Mr. Franke criticizes the staff's 1998 decision to issue HRI its license. Below, I address the following topics he discusses: (1) the assumed radon concentration in the lixiviant; (2) collection of additional baseline data; (3) the application of the Gallup, NM wind rose to the Church Rock site; and (4) the Section 8 processing facility's alleged reliance on unproven technology to reduce radon releases.

Assumed Radon Concentration in Lixiviant

21. With respect to the issue of the assumed radon concentration in the lixiviant, Mr. Franke notes that HRI has not yet collected dissolved radon data from Section 17 groundwater, relying instead in its license application on data from existing Unit 1 production wells. I note that there are, as yet, no such wells at Section 17 from which HRI could obtain the type of site-specific radon data Mr. Franke references. He claims that without site-specific data, compliance with 10 CFR Part 20 requirements cannot be shown with respect to Section 17 operations (Exhibit L, ¶¶ 12-14, and 17). I disagree, and find Mr. Franke's evaluation to be faulty. He assumes, without support, that the Church Rock annual average radon concentration would be 12 times the Unit 1 average value (Exhibit L, ¶ 13). I note that an annual average concentration 12 times the assumed average value for the MILDOS calculations would be in excess of any measurement taken from the Unit 1 data set. Additionally, in his argument, he uses the wrong concentrations from FEIS Table 4.24. Mr. Franke cites a value of 8.4×10^{-5} WL (working levels) as the radon concentration at receptor CRR 4, but this concentration is the maximum radon concentration for the unpressurized downflow ion exchange system, where full radon releases from the system were assumed to occur (i.e., the August 1993 MILDOS

modeling). For the pressurized downflow ion exchange system that will be used, the CRR 4 concentration value is $5.7x10^{-6}$ WL. *See* FEIS Table 4.24. Twelve times (notwithstanding that this is an arbitrary number) this value is $6.8x10^{-5}$, which is less than 1/10th the Appendix B limit of 1.1×10^{-3}. Moreover, calculations for even the unpressurized system in Table 4.24 of the FEIS show that a margin of safety exists to allow for differences in site-specific radon concentrations in lixiviant. Based on the margin of safety, it is unlikely, in my opinion, that differences in annual average concentrations of radon in lixiviant between the assumed Unit 1 concentrations and the Church Rock actual values would result in doses exceeding the limits in 10 CFR 20.1301.

Collection of Additional Baseline Data

22. Mr. Franke implies that radiological monitoring by HRI will not occur until operations begin (Exhibit L, ¶ 17). But Mr. Franke does not identify or address HRI License Condition 10.30, which states:

> Prior to the injection of lixiviant at any of the sites, the licensee shall submit an NRC-approved procedure-level, detailed effluent and environmental monitoring program. In addition, the licensee shall develop and administer its radiological effluent and environmental monitoring program consistent with Regulatory Guide 4.14. The licensee shall maintain, at a minimum, three airborne effluent monitoring stations at each site, at the locations described in COP [Consolidated Operations Plan] (Rev.2.0) Table 9.5-1."

Moreover, part of the guidance of Regulatory Guide 4.14 is that concentrations and exposure rates should be established prior to operations, in order to allow comparison with monitoring data after operations begin. In accordance with this guidance, the staff's December 1997 SER for HRI's license (a copy of this SER was attached as Staff Exhibit 5 to the April 29, 2005 staff groundwater presentation) states that three months prior to operations at each ISL site, "sampling and monitoring will begin at each environmental monitoring station." SER, at 16. Mr. Franke's implication that additional background sampling will not occur prior to ISL operations is therefore incorrect.

Reliance on Gallup Wind Data

23. Mr. Franke argues that the staff should have denied HRI's license application in 1998 due to HRI's reliance on wind data from Gallup, NM – rather than site-specific data – and that members of Larry King's family will be exposed to high levels of radon. Exhibit L, ¶¶ 19-22. As discussed below, Mr. Franke does not demonstrate that a modification of the wind rose would result in higher radon doses at the Section 17 boundary, and he does not show that HRI's operations on Section 17 will expose members of Larry King's family to high levels of radon.

24. In evaluating Mr. Franke's declaration, I noted that if one looks at the topographical features around the HRI Church Rock site (such as displayed on McKenney Attachment 3), the valley generally trends in the same direction as the prevailing wind – southwest to northeast – shown in the wind rose. While it may be argued that, for topographical reasons, releases from Section 8 would travel in a more west to east direction due to the presence of steep cliffs on the northern portions of Section 8, there are no such cliffs on Section 17. Thus, any releases from the Section 17 wellfields would likely be blown to the northeast and away from the King family residences. I further note that these residences are to the southeast of the Section 8 satellite processing facility. Due to the presence of its ion exchange columns, the satellite facility is by far the largest potential source of radon from HRI's Church Rock operations. Because this facility is northwest of the King family residences, the King family would not be predominately downwind of its potential releases.

25. The dose modeling performed in reviewing HRI's license application calculated the dose to an individual downwind of both a wellfield and the satellite facility (*i.e.*, at location CRR 4) – a location approximately 500 meters (1650 feet) from the satellite facility. *See* FEIS Figure 4.5 (page 4-84). As reflected on FEIS Table 4.24, the concentration rises from the working levels (WL) calculated at the boundary (BR-2 NE), and the assumed nearest residence

(CRR 4). This result is consistent with the mechanics of radon release, because progeny concentrations increase with time. Based on the fact that the King family residences could only routinely be exposed to possible radon releases from the Section 17 wellfields – any such releases would be quite low – any radon concentrations at their homes as the result of HRI's ISL operations would be much less than that calculated for CRR 4.

26. In short, in my opinion, the Intervenors have produced no evidence calling into question the following conclusion stated in the FEIS:

> For the Church Rock analysis, radon emission controls reduce the airborne concentration by approximately a factor of 10 (see Table 4.24). The resulting values at the nearest residence are approximately 0.5 percent and 7.6 percent of the limit, with and without the emissions controls, respectively. The calculated exposures and potential concentrations, with emission controls, are a small fraction of the regulatory limits.

FEIS, at 4-83.

Unproven Technology Claim Previously Rejected

27. Mr. Franke claims that HRI's pressurized downflow ion exchange system to reduce radon releases from lixiviant at its Section 8 satellite processing facility would represent use of an unproven technology. Exhibit L, ¶¶ 23-29. On this point, Mr. Franke merely reiterates arguments made by a previous Intervenor expert (Dr. Alan Eggleston), and provides no new evidence. Significantly, Mr. Franke's list of information he reviewed (Exhibit L, ¶ 8) does not include the staff affidavit of Ron C. Linton filed in this proceeding in June 2004. There, in paragraphs 17 through 19, Mr. Linton discusses the successful use of similar technology at the Power Resources, Inc's Highland-Smith Ranch ISL facility in Wyoming. Mr. Franke also apparently did not review LBP-04-23, 60 NRC 441 (2004). There, former Presiding Officer Thomas Moore rejected Dr. Eggleston's unproven technology claim (60 NRC at 457), ruling in pertinent part as follows:

> As pointed out by Mr. Pelizza, the pressurized downflow ion exchange system that will be used by HRI is not experimental and, in fact, is employed at other ISL

> sites in Wyoming licensed by the NRC. Further, according to both these parties' affiants, the process to be employed by HRI will serve to reduce significantly radon release during the production phase of the facility. As stated by Mr. Linton, HRI plans to use a vacuum pump to remove and compress the radon in intermediate holding tanks, dissolve it in the lixiviant injection system, and then recirculate it back into the well field. He states that the primary emissions of radon will occur when excess vapor pressure is vented by relief valves at outdoor locations, when ion exchange columns are opened for resin transfer and elution, and when waste water is treated, and each of these scenarios has been sufficiently modeled in the FEIS. ...
>
> The Intervenors' position with respect to the type of processing facility to be used by HRI is without merit. First, the Intervenors present no evidentiary support for their claims. Second, the FEIS adequately evaluates the processes to be utilized by HRI to minimize the emission of airborne effluents. Finally, as discussed in section II.B.2.a., above, the FEIS also examines the radiological levels of airborne emissions at various, higher-risk locations and finds them to be within regulatory limits.

LBP-04-23, 60 NRC at 458 (footnotes omitted).

28. In addition to Mr. Franke's reliance on the discredited opinions of Dr. Eggleston, his own analysis lacks technical validity. Mr. Franke quotes from HRI's August 1993 MILDOS analysis (Exhibit L, ¶ 26), and states that HRI's consultants considered these results to demonstrate that HRI would not meet the 10 CFR Part 20 regulatory limits because of the Polonium-218 concentration. However, the HRI consultant was mistaken in this regard. The MILDOS code had compared the wrong limit out of Appendix B of 10 CFR Part 20. Polonium-218 is one of the initial set of short-lived progeny of radon-222 with a half-life of 3.1 minutes. Appendix B lists no specific concentration limit for Polonium-218, so the HRI consultant had used the generic listing for "Any single radionuclide not listed above that decays by alpha emission..." at the end of Appendix B. However, while not specifically listed, the limit for Polonium-218 (and the other short-lived progeny of radon-222) is included in the dual limits for radon-222 ("With daughters present" and "With daughters removed"). These limits apply when the situation is either 100% equilibrium or 0%, neither of which is probable in an outdoor radon release. A more accurate assessment of the compliance of radon-222 and its progeny is

the use of the WL unit, which can be used to estimate the resulting radon dose from any degree of equilibrium. This is the unit used in Table 4.24 of the FEIS. As shown in that table, the results of the 1993 MILDOS analysis, which are the numbers under the title "Totals (unpressurized system)," meet the concentration limits for Appendix B.

29. Thus, with both HRI's pressurized system and unpressurized system showing compliance with the 10 CFR Part 20 limits, the staff did not rely on the performance of the pressurized system to grant HRI its license.

30. The statements and opinions expressed above are true and correct to the best of my knowledge, information, and belief, and are based on my best professional judgement.

Christopher A. McKenney

Sworn and subscribed to before me
this 5th day of August, 2005

Notary Public

My commission expires: March 1, 2006

McKenney Attachment 1

Statement of Professional Qualifications

Christepher A. McKenney

Statement of Professional Qualifications

U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Division of Waste Management
and Environmental Protection
Environmental and Performance
Assessment Directorate

CONTACT INFORMATION

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EXPERIENCE:

May 2004 - present	**Senior System Performance Analyst,** Division of Waste Management and Environmental Protection, Activities include biosphere modeling for low-level waste disposal and decommissioning activities; responses to Congressional questions; interfacing with other Federal and State Agencies
Mar 1994 - May 2004	**System Performance Analyst (Health Physicist/Engineer),** Division of Waste Management, Activities include biosphere modeling for high-level waste disposal, low-level waste disposal, decommissioning activities and uranium recovery wastewater disposal options; NRC Representative to the International Atomic Energy Agency's Biosphere Modeling and Assessment Methods (BIOMASS) program; technical reviewer of operational health physics; responses to Congressional questions; interfacing with other Federal and State Agencies.
Oct 1993 - Mar 1994	**Nuclear Engineer,** Low-Level Waste Management and Decommissioning Division, Activities included biosphere modeling for low-level waste disposal, decommissioning activities, and uranium recovery wastewater disposal options; technical reviewer of operational health physics.
July 1991 - Oct 1993	**Nuclear Engineer - Intern,** Office of Nuclear Material Safety and Safeguards, Activities included multiple rotations to numerous NRC offices and divisions.

June 1993 - Oct 1993	Rotation with Region III/Division of Nuclear Materials Safety, Activities involved inspection of NRC licenses including hospitals, universities, military applications, and radiography.
Jan 1993 - June 1993	Rotation with Division of Industrial and Medical Nuclear Safety, Director's Office, Activities included paper for European Union Council and project managment of NRC's safety assessment of the Leksell Gamma Unit, a gamma stereotactic radiosurgical device.
Oct 1992 - Jan 1993	Rotation with Division of Industrial and Medical Nuclear Safety, Operations Branch, Activities included drafting inspection guidance, answering generic questions for Part 20 implementation.
Aug 1992 - Oct 1992	Rotation with Region IV/Uranium Recovery Field Office, Activities included safety and environmental reviews of licensee requests and inspections of uranium recovery facilities.
July 1992	Rotation with Office of State Programs, Activities included technical support of Agreement State programs, and assisting in coordination of an All-Agreement States meeting on Low-Level Radioactive Waste.
July 1991 - July 1992	Initial assignment to Low-Level Waste Management and Decommissioning Division, Activities included biosphere modeling for low-level waste disposal, and decommissioning activities; technical reviewer of operational health physics; member of Low-Level Waste Performance Assessment Working Group.
June 1990 - Sept 1990	**Summer Intern,** Westinghouse-Hanford Company, Health Physics Support, Activities included coordinating bioassay program.

Education

Oregon State University Corvallis, Oregon	Bachelor's of Science in Nuclear Engineering, Radiation Protection Option, June 1991

McKenney Attachment 2

HRI Table 2.9-1 (from HRI's revised 1993 environmental report)

TEL. 512-884-0371

Table 2.9-1

PO BOX 2552 78403

JORDAN LABORATORIES, INC.
CHEMISTS AND ENGINEERS
CORPUS CHRISTI, TEXAS
SEPTEMBER 21, 1987

URANIUM RESOURCES, INC.
SUITE #735, PROMENADE BANK TOWER
RICHARDSON, TEXAS 75080

REPORT OF ANALYSIS

IDENTIFICATION	*PH	URANIUM PPM	RADIUM 226 PCI/L	LEAD 210 PCI/L	THORIUM 230 PCI/L
SOIL 8S-1 6-30-87	7.69	5.5	2.4 +/- 0.1	3.6 +/- 0.7	4.5 +/- 0.5
SOIL 8S-2 6-30-87	7.82	13	8.7 +/- 0.3	13 +/- 1	15 +/- 1
SOIL 8S-3 6-30-87	7.91	7.8	3.9 +/- 0.2	6.4 +/- 0.9	8.0 +/- 0.7
SOIL 8S-4 6-30-87	7.97	12	5.7 +/- 0.2	8.9 +/- 1.0	11 +/- 1
SOIL 8S-5 6-30-87	7.85	8.5	4.2 +/- 0.2	5.9 +/- 0.8	9.2 +/- 0.7
SOIL 8S-6 6-30-87	7.84	3.3	1.1 +/- 0.1	1.9 +/- 0.6	2.2 +/- 0.3
SOIL 8S-7 6-30-87	8.07	1.7	0.7 +/- 0.1	0.85 +/- 0.55	1.3 +/- 0.4
SOIL 8S-8 0-12" 6-30-87	7.64	2.9	0.8 +/- 0.1	1.3 +/- 0.6	1.5 +/- 0.3
SOIL 8S-8 12-24" 6-30-87	7.54	2.5	1.3 +/- 0.1	0.99 +/- 0.57	1.7 +/- 0.4
SOIL 8S-8 24-36" 6-30-87	7.66	2.5	1.1 +/- 0.1	1.4 +/- 0.6	2.0 +/- 0.3
SOIL 8S-9 6-30-87	7.86	2.1	0.9 +/- 0.1	2.2 +/- 0.7	1.7 +/- 0.4
SOIL 8S-10 6-30-87	7.76	2.2	0.9 +/- 0.1	1.9 +/- 0.6	1.3 +/- 0.2
SOIL 8S-11 0-12" 6-30-87	4.85	3.7	1.4 +/- 0.1	2.5 +/- 0.6	4.2 +/- 0.5
SOIL 8S-12 6-30-87	7.88	1.6	0.5 +/- 0.1	0.64 +/- 0.49	0.75 +/- 0.2
SOIL 8S-13 6-30-87	7.77	2.7	1.0 +/- 0.1	1.6 +/- 0.6	2.6 +/- 0.4
SOIL 8S-14 6-30-87	6.66	5.3	1.8 +/- 0.1	3.5 +/- 0.7	3.4 +/- 0.4
SOIL 8S-15 6-30-87	7.70	3.1	1.6 +/- 0.1	2.1 +/- 0.6	3.1 +/- 0.5
SOIL 8S-16 7-1-87 12-24"	7.56	56	4.9 +/- 0.2	7.8 +/- 0.9	7.0 +/- 0.5
SOIL 8S-16 6-30-87	7.59	650	49 +/- 1	90 +/- 3	89 +/- 2
SOIL 8S-17 6-30-87	7.94	3.3	1.0 +/- 0.1	1.2 +/- 0.5	1.9 +/- 0.3

TEL. 512-884-0371 PO BOX 2552 78403

JORDAN LABORATORIES, INC.
CHEMISTS AND ENGINEERS
CORPUS CHRISTI, TEXAS
SEPTEMBER 21, 1987

URANIUM RESOURCES, INC.
PAGE 2

REPORT OF ANALYSIS

IDENTIFICATION	*PH	URANIUM PPM	RADIUM 226 PCI/L	LEAD 210 PCI/L	THORIUM 230 PCI/L
SOIL BS-18 6-30-87	8.06	4.0	1.5 +/- 0.1	2.2 +/- 0.6	2.6 +/- 0.4
SOIL BS-20 6-30-87	7.85	2.9	1.1 +/- 0.1	1.6 +/- 0.6	1.7 +/- 0.3
SOIL BS-21	8.42	144	48 +/- 1	97 +/- 3	92 +/- 2
SOIL BS-22 7-1-87	8.00	2.2	1.1 +/- 0.1	1.7 +/- 0.6	1.4 +/- 0.2
SOIL BS-23 7-1-87	7.93	3.5	1.7 +/- 0.1	2.6 +/- 0.7	3.9 +/- 0.5
SOIL BS-24 7-1-87	7.92	2.7	1.1 +/- 0.1	1.7 +/- 0.6	1.1 +/- 0.2
SOIL BS-25 7-1-87	8.08	310	99 +/- 1	241 +/- 4	261 +/- 3
SOIL BS-26 7-1-87	8.48	420	149 +/- 1	283 +/- 5	242 +/- 3

*PH DETERMINED ON SATURATED SOIL PASTE.

LAB. NOS. M25-4684 THROUGH M25-4711

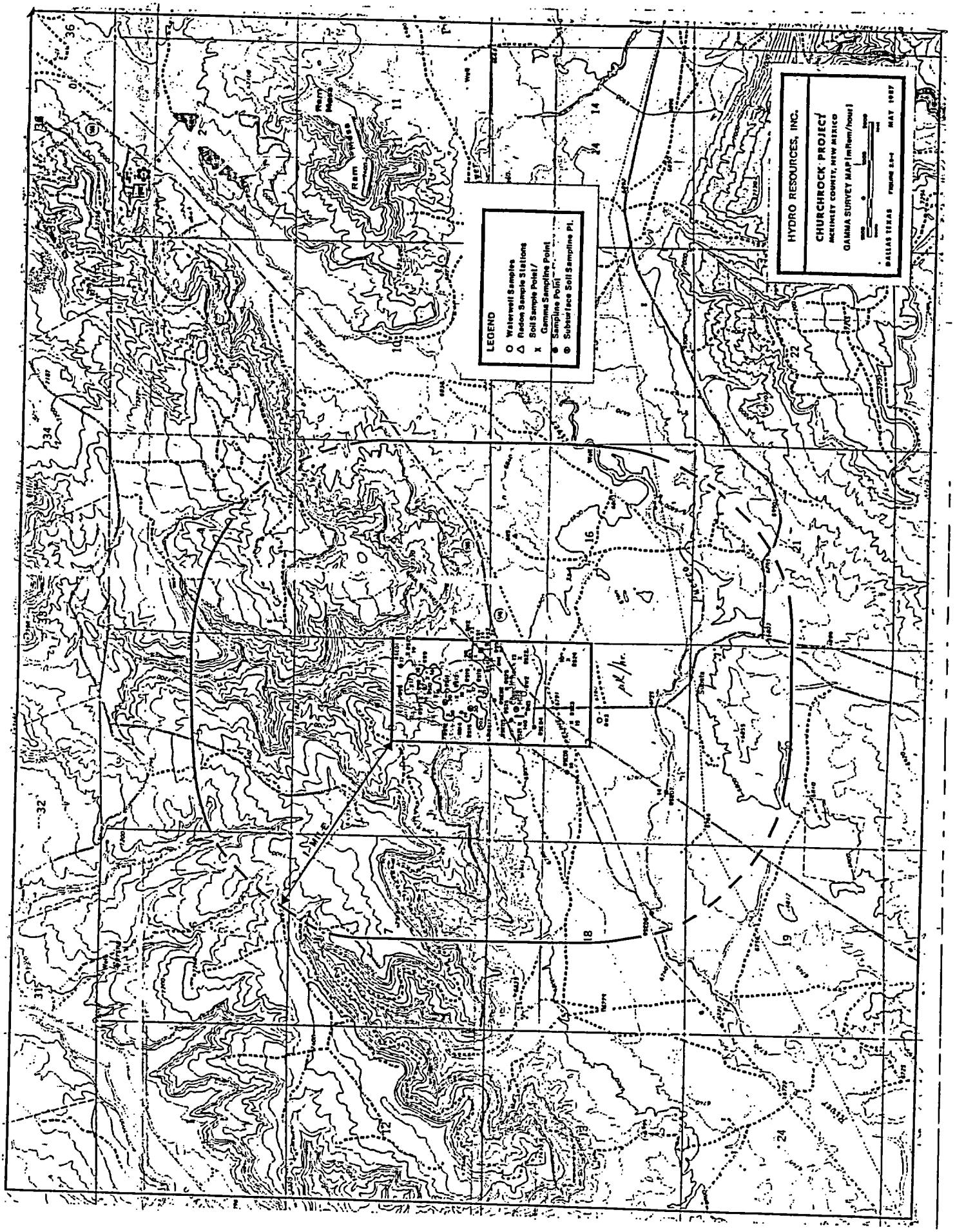
RESPECTFULLY SUBMITTED,

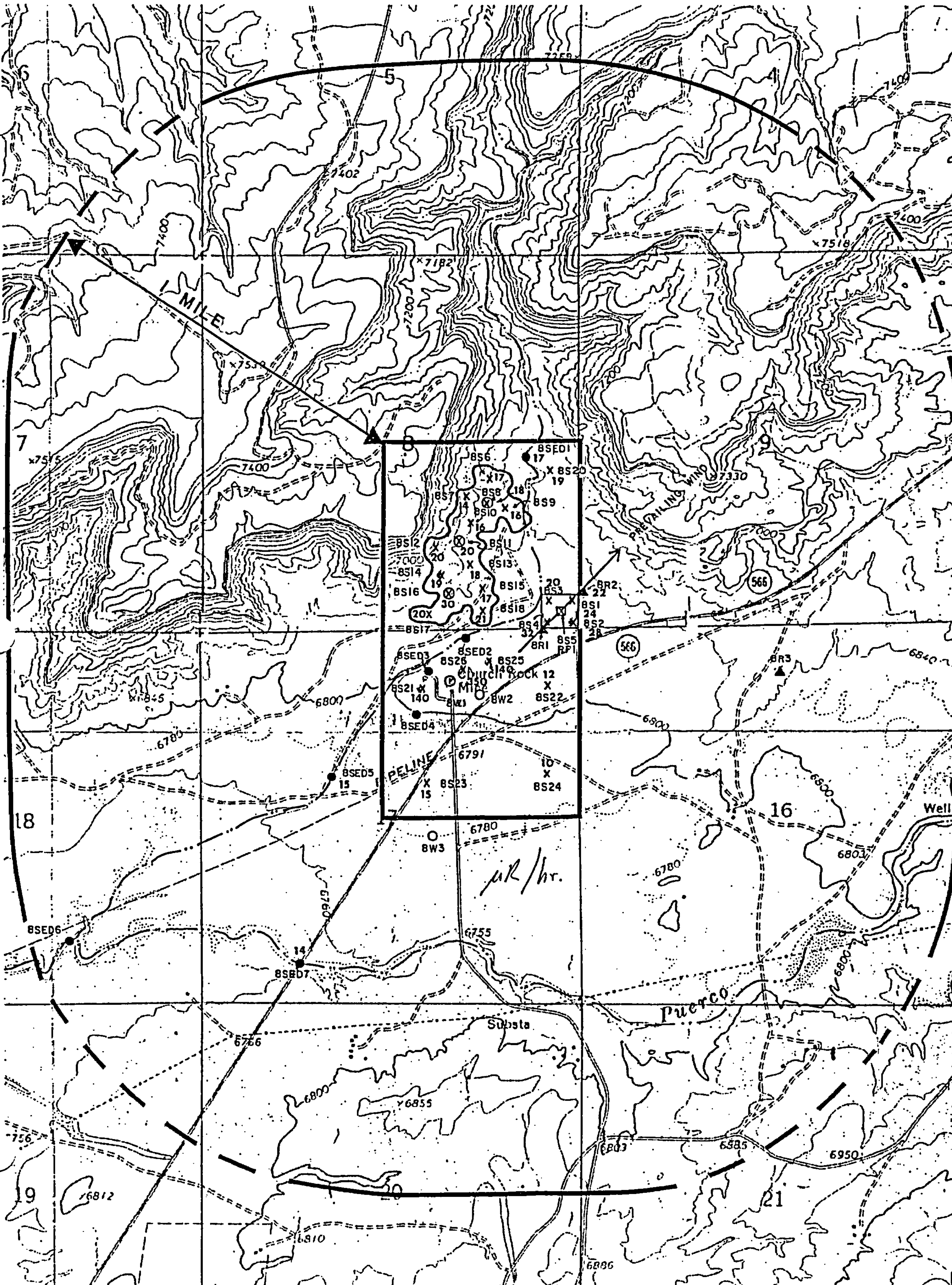
CARL F. CROWNOVER

McKenney Attachment 3

HRI Figure 2.9-1 "Gamma Survey Map" (May 1987)

McKenney Attachment 3





1 MILE
PREVAILING WIND
Church Rock Mine
BSED1
BSED2
BSED3
BSED4
BSED5
BSED6
BSED7
BS1
BS2
BS3
BS4
BS5
BS6
BS7
BS8
BS9
BS10
BS11
BS12
BS13
BS14
BS15
BS16
BS17
BS18
BS20
BS21
BS22
BS23
BS24
BS25
BS26
BR1
BR2
BR3
BW2
BW3
PELINE
Puerco
Substa
Well
566
µR/hr.

Staff Exhibit 2

Affidavit of Richard A. Weller

Staff Exhibit 2

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE PRESIDING OFFICER

In the Matter of	)	
	)	
HYDRO RESOURCES, INC.	)	Docket No. 40-8968-ML
P.O. Box 777	)	
Crownpoint, NM 87313	)	

AFFIDAVIT OF RICHARD A. WELLER

I, Richard A. Weller, being duly sworn, declare as follows:

1. I am the Project Manager for the Hydro Resources, Inc. (HRI) license, and I am familiar with the technical issues pertaining to the Crownpoint Uranium Project (CUP). I am competent to make this affidavit, and the factual statements herein are true and correct to the best of my knowledge, information, and belief. My April 29, 2005 affidavit was filed in this proceeding as part of the "NRC Staff's Written Presentation on Groundwater Protection, Groundwater Restoration, and Surety Estimates," as Staff Exhibit 3 thereto.

2. In part, my present affidavit serves to describe the relative locations of (1) the abandoned United Nuclear Corporation (UNC) uranium ore mine on Church Rock Section 17, (2) the UNC mill on Section 2 where the uranium ore from Section 17 was processed into "yellowcake" (uranium oxide), and (3) the UNC mine on Section 35, to which some of the tailings from the UNC mill were sent (the Section 35 mine was subject to UNC remediation actions approved by the Staff in 1989). I also show below some of the differences between byproduct material regulated by the NRC, and uranium mine waste materials which are not byproduct material and which are not regulated by the NRC.

3. Included among the materials I have reviewed in preparing this affidavit are the following items:

A. The 1988 "Environmental Report for the Church Rock In Situ Uranium Mine" (1988 ER), forwarded with a letter (dated April 13, 1988) from M. Pelizza, HRI, to D. Smith, NRC. A copy of **Figure 2.7-1** from the 1988 ER (reduced in size to 8.5 by 11 inches) **is provided as Attachment 1 of this affidavit.**

B. UNC Report dated April 27, 1989, titled "Tailings Sand Backfill Cleanup Verification Report Northeast Church Rock Mine" **(a copy of which is attached hereto as Attachment 2 of this affidavit).** The photographs appended to Attachment 2 are of poor quality, but are included for the sake of completeness.

C. NRC Memorandum dated October 31, 1989, titled "Cleanup of Tailings at the Northeast Church Rock Mine" **(a copy of which is attached hereto as Attachment 3 of this affidavit).**

D. UNC's "Annual Review Report - 2004 Groundwater Corrective Action Church Rock Site Church Rock New Mexico" (submitted to the NRC in December 2004), specifically Figure 2 of this report. Figure 2 is titled "Site Layout and Performance Monitoring Well Locations 2004 Operating Year." **A copy of Figure 2 (reduced in size to 8.5 by 11 inches) is provided as Attachment 4 of this affidavit.**

4. The location of the UNC uranium ore mine on Church Rock Section 17 is depicted on Attachment 1. To show the mine's location relative to the location of the UNC mill, I have circled the UNC mill site on Attachment 1. As indicated on Attachment 1, the UNC mill was located on the northwest quadrant of Section 2. I measured the distance between the UNC mine on Section 17 and the UNC mill using the scale of 2,000 feet per inch provided on Attachment 1. My measurement shows that the site of the UNC mill, which was decommissioned in 1991-92, is approximately 3.22 miles northeast of the Section 17 mine.

5. Attachment 4 more clearly depicts the site of the UNC mill, and also shows the existing tailings cells located on the central portion of Section 2. Additionally, Attachment 4 shows the site of a second uranium mine operated by UNC – the Northeast Church Rock Mine.

This mine – identified on Attachment 4 as "NECR Mine Site" – is located to the north of the UNC mill site.

6. As reflected in Attachment 3 (at page 1), the UNC mill operated pursuant to NRC license SUA-1475. In January 1979, the Northeast Church Rock Mine was authorized by the State of New Mexico to use UNC mill tailings – which contain byproduct materials – at the mine for backfilling purposes.

7. Attachment 2 details the cleanup performed by UNC during 1986-88 to remove the byproduct materials contained in the mill tailings from the Northeast Church Rock Mine site. The following excerpt from UNC's 1989 report is relevant to the Intervenors' air emission concerns, because it shows key differences between byproduct materials regulated by the NRC, and non-byproduct materials produced by traditional uranium mining operations which are not regulated by the NRC:

> In determining the uranium/radium ratio of tailings versus low grade ore and other non-byproduct materials various types of samples representing these sources were obtained. They included samples from representative areas like the Mine parking lot (made up of mineralized ore and waste rock), various low ore grade stock piles, and tailings. The results clearly indicate a significant difference in the uranium/radium ratio in tailings versus non-byproduct sources. Representative ore, other non-tailings, and tailings samples were analyzed for radium-226 and natural uranium to establish uranium to radium ratios in non-byproduct versus byproduct sources. The data is presented in Table I. The average ratios of uranium to radium-226 in the low ore grade samples is 1.44. In tailings samples the average ratio is 0.035. Therefore, uranium/radium ratios of 0.035 or less identified in soils sampled would indicate byproduct contamination.

Attachment 2, at 5 (emphases added).

8. Based on the equilibrium ratio and natural uranium data provided by UNC, the Staff found that UNC had adequately removed byproduct material from the Northeast Church Rock Mine site. *See* Attachment 3 (at page 3).

9. In contrast to UNC's Northeast Church Rock Mine site, UNC's Church Rock Section 17 mine never contained byproduct materials. Ore mined from the UNC Church Rock

Section 17 mine was sent to the UNC mill for processing. The references in Intervenors' Exhibit G to the presence of "dry ponds" at UNC's Church Rock Section 17 mine site are not evidence that tailings ponds were ever present there. Instead, the "dry ponds" refer to former mine dewatering ponds typically used at non-ISL underground uranium mines as surface storage areas to keep the mines free from excess water. Mine waste – in the form of radium 226 contained in pond sludge – was removed from the ponds more than ten years ago and was disposed of off-site. *See* Intervenors' Exhibit 4, at page 2 (letter from HRI to the State of New Mexico dated August 31, 1994, contained within Intervenors' Exhibit L).

10. The statements expressed above are true and correct to the best of my knowledge, information, and belief, and are based on my best professional judgement.

Richard A. Weller

Richard A. Weller

Sworn and subscribed to before me
this 5th day of August, 2005

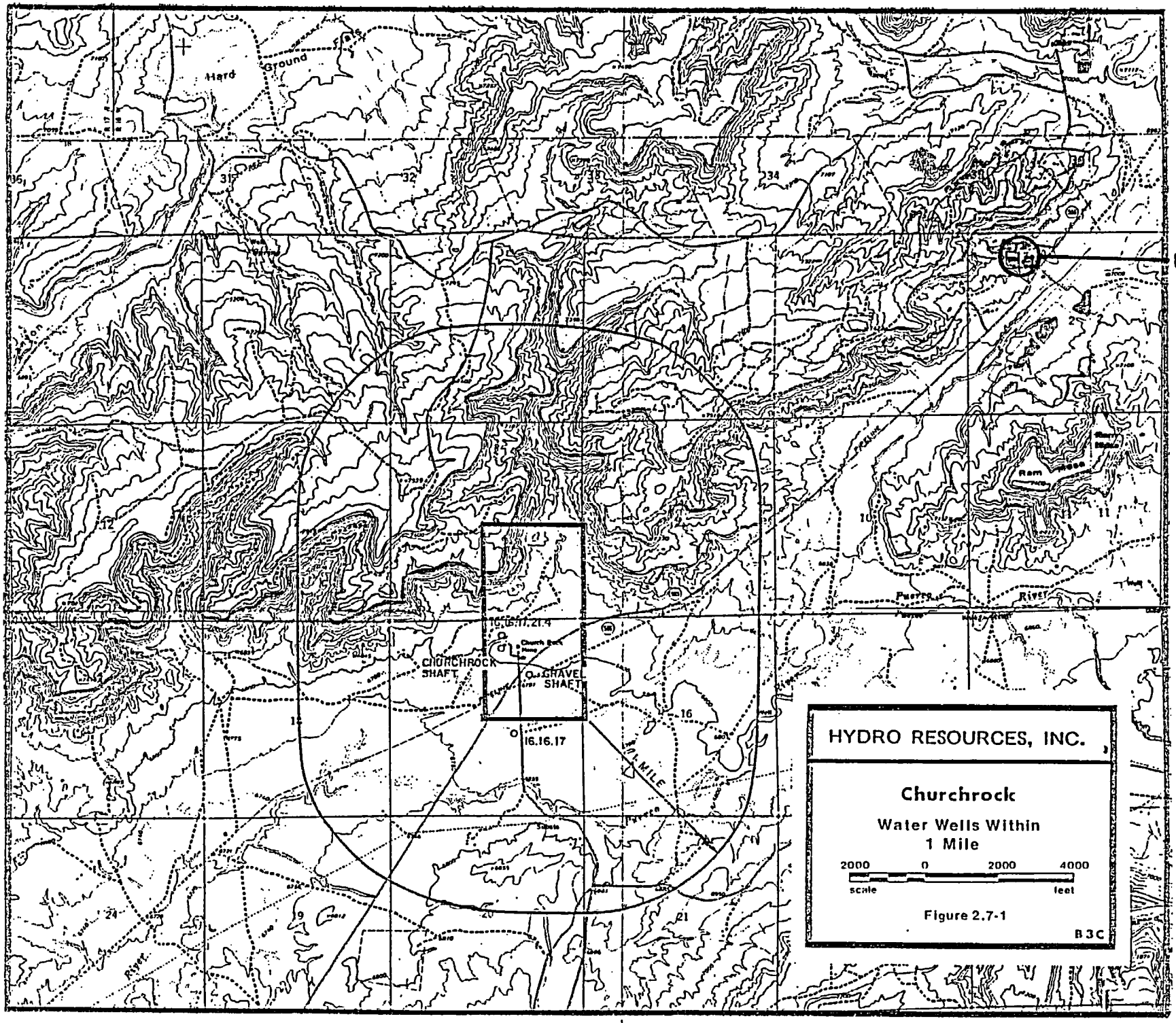
Patricia K. Isaacson

Notary Public

My commission expires: March 1, 2006

Weller Attahment 1

HRI Figure 2.7-1 (from HRI's 1998 environmental report)



Weller Attachment 1

Weller Attachment 2

UNC's Tailings Sand Backfill Cleanup Verification Report (April 1989)

4/27/89

Weller Attachment 2

TAILINGS SAND BACKFILL

CLEANUP VERFICATION REPORT

NORTHEAST CHURCH ROCK MINE

UNITED NUCLEAR CORPORATION

LICENSE SUA-1475
CONDITION NO. 33

A-18

89-0623

1.0 INTRODUCTION

This report has been prepared pursuant to License Condition 33 of United Nuclear Corporation's License No. SUA-1475. The purpose of this report is to provide the data for verification that the byproduct materials from the tailings sands backfill areas and associated mine water ponds at United Nuclear's Northeast Church Rock (NECR) mine site have been removed.

On January 29, 1979, the State of New Mexico Environmental Improvement Division authorized United Nuclear to use coarse tailings sands produced from the milling process for backfilling excavated mine stopes in the Northeast Church Rock mine. These sands came from the tailings disposal area after they had been separated from the slimes.

Sandfill areas 1, 2 and 3 shown on Figure 1 were established at the mine site to store the tailings sands prior to use. Runoff from these areas was routed to mine dewatering ponds 1, 2, 3 and 3A (see figure 1). Water from the ponds was treated in the NECR Ion Exchange Plant before being discharged in accordance with an NPDES permit. The ponds were periodically dredged to remove sediments. These sediments were stored at the mine site pond muck pad (see figure 1). From there, the pond muck was transported to the mill for processing. The following areas require cleanup of tailings sands byproduct residual as a result of these activities.

- Sandfill Area #1
- Sandfill Area #2
- Sandfill Area #3
- Pond #1
- Pond #2
- Pond #3
- Pond #3A
- Pond Muck Pad

2.0 CLEANUP PROCEDURES

As the initial step of cleanup in 1986 United Nuclear transported the remaining stored tailings sands from the NECR mine and deposited them back in the tailings disposal area at the location shown on Figure 1. A total of 13,593 tons of tailings sands were moved from the mine.

In 1988, the areas identified above were excavated to remove byproduct residual. Figure 1 identifies the initial depth to which each area was excavated. Soils sampling was then conducted to determine which areas should be more selectively excavated. The depth to which final selective excavation actually took place was determined using the results of the soils sampling as described later herein. A total of 58,284 dry tons of soil material was removed from the NFCR mine site.

2.1 Clean Up Criteria

2.1.1 Preliminary Surveys

Preliminary surface gamma surveys were conducted in an attempt to determine the magnitude of cleanup required at the backfill sand areas. Attempts made to evaluate Backfill Area No. 1 using gamma surveys were unsuccessful because the berms of low grade ore placed along the edges of the area affected the gamma measurements to the extent that any gamma measurements from tailings materials were overshadowed. Gamma ray surveys attempted in the vicinity of Backfill Areas No. 2 and No. 3 were similarly unsuccessful as the surface gamma ray readings from stored mine water treatment pond sediment overshadowed readings from backfill sands. It became clear that gamma surveys would be useless in determining byproduct contamination because mine related sources (i.e., non-byproduct sources) of gamma radiation could not be distinguished from byproduct related sources. Mine waste and low grade ore has been distributed in various areas of the mine site as a result of development and operation of the mine. Gamma radiation could not be used as a control for determining tailings contaminated areas because of the contribution to gamma readings from the low grade ore.

In order to determine the depth to which each area would be initially excavated, boreholes were drilled in the tailings backfill sands storage areas using a truck-mounted and hand-held augers to a depth of approximately three meters (10 ft) in Backfill Areas Nos. 1 and 2 and one meter (3.3 ft) in Backfill Area No. 3. A borehole gamma probe was lowered into each hole to determine the Ra-226 concentration below the surface. Borehole logging readings of 12.8 are approximately equivalent to Ra-226 concentrations of 16 pCi/g. Area 1 showed high readings to a depth of 30 centimeters 1.0 ft). Logging in Area 2 indicated elevated readings to approximately 150 centimeters

(5.0 ft). Borehole logger readings in Backfill Storage Area 3 indicated elevated readings to approximately 15 centimeters (0.5 ft) depth. While this method could not distinguish between byproduct and non-byproduct related radium, the elevated levels were assumed to be due to piles of backfill sands and/or affected soil remaining at the perimeter of the areas for the initial purpose of excavation, even though the highest percentage of the contribution to those readings was most likely to be non-byproduct related.

Auger holes were also drilled and probed in the Ponds. Samples of pond sediment from all four ponds were also obtained using pipes forced into the sediment. A pipe was hammered to the greatest depth possible then removed carefully to retain the soil sample in the pipe. The depth to which the pipe was submerged in sediment was noted. The pipes were frozen overnight and later sawed into sections. The sections were counted using a portable gamma spectroscopy unit. The estimated depth of elevated Ra-226 activity levels in each of the ponds is reflected in the amounts excavated (shown on Figure 1). Again the elevated readings were assumed to be byproduct related for the purposes of initial excavation.

2.2 Excavation

Sandfill Areas 1, 2 and 3, and Pond 3A and the Pond Muck Pad area were excavated by ripping the soils with a dozer, then windrowing the soils with a grader. If the soils were soft, only the grader was used. A front-end loader was used to stockpile the windrowed soils and load the haul trucks. Ponds 1, 2 and 3 were wet requiring that a track backhoe be used. The backhoe excavated and stockpiled the wet soils. A front-end loader was used to load the haul trucks.

2.3 Excavation/Controls and Verification Criteria

It became necessary to establish a procedure by which to determine if the areas excavated contained byproduct material or if soils surveys results were indicative of non-byproduct sources, particularly for areas where mine waste or natural rock outcrops masked byproduct contamination. As indicated before, surface gamma surveys were of no use because of there inability to differentiate between byproduct and non-byproduct sources. Also, radium content alone could not by used to differentiate whether the source was non-byproduct or tailings related.

It was determined that the use of a ratio between uranium and radium would be the best indicator of the source. Uranium would be expected to be essentially absent in the tailings sands because it would have been extracted by the milling process. The milling process used by United Nuclear was over 90% efficient. The uranium to radium ratios in tailings should, therefore, show a significant bias toward radium if the soil sample was tailings contaminated. The uranium/radium ratio in ore from the mine or other non-byproduct related soils would be expected to be much closer to equilibrium. Determination of the uranium/radium ratio is discussed in Section 3.1.

After the uranium/radium ratio indicative of byproduct versus non-byproduct material was established, an excavation control was set by averaging the byproduct and non-byproduct uranium ratio. The resulting excavation control was used to identify areas of additional selective excavation.

Sampling was conducted after the initial excavation generally on a 50 to 100 foot grid spacing. Two types of soils samples were taken; surface and core samples. The surface samples were taken at the first 15 centimeters (cm). The core samples were taken at each 15 cm down to 60 cm or every 0.5 feet down to 2 feet. Section 3.0 of the report contains maps of each area cleaned with each sampling location plotted. The maps also contain the analytical results. Areas that did not meet the excavation control criteria after initial excavation were selectively excavated until analytical results were acceptable. Selective excavation took place in all directions from the location of the sampling points not meeting the excavation control criteria to the location of sampling points that did meet the criteria. Selective excavation depth was generally from one to three feet. In a few cases the excavation control criteria could not be achieved even after several episodes of selective excavation. However, as explained below, the excavation control is criteria is conservative relative to the verification criteria (i.e., the tailings uranium/radium ratio). The excavation control criteria was used in conjunction with the remediation criteria in 10 CFR 40, Appendix A of 5 pCi Radium-226 above background, where possible. However, the 5 pCi/l above background criteria could not be used as the only guide because it is not possible to discriminate between radium contribution by mine waste, other natural sources, or byproduct material.

3.0 RESULTS

This section presents the results of the sampling conducted to verify that byproduct has been removed from the sand backfill areas and the ponds.

3.1 Uranium/radium Ratio Determination

In determining the uranium/radium ratio of tailings versus low grade ore and other non-byproduct materials various types of samples representing these sources were obtained. They included samples from representative areas like the Mine parking lot (made up of mineralized ore and waste rock), various low ore grade stock piles, and tailings. The results clearly indicate a significant difference in the uranium/radium ratio in tailings versus non-byproduct sources. Representative ore, other non-tailings, and tailings samples were analyzed for radium-226 and natural uranium to establish uranium to radium ratios in non-byproduct versus byproduct sources. The data is presented in Table I. The average ratios of uranium to radium-226 in the low grade ore samples is 1.44. In tailings samples the average ratio is 0.035. Therefore, uranium/radium ratios of 0.035 or less identified in soils sampled would indicate byproduct contamination. As an additional conservative measure for excavation control, United Nuclear averaged the ore and tailings uranium/radium ratios (i.e., 0.035 and 1.44) using the result (i.e., 0.75) as the excavation control criteria. Any ratios below 0.75 identified during soils sampling was used to identify areas of additional selective excavation.

3.2 Sandfill Area No.1

Sandfill area No. 1 is located on top of a mesa southeast of the Northeast Church Rock mine shaft No. 1 (see Figure 1). Figure 2 contains photographs of the area before and after cleanup. A 4 ft. to 6 ft. berm made of mine waste was placed on three sides to direct runoff to a collection pipe which diverted collected runoff to the mine water ponds. The berm and collection pipe can be seen in the photographs. The piles in the pre-cleanup photographs are tailings sands which were removed to the tailings impoundment.

As indicated on Figure 1, approximately 1.5 ft. of material was excavated initially from this area. The area sits on sandstone outcrops. The total area cleaned at this

location is approximately 171,000 square feet. Figures 3 and 4 are topographic maps which depict sandfill area No. 1. The sand storage pile occupied the area shown on the map by broken lines. Figure 3 identifies the locations and results of soils samples taken after the area was initially excavated. Additional selective excavation was conducted over the majority of the areas based on these results. As discussed before, as an conservative measure, United Nuclear used an excavation control criteria of 0.75 to determine where to conduct additional selective excavation. Figure 4 provides the uranium/radium ratios obtained soils sampling after selective excavation.

Tables III and IV contain the description of the sample location of the soils samples taken. It also contains the uranium and radium results from which the ratios were derived. The results indicate that all of the area was cleaned of byproduct material from tailings as all of the uranium/radium ratios were above the 0.035 verification criteria.

Sandfill Area No. 1 is sufficiently isolated from the remainder of the surface facilities at Northeast Church Rock mine that background radium values could be obtained. The area is located above the valley in which the surface facilities are located. A background site sufficiently upgradient from the area (as shown on Figure 3) so as to not be affected by its activity was sampled to determine radium background. Table II contains the results. Average background radium concentration at this location was 2.85 pCi/gm. The data contained in Table IV indicates that many of the locations were cleaned to below 5 pCi/g above background.

3.3 Sandfill Area No. 2

Sandfill area No. 2 is located approximately 225 feet south of Northeast Church Rock shaft No. 2 (see Figure 1). It is located at the head of the valley which contains the mine surface facilities. Its location allowed diversion of all runoff to the mine water ponds. Figures 5 contains photographs of the area prior to and after cleanup. The total area cleaned at sandfill area No. 2 was approximately 130,000 square feet. The area was excavated initially to a depth of approximately 1.5 ft as shown on Figure 1. Figure 6 contains the results of the soils analyses conducted after initial excavation. Based on these results the area was more selectively cleaned. Figure 7 provides the uranium/radium ratio analysis after additional selective cleanup. Tables V and VI contain the description of the location of the soils samples taken. It also contains the

uranium and radium results from which the ratios were derived. The results indicate that all of the area was cleaned of byproduct material from tailings as the uranium/radium ratios were above the 0.035 verification criteria.

Sandfill area No. 2 is located upgradient of all other Northeast Church Rock mine surface facilities. It was, therefore, possible to obtain a background radium sample for this area. Table II contains the results of background radium analysis for sandfill area No. 2. The average background is 1.3 pCi/g. The results indicate that many of the locations were cleaned to below 5 pCi/gm above background.

3.4 Sandfill Area No. 3 And Pond Muck Area

Sandfill area No. 3 and the Pond Muck Area are adjacent to each other as depicted in Figure 1. Figures 8 and 9 are photographs of these areas prior to and after clean.up. As shown on Figure 1, sandfill area No. 3 is located upgradient from the pond muck pile and mine water ponds 3A and 3. Runoff from both of these areas was captured in the mine water ponds.

Sandfill area No. 3 was used to store tailings sands, as well as, low grade ore. The pond muck pile was used to store all materials dredged from the mine water ponds. Therefore, there would be expected to be a mixture of byproduct and non-byproduct materials in this area. The larger volume by far, however, would have been non-byproduct material because of the larger volume of sediments produced from dewatering the mine versus the much smaller volume of sediments contributed by runoff through the sandfill areas.

Figure 1 shows that approximately 1.5 feet and 3.75 feet of material was excavated initially from sandfill area No. 3 and the pond muck area, respectively. The total area cleaned in these areas was 50,000 square feet at the sandfill area and 110,000 square feet at the pond muck area.

Figures 10 and 11 provide the results of the uranium/radium ratio results of soil sampling conducted in these areas after initial and selective excavation. Tables VII, VIII, IX, and X contain the description of the location of the soils samples taken. They also contain the uranium and radium results from which the ratios were derived. The results indicate that these areas were cleaned of byproduct material from tailings as all

of the uranium/radium ratios were above the 0.035 verification criteria. Because of the location of these areas it was not possible to produce representative radium background values of this area.

3.5 Pond 1 And Pond 2

Ponds 1 and 2 are located on top of a mesa southeast of NECR mine shaft No. 1 and west of sandfill area No. 1, as shown on Figure 1. Pond No. 1 was the first pond to receive the mine water as it was pumped from the mine. Pond No. 1 also received the runoff from sandfill area No. 1. Pond No. 2 was the second in the series to receive the water as it flowed through the ditch leading from pond No. 1. Figures 12 and 13 contain photographs of these two ponds before and after cleanup.

The largest volume of materials contained in the ponds was non-byproduct related. However, some small quantity of tailings byproduct material gathered in these ponds as a result of runoff. Figure 1 indicates that over seven feet of material was excavated initially from some areas of pond No. 1. Three feet was excavated initially from other areas of the pond. Approximately 2.5 feet was excavated initially from the ditch leading to Pond No. 2. The total area cleaned at these ponds was 125,000 square feet. The majority of this material was sediment from mine dewatering.

Figure 14 contains the uranium/radium ratios derived from samples taken in Ponds No. 1 and No. 2 after initial excavation. Figure 15 contains the uranium/radium ratios for soils analysis after selective excavation. Tables XI, XII, XIII and XIV contain the description of the location of the soils samples taken and the uranium and radium results from which the uranium/radium ratios were derived. The data indicate that the ponds were cleaned of byproduct material as all of the uranium radium ratios were above the 0.035 verification criteria. Because the ponds were used for the purpose of retaining mine water and collecting sandfill runoff and are located in the midst of the NECR mining activity that it was not possible to obtain representative background radium values.

3.6 Pond 3 And Pond 3A

Ponds 3 and 3A are located in the valley in a position downgradient from the pond muck pad and sandfill areas No. 2 and No. 3 (see Figure 1). They are the last in the

series of ponds to receive mine water and any sandfill area runoff. Figures 16 and 17 are photographs of these ponds prior to and after cleanup.

As with the other ponds the largest volume of materials contained in these ponds was non-byproduct related. Figure 1 indicates that approximately 4.3 feet of material was excavated initially from pond 3. Approximately 1.25 to 4.4 feet were excavated initially from pond 3A. Figure 18 shows the uranium/radium ratios at sampling locations in these ponds after initial excavation. Figure 19 shows the results of additional verification sampling. Tables XV, XVI, XVII and XVIII contain the description of the location of soils samples taken and the uranium and radium results from which the uranium/radium ratios were obtained. The data indicate that all byproduct related materials have been removed from the ponds as all the uranium/radium ratios were above the 0.035 verification criteria.

TABLE I

URANIUM/RADIUM RATIO
BYPRODUCT VERSUS NON-BYPRODUCT MATERIALS

SAMPLE TYPE	Radium-226 pCi/gm	Uranium pCi/gm	U/Ra Ratio
Mine Parking Lot	101.9±2.3	153.7	1.51
Ore Stock Pile Near Vent #7	83.1±2.2	112.7	1.36
Ore Stockpile #1 - Scale House	242.1±3.8	304	1.26
Ore Stockpile #2 - Scale House	376.8±4.8	502	1.33
Ore Pad Composite	191.0±4.80	323	1.69
Ore Lot #22	807.7±7.0	1246.6	1.54
Tailings Sample #1	104.0±2.8	3.90	0.04
Tailings Sample #2	120.0±3.0	4.17	0.03

TABLE II
BACKGROUND RADIUM IN SOIL

Sandfill No. 1 Background Sample	Radium-226 pCi/gm
@ 0.5 ft.	4.00±0.50
@ 1.0 ft.	1.70±0.30
@ 1.5 ft.	3.30±0.50
@ 2.0 ft.	2.40±0.40
Average	2.85
Sandfill No. 2 Background Sample	
@ 0.5 ft.	1.80±0.10
@ 1.0 ft.	1.30±0.10
@ 1.5 ft.	0.80±0.10
Average	1.30

TABLE III

Sandfill No. 1 Uranium/Radium Ratios
Soils Analysis After Initial Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
0.00'	14.2±1.00	2.40	0.17
100'	51.6±2.10	10.20	0.17
125'	56.2±0.84	17.60	0.31
200'	36.6±1.60	6.30	0.17
300'	17.4±1.10	3.70	0.21
400'	3.7±0.50	1.60	0.43
500' @ 0.5'	77.4±2.40	5.60	0.07
500' @ 1.0'	70.1±1.10	12.40	0.18
500' @ 1.5'	63.9±1.18	12.10	0.19
500' @ 2.0'	58.1±0.91	27.60	0.48
East Line			
100'-100'	29.1±1.50	10.3	0.35
100'-242'	71.3±2.60	11.3	0.16
133'-228'	57.9±2.10	7.5	0.13
166'-218'	95.4±2.60	4.9	0.05
199'-205'	77.0±2.60	135.0	1.75
200'-100'	57.6±1.90	10.0	0.17
233'-185'	166.0±3.80	6.3	0.04
300'-50'	36.2±1.50	6.9	0.19
300'-100'	15.9±1.10	0.8	0.05
400'-50'	56.9±2.10	11.5	0.20
500'-50'	18.4±1.20	3.9	0.21
570'-32'	5.72±0.36	7.91	1.38

TABLE III (continued)

Sandfill No. 1 Uranium/Radium Ratios
Soils Analysis After Initial Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
West Line			
0.00-50'	79.9±2.20	17.1	0.21
200'-50'	13.0±1.00	3.2	0.25
300'-50'	7.2±0.70	2.6	0.36
400'-50'	9.8±0.90	3.9	0.40
500'-50'	152.4±3.10	16.5	0.11

TABLE IV

Sandfill . 1 Soils Analysis Uranium/Radium Ratios
After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
000'@0.5'	0.97±0.16	36.2	37.32
0.00'@1.0'	0.98±0.16	17.2	17.55
0.00'@1.5'	1.13±0.15	9.33	8.26
0.00'@2.0'	0.83±0.15	17.9	21.57
125'*	1.70±0.20	0.7	0.41
375'*	1.32±0.18	1.69	1.28
500'@0.5'	68.7±0.90	40.4	0.59
500'@1.0'	64.4±0.90	46.4	0.72
East Line			
100'-242'	4.99±0.33	1.74	0.35
125'-100'*	7.74±0.38	2.60	0.34
125'-200'	1.99±0.21	1.10	0.55
133'-228'	9.80±0.10	2.37	0.24
166'-218'	15.70±0.57	4.31	0.27
199'-205'	20.90±0.20	3.47	0.17
200'-100'	13.1±1.00	9.90	0.76
233'-185'	8.70±0.10	1.87	0.21
250'-100'@0.5'*	1.25±0.14	0.66	0.53
250'-100'@1.0'	1.13±0.15	0.45	0.40
250'-100'@1.5'	0.77±0.11	0.55	0.71
250'-100'@2.0'	0.95±0.13	0.68	0.72
375'-50'*	1.05±0.18	0.76	0.72
500'-50'@0.5'	98.8±1.00	40.40	0.41
500'-50'@1.0'	77.8±0.90	46.10	0.59
570'-32'**	5.72±0.36	7.91	1.38

TABLE IV (continued)
Sandfill No. 1 Soils Analysis Uranium/Radium Ratios
After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
West Line			
125'-50'*	5.84±0.33	3.10	0.53
250'-50'@0.5'*	0.64±0.12	0.48	0.75
250'-50'@1.0'	0.61±0.10	0.46	0.75
250'-50'@1.5'	0.54±0.11	0.59	1.09
250'-50'@2.0'	0.67±0.14	0.38	0.57
300'-50'	1.8±0.40	1.83	1.02
375'-50'*	2.63±0.23	13.60	5.17
500'-50'@0.5'	98.1±1.0	14.80	0.15
500'-50'@1.0'	90.7±1.0	12.60	0.14

*These samples were taken at locations er cleanup generally within 75 ft. of the initial excavation sample locations they replace.

**This data is the same as that shown on Table III, indicating that additional excavation was not conducted at this location.

TABLE V

Sandfill No. 2 Soils Analysis Uranium/Radium Ratios

After Initial Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
0.00'@0.5'	105.7±2.7	13.8	0.13
0.00'@1.0'	124.0±2.5	12.9	0.10
0.00'@1.5'	136.0±3.1	15.6	0.11
0.00'@2.0'	100.0±2.8	21.9	0.22
100'	95.9±2.4	55.5	0.58
200'	109.7±2.8	129.8	1.18
300'@0.5'	6.3±0.6	22.9	3.63
300'@1.0'	18.6±1.1	29.3	1.58
300'@1.5'	2.9±0.5	23.2	8.00
300'@2.0'	3.3±0.5	19.5	5.91
400'	41.4±1.7	21.7	0.52
500'	68.4±2.1	18.8	0.27
600'	143.8±2.9	49.5	0.34
640'	196.1±3.4	20.1	0.10
East Line			
0.00'-50'	35.7±1.6	80.3	2.25
0.00'-100'	27.6±1.3	30.7	1.11
100'-50'@0.5'	149.3±3.1	133.2	0.89
100'-50'@1.0'	58.9±2.1	48.8	0.83
100'-50'@1.5'	40.8±1.7	46.3	1.13
100'-50'@2.0'	69.0±2.2	46.3	0.67
100'-75'	419.1±4.1	140.0	0.33
200'-50'	164.4±3.1	218.5	1.33
200'-75'	154.9±3.2	232.2	1.50

TABLE V (continued)

Sandfill No. 2 Soils Analysis Uranium/Radium Ratios

After Ir l Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
East Line			
300'-50'	63.3±2.1	32.4	0.51
300'-75'	160.4±3.4	97.3	0.61
400'-50'	9.7±0.8	9.2	0.95
400'-75'	106.7±2.7	12.8	0.12
500'-50'	57.4±2.1	25.5	0.44
500'-75'	28.9±1.4	23.5	0.81
500'-100'@0.5'	52.6±3.1	8.49	0.16
500'-100'@1.0'	1.3±0.3	1.01	0.78
500'-100'@1.5'	1.5±0.3	1.16	0.77
500'-100'@2.0'	1.7±0.3	1.19	0.70
600'-1.5'	104.2±2.7	16.2	0.16
West Line			
0.00'-50'	35.8±1.6	54.7	1.53
0.00'-100'	109.5±2.6	58.1	0.53
100'-50'@0.5'	74.5±2.3	87.1	1.17
100'-50'@1.0'	47.6±1.9	10.7	0.22
100'-50'@1.5'	62.8±2.1	19.5	0.31
100'-75'	180.1±3.9	20.1	0.11
200'-5	294.6±4.7	529.4	1.80
200'-75	50.5±2.1	34.2	0.68
300'-75'	41.7±1.9	11.9	0.29
400'-50'	40.2±1.8	22.0	0.55
400'-75'	74.0±2.3	34.2	0.46
500'-50'	23.1±1.4	10.4	0.45
500'-75'	233.2±4.3	29.0	0.12
600'-50'	106.7±2.7	34.2	0.32
600'-75'	158.1±3.2	19.5	0.12

TABLE VI

Sandfill No. 2 Soils Analysis Uranium/Radium Ratios
After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
0.00'@0.5'	9.0±0.30	33.1	3.68
0.00'@1.0'	14.2±0.46	33.1	2.33
0.00'@1.5'	7.44±0.30	23.8	3.20
0.00'@2.0'	4.83±0.24	23.1	4.78
100'**	95.9±2.4	55.5	0.58
200'**	109.7±2.8	129.8	1.18
300'@0.5'**	6.3±0.6	22.9	3.63
300'@1.0'**	18.6±[illegible].1	29.3	1.58
300'@1.5'**	2.9±0.5	23.2	8.00
300'@2.0'**	3.3±0.5	19.5	5.91
375'	43.5±0.8	42.7	0.98
400'@0.5'	1.1±0.11	2.19	1.99
400'@1.0'	1.08±0.11	1.81	1.68
400'@1.5'	0.77±0.09	1.43	1.86
400'@2.0'	0.85±0.09	2.00	2.35
540'*	4.30±0.2	25.8	6.00
640'	12.4±0.7	5.15	0.42
East Line			
0.00'-50'**	35.7±1.6	80.3	2.25
0.00'-100'**	27.6±1.3	30.7	1.11
75'-50'*	6.21±0.24	35.7	5.75
100'-75'	26.4±2.00	26.4	1.00
200'-50'**	164.4±3.10	218.5	1.33
200'-75'**	154.9±3.2	232.2	1.50

*These samples were taken at locations after cleanup generally with 75 ft. of the initial excavation samples locations they replace.

**This data is the same as that shown on Table V, indicating that additional excavation was not conducted at this location.

TABLE VI (continued)
Sandfill No. 2 Soils Analysis Uranium/Radium Ratios
After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
East Line			
375'-50'*	1.3±0.11	4.94	3.80
400'-75'	2.7±0.40	6.50	2.41
450'-50'@0.5'*	1.8±0.3	5.81	3.23
450'-50'@1.0'	0.9±0.2	5.28	5.87
450'-50'@1.5'	1.1±0.2	2.24	2.04
450'-50'@2.0'	0.8±0.2	3.57	4.46
500'-50'	25.6±0.6	9.5	0.37
500'-100'@0.5'**	52.6±3.1	8.49	0.16
500'-100'@1.0'**	1.3±0.3	1.01	0.78
500'-100'@1.5'**	1.5±0.3	1.16	0.77
500'-100'@2.0'**	1.7±0.3	1.19	0.70
West Line			
0.00'-50'**	35.8±1.6	54.7	1.53
0.00'-100'**	109.5±2.6	58.1	0.53
75'-50'*	298.0±1.6	1,177.0	3.95
100'-75'@0.5'	66.0±1.9	84.6	1.28
100'-75'@1.0'	72.6±3.7	79.3	1.09
100'-75'@1.5'	36.0±2.4	38.3	1.06
100'-75'@2.0'	62.2±3.4	75.7	1.22
200'-50'	294.6±4.7	529.4	1.80
200'-75'	50.5±2.1	34.2	0.68
375'-50'*	4.22±0.2	12.4	2.94
500'-75'	19.3±0.2	19.6	1.02

*These samples were taken at locations after cleanup generally with 75 ft. of the initial excavation samples locations they replace.

**This data is the same as that shown on Table V, indicating that additional excavation was not conducted at this location.

TABLE VII

Sandfill No. 3 Soils Analysis Uranium/Radium Ratios
After Initial Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
-50'@0.5'	121.0±1.1	84.0	0.69
-50'@1.0'	101.0±1.0	99.6	0.99
-50'@1.5'	51.1±0.75	99.6	1.95
-50'@2.0'	63.4±1.6	86.0	1.36
0.00'	50.4±1.6	58.1	1.15
100'@0.5'	61.7±3.1	46.3	0.75
100'@1.0'	52.8±3.1	31.7	0.60
100'@1.5'	58.3±3.3	39.6	0.68
100'@2.0'	53.6±2.9	54.2	1.01
125'	51.2±1.8	26.4	0.52
East Line			
0.00'-50'	29.5±1.4	20.1	0.68
0.00'-100'	118.8±3.0	39.6	0.33
75'-50'	52.9±2.5	48.4	0.91
100'-50'	71.0±2.1	37.0	0.52
100'-100'	199.6±3.6	27.8	0.14
West Line			
0.00'-50'	77.9±1.9	52.9	0.68
75'-50'	50.9±2.5	45.7	0.90
100'-40'	23.6±1.3	15.6	0.66

TABLE VIII

Sandfill No. 3 Soils Analysis Uranium/Radium Ratios
After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
-50'@0.5'**	121.0±1.1	84.0	0.69
-50'@1.0'**	101.0±1.0	99.6	0.99
-50'@1.5'**	51.1±0.75	99.6	1.95
-50'@2.0'**	63.4±0.88	86.0	1.36
0.00'	105.0±3.5	102.0	0.97
100'	61.7±2.7	108.0	1.75
125'@0.5'	73.6±0.88	137.5	1.87
125'@1.0'	39.7±0.62	145.1	3.65
125'@1.5'	24.4±0.5	188.4	7.72
125'@2.0'	18.3±0.44	66.2	3.62
East Line			
-100'-50'	72.3±2.9	121.0	1.67
0.00'-50'*	19.7±0.49	248.9	12.63
75'-50'	28.9±0.52	211.6	7.32
100'-100'	35.0±2.10	12.6	0.42
West Line			
-100'-50'	116.0±3.4	109.0	0.94
0.00'-50'	129.0±1.3	167.5	1.30
75'-50'	44.8±0.67	52.1	1.16
100'-40'	37.2±1.9	29.6	0.80

*These samples were taken at locations after cleanup generally within 75 ft. of the initial excavation samples locations they replace.

**This data is the same as that shown on Table VII, indicating that additional excavation was not conducted at this location.

TABLE IX (continued)
Pond Muck Pad Soils Analysis Uranium/Radium Ratios
After Initial Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
West Line			
250'-50'	335.7±4.8	307.4	0.92
250'-100'	191.1±3.5	251.1	1.31
300'-50'	140.3±2.9	204.9	1.46
300'-100'	219.6±4.0	251.0	1.14
400'-50'	150.7±3.3	211.7	1.40
400'-100'@0.5'	106.2±2.8	100.7	0.95
400'-100'@1.0'	29.1±1.6	117.0	4.02
400'-100'@1.5'	13.6±1.1	73.1	5.38
400'-100'@2.0'	4.6±0.7	87.7	19.07
500'-50'	79.7±2.3	53.4	0.67
500'-100'	105.9±2.7	71.7	0.68
600'-50'	155.9±3.2	56.3	0.36
600'-100'@0.5'	205.8±3.9	88.8	0.43
600'-100'@1.0'	221.0±3.7	256.0	1.16
600'-100'@1.5'	217.0±3.1	317.0	1.46
600'-100'@2.0'	231.0±3.9	329.0	1.42
600'-150'	61.9±2.1	129.8	2.1
700'-50'	27.0±1.4	15.4	0.57
700'-100'	90.9±2.5	73.4	0.81
700'-150'	107.3±2.8	109.3	1.02
750'-150'	158.3±3.4	187.9	1.19

TABLE IX

Pond Muck Pad Soils Analysis Uranium/Radium Ratios

After Initial Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
250'	479.0±5.7	785.5	1.64
300'@0.5'	146.9±3.2	3927.0	26.73
300'@1.0'	138.0±3.3	185.0	1.34
300'@1.5'	165.0±3.3	146.0	0.88
300'@2.0'	150.0±3.1	158.0	1.05
400'	213.4±3.8	136.6	0.64
500'@0.5'	249.0±4.2	273.2	1.10
500'@1.0'	225.0±3.9	197.0	0.87
500'@1.5'	158.0±3.6	143.0	0.91
600'	25.1±1.3	12.5	0.50
700'	32.9±1.5	15.2	0.46
750'	44.1±1.7	18.6	0.42
East Line			
250'-50'	18.1±1.1	37.6	2.09
300'-50'	167.5±3.4	478.1	2.85
400'-50'@0.5'	163.7±3.3	341.5	2.09
400'-50'@1.0'	86.0±2.4	70.7	0.82
400'-50'@1.5'	142.0±3.3	85.3	0.60
400'-50'@2.0'	34.2±1.7	58.5	1.71
500'-30'	66.5±2.2	99.0	1.49
500'-50'	26.5±1.4	24.9	0.94
600'-50'	19.6±1.2	22.5	1.15

TABLE X

Pond Muck Pad Soils Analysis Uranium/Radium Ratios

After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
250'	479.0±5.7	785.5	1.64
300'@0.5'	146.9±3.2	3927.0	26.73
300'@1.0'	138.0±3.3	185.0	1.34
300'@1.5'	165.0±3.3	146.0	0.88
300'@2.0'	150.0±3.1	158.0	1.05
400'@0.5'*	126.0±2.8	177.0	1.40
400'@1.0'	78.0±2.5	113.0	1.45
400'@1.5'	80.5±2.5	110.0	1.37
400'@2.0'	96.1±2.7	140.0	1.46
500'@0.5'	249.0±4.2	273.2	1.10
500'@1.0'	227.0±3.9	197.0	0.87
500'@1.5'	158.0±3.6	143.0	0.91
East Line			
250'-50'	18.1±1.1	37.6	2.09
300'-50'	219.0±4.3	377.0	1.72
400'-50'@0.5'	163.7±3.3	341.5	2.09
400'-50'@1.0'	86.0±2.4	70.7	0.82
400'-50'@1.5'	142.0±3.3	85.3	0.60
400'-50'@2.0'	34.2±1.7	58.5	1.71
500'-30'	66.0±2.2	99.0	1.49
500'-50'	26.5±1.4	24.9	0.94
600'-50'	19.6±1.2	22.5	1.15

TABLE X (continued)

Pond Muck Pad Soils Analysis Uranium/Radium Ratios

After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
West Line			
250'-50'*	34.7±2.3	67.4	1.94
250'-100'	191.1±3.5	251.1	1.31
300'-50'*	106.0±3.0	223.0	2.10
300'-100'*	219.6±4.0	251.0	1.14
400'-50'	150.7±3.3	211.7	1.40
400'-100'@0.5'	106.2±2.8	100.7	0.95
400'-100'@1.0'	29.1±1.6	117.0	4.02
400'-100'@1.5'	13.6±1.1	73.1	5.38
400'-100'@2.0	4.6±0.7	87.7	19.07
500'-50'**	58.2±2.0	63.2	1.09
550'-100'	103.0±2.7	171.0	1.66
600'-50'*	183.0±5.0	182.0	0.99
600'-100'@0.5'*	121.0±3.1	323.0	2.67
600'-100'@1.0'	107.0±3.0	456.0	4.26
600'-100'@1.5'	104.0±3.0	283.0	2.72
600'-100'@2.0'	109.0±3.1	377.0	3.46
600'-150'	61.9±2.1	129.8	2.1
700'-50'	27.0±1.4	15.4	0.57
700'-100'	90.9±2.5	73.4	0.81
700'-150'	107.3±2.8	109.3	1.02
750'-150'	158.3±3.4	187.9	1.19

*Only area(s) requiring selective excavation.

**This sample was taken after cleanup to replace location 500'-50' east.

TABLE XII

Pond No. 1 Soils Analysis Uranium/Radium Ratios

After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
50'*	27.0±2.3	1322.0	48.96
100'	42.8±2.9	383.0	8.95
125'@0.5'***	717.0±2.2	1092.0	1.52
125'@1.0'	799.0±2.3	1265.0	1.58
125'@1.5'	549.0±2.1	1064.0	1.94
125'@2.0'	581.0±2.0	1380.0	2.38
200'	46.1±2.9	264.0	5.73
400'@0.5'	307.0±5.3	409.0	1.33
400'@1.0'	108.0±3.1	121.0	1.12
400'@1.5'	289.0±5.2	377.0	1.30
400'@2.0'	206.0±4.2	239.0	1.16
East Line			
100'-50'**	414.6±5.8	658.0	1.59
100'-75'@0.5'***	464.0±6.8	672.0	1.45
100'-75'@1.0'	208.0±4.5	336.0	1.62
100'-75'@1.5	231.0±4.8	376.0	1.63
100'-75'@2.0'	10.5±1.0	14.9	1.42
200'-50'@0.5'	379.0±6.2	403.0	1.06
200'-50'@1.0'	399.0±6.4	457.0	1.15
200'-50'@1.5'	406.0±6.4	591.0	1.46
200'-50'@2.0'	377.0±6.2	565.0	1.50
300'-50'**	367.1±5.2	424.0	1.16
300'-85'**	303.2±5.1	395.0	1.30
400'-50'**	291.6±4.4	468.0	2.13

*This sample was taken after cleanup to replace Center Line-25'.

**This data is the same as that shown on Table XI, indicating that additional excavation was not conducted at this location.

***Extra samples at same or new location.

TABLE XIV (continued)
Pond No. 2 Soils Analysis Uranium/Radium Ratios
After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
West Line			
100'-20'@2.0'	73.2±2.7	112.0	1.53
100'-30'**	14.1±0.4	34.5	2.45
150'-30'	347.7±4.8	546.4	1.57
200'-15'	85.0±2.1	199.8	2.35

*Only area(s) requiring additional excavation.

**Extra sample at the same or new location.

TABLE XI

Pond No. 1 Soils Analysis Uranium/Radium Ratios

After Initial Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
25'	90.5±2.6	41.0	0.45
100'	433.3±6.0	263.0	0.61
200'	713.3±7.7	644.0	0.90
400'@0.5'	273.3±4.9	417.0	1.53
400'@1.0'	129.0±3.6	145.0	1.12
400'@1.5'	33.5±1.8	18.5	0.55
400'@2.0'	129.0±3.6	92.7	0.72
East Line			
100'-50'	414.6±5.8	658.0	1.59
200'-50'	68.1±2.4	43.9	0.65
300'-50'	367.1±5.2	424.0	1.16
300'-85'	303.2±5.1	395.0	1.30
400'-50'	219.6±4.4	468.0	2.13
West Line			
100'-50'	65.9±2.4	129.0	1.96
100'-100'	163.2±3.7	170.0	1.04
100'-150'	24.9±1.4	26.4	1.06
100'-200'	107.4±3.1	263.0	2.45
200'-50'	381.2±5.9	541.0	1.42
200'-85'	55.1±2.1	49.8	0.90
200'-100'	378.5±5.8	629.0	1.66
300'-50'	177.3±3.5	196.0	1.11
300'-80'	69.7±2.2	71.7	1.03
400'-50'	107.7±3.0	99.5	0.92
125'-226'	677.6±7.1	476.0	0.70
125'-340'	51.5±1.8	63.4	1.23

TABLE XV

Pond No. 3 Soils Analysis Uranium/Radium Ratios
After Initial Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
50'	52.5±2.1	1887.0	35.94
100'	54.1±2.0	4045.0	74.77
100'@0.5'	932.0±8.8	968.0	1.04
100'@1.0'	405.0±5.8	430.0	1.06
100'@1.5'	314.0±5.6	169.0	0.54
100'@2.0'	118.0±3.6	145.0	1.23
150'	677.2±7.2	687.3	1.01
East Line			
50'-25'	21.9±1.3	38.3	1.75
75'-25'@0.5'	52.7±2.4	3226.0	61.21
75'-25'@1.0'	88.9±3.1	2070.0	23.28
75'-25'@1.5'	132.0±3.2	597.0	4.52
75'-25'@2.0'	106.0±2.9	2823.0	26.63
100'-25'	384.3±5.0	422.9	1.10
150'-25'	831.8±8.0	1110.2	1.33
West Line			
50'-50'	151.9±3.6	1401.0	9.22
50'-75'	52.6±2.1	370.0	7.04
100'-50'	918.0±7.7	1136.6	1.24
100'-75'	24.8±1.3	89.8	3.62
150'-25'	44.2±1.9	195.6	4.43

TABLE XVI

Pond No. 3 Soils Analysis Uranium/Radium Ratios

After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
50'@0.5'	35.0±1.9	80.7	2.31
50'@1.0'	91.3±3.0	171.0	1.87
50'@1.5'	101.0±3.3	121.0	1.20
50'@2.0'	2.8±0.5	39.0	13.93
100'@0.5'*	879.0±7.9	1163.0	1.32
100'@1.0'	452.0±6.4	503.0	1.11
100'@1.5'	315.0±5.4	487.0	1.55
100'@2.0'	421.0±6.2	754.0	1.79
150'	677.2±7.2	687.3	1.01
East Line			
50'-10'**	56.1±.74	741.0	13.21
50'-25'	21.9±1.3	38.3	1.75
65'-20'@0.5'**	44.7±0.67	2413.0	53.98
65'-20'@1.0'	33.6±0.58	2275.0	67.71
65'-20'@1.5'	68.7±0.83	689.0	10.03
65'-20'@2.0'	110.7±1.05	310.0	2.80
75'-25'@0.5'**	52.7±2.4	3226.0	61.21
75'-25'@1.0'	88.9±3.1	2070.0	23.28
75'-25'@1.5'	132.0±3.2	597.0	4.52
75'25'@2.0'	106.0±2.9	2823.0	26.63
95'-15'**	130.9±1.13	827.0	6.32

TABLE XVI (continued)
Pond No. 3 Soils Analysis Uranium/Radium Ratios
After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
West Line			
50'-50'	151.9±3.6	1401.0	9.22
50'-75'	52.6±2.1	370.1	7.04
75'-30'@0.5'**	102.0±2.8	101.0	0.99
75'-30'@1.0'	1.1±0.3	13.7	12.45
75'-30'@1.5'	1.7±0.3	5.11	3.01
75'-30'@2.0'	2.4±0.4	6.69	2.79
100'-50'	918.0±7.7	1136.6	1.24
100'-75'	24.8±1.3	89.8	3.62
150'-25'	44.2±1.9	195.6	4.43

*Only area(s) requiring additional excavation.

**Extra sample at the same or new location.

TABLE XVII

Pond No. 3A Soils Analysis Uranium/Radium Ratios
After Initial Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
50'	43.9±2.3	2965.0	67.54
100'	42.5±2.2	872.0	20.52
200'@0.5'	46.2±2.3	1352.0	29.26
200'@1.0'	31.2±1.7	232.0	7.44
200'@1.5'	17.2±1.3	117.0	6.80
200'@2.0'	42.0±4.2	244.0	5.81
300'	11.9±1.2	39.2	3.29
400'@0.5'	1.3±0.4	52.4	40.31
400'@1.0'	1.2±0.3	48.8	40.67
400'@1.5'	0.9±0.3	54.1	50.11
400'@2.0'	0.8±0.2	45.1	56.38
500'	63.8±2.7	260.0	5.82
600'@0.5'	76.4±3.0	480.0	6.28
600'@1.0'	46.3±2.1	134.0	2.89
600'@1.5'	21.9±1.5	31.7	1.45
600'@2.0'	20.9±1.3	28.0	1.34
700'	18.9±1.8	85.0	4.50
East Line			
100'-50'	41.5±2.3	25.7	0.62
200'-50'	20.5±1.6	153.0	7.46
300'-50'	16.7±1.5	91.6	5.49
300'-75'	19.6±1.6	157.0	8.01
400'-50'	17.3±1.5	54.5	3.15
500'-50'	53.9±2.6	447.0	8.29

TABLE XVII (continued)

Pond No. 3A Soils Analysis Uranium/Radium Ratios

After Initial Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
East Line			
500'-75'	61.0±2.8	266.0	4.36
600'-50'	35.2±2.5	25.1	0.71
700'-50'	12.4±0.9	30.2	2.44
West Line			
50'-75'	37.2±2.1	994.0	26.72
100'-75'	6.2±0.8	45.8	7.39
200'-75'	7.4±0.9	25.3	3.42
300'-75'	17.9±1.5	131.0	7.32
400'-75'	2.1±0.5	17.0	8.10
500'-100'	40.2±2.2	414.0	10.30
600'-100'@0.5'	17.2±1.4	192.0	11.16
600'-100'@1.0'	22.9±1.5	87.7	3.83
600'-100'@1.5'	2.8±0.4	26.8	9.57
600'-100'@2.0'	2.9±0.5	26.8	9.24
600'-200'	54.5±2.6	1262.0	23.16
700'-100'	19.3±1.6	255.0	5.18
700'-200'	40.3±2.2	414.0	10.27

TABLE XVIII

Pond No. 3A Soils Analysis Uranium/Radium Ratios
After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
Centerline			
20'*	28.9±1.6	151.0	5.22
50'**	10.7±0.9	50.4	4.71
100'**	7.6±0.8	37.6	4.95
200'@0.5'	46.2±2.3	1352.0	29.26
200'@1.0'	31.2±1.7	232.0	7.44
200'@1.5'	17.2±1.3	117.0	6.80
200'@2.0	42.0±4.2	244.0	5.81
300'	11.9±1.2	39.2	3.29
400'@0.5'	1.3±0.4	52.4	40.31
400'@1.0'	1.2±0.3	48.8	40.67
400'@1.5'	0.9±0.3	45.1	50.11
400'@2.0'	0.8±0.2	45.1	56.38
500'	63.8±2.7	260.0	5.82
600'@0.5'	76.4±3.0	480.0	6.28
600'@1.0'	46.3±2.1	134.0	2 89
600'@1.5'	21.9±1.5	31.7	1.45
600'@2.0'	20.9±1.3	28.0	1.34
700'	18.9±1.8	85.0	4.50
East Line			
100'-50'	41.5±2.3	25.7	0.62
200'-50'	20.5±1.6	153.0	7.46
300'-50'	16.7±1.5	91.6	5.49
300'-75'	19.6±1.6	159.0	8.01
400'-50'	17.3±1.5	54.5	3.15
500'-50'	53.9±2.6	447.0	8.29

TABLE XVIII (continued)
Pond No. 3A Soils Analysis Uranium/Radium Ratios
After Final Excavation

Sample Location	Radium-226 (pCi/gm)	Uranium (pCi/gm)	U/Ra Ratio
East Line			
500'-75'	61.0±2.8	266.0	4.36
600'-50'	35.2±2.5	25.1	0.71
700'-50'	12.4±0.9	30.2	2.44
West Line			
50'-75'	37.2±2.1	994.0	26.72
100'-75'	6.2±0.8	45.8	7.39
200'-75'	7.4±0.9	25.3	3.42
300'-75'	17.9±1.5	131.0	7.32
400'-75'	2.1±0.5	17.0	8.10
500'-100'	40.2±2.2	414.0	10.30
600'-100'@0.5'	17.2±1.4	192.0	11.16
600'-100'@1.0'	22.9±1.5	87.7	3.83
600'-100'@1.5'	2.8±0.4	26.8	9.57
600'-100'@2.0'	2.9±0.5	26.8	9.24
600'-200'	54.5±2.6	1262.0	23.16
700'-100'	19.3±1.6	255.0	5.18
700'-200'	40.3±2.2	414.0	10.27

*Only area(s) requiring additional excavation.

**Extra sample at the same or new location.

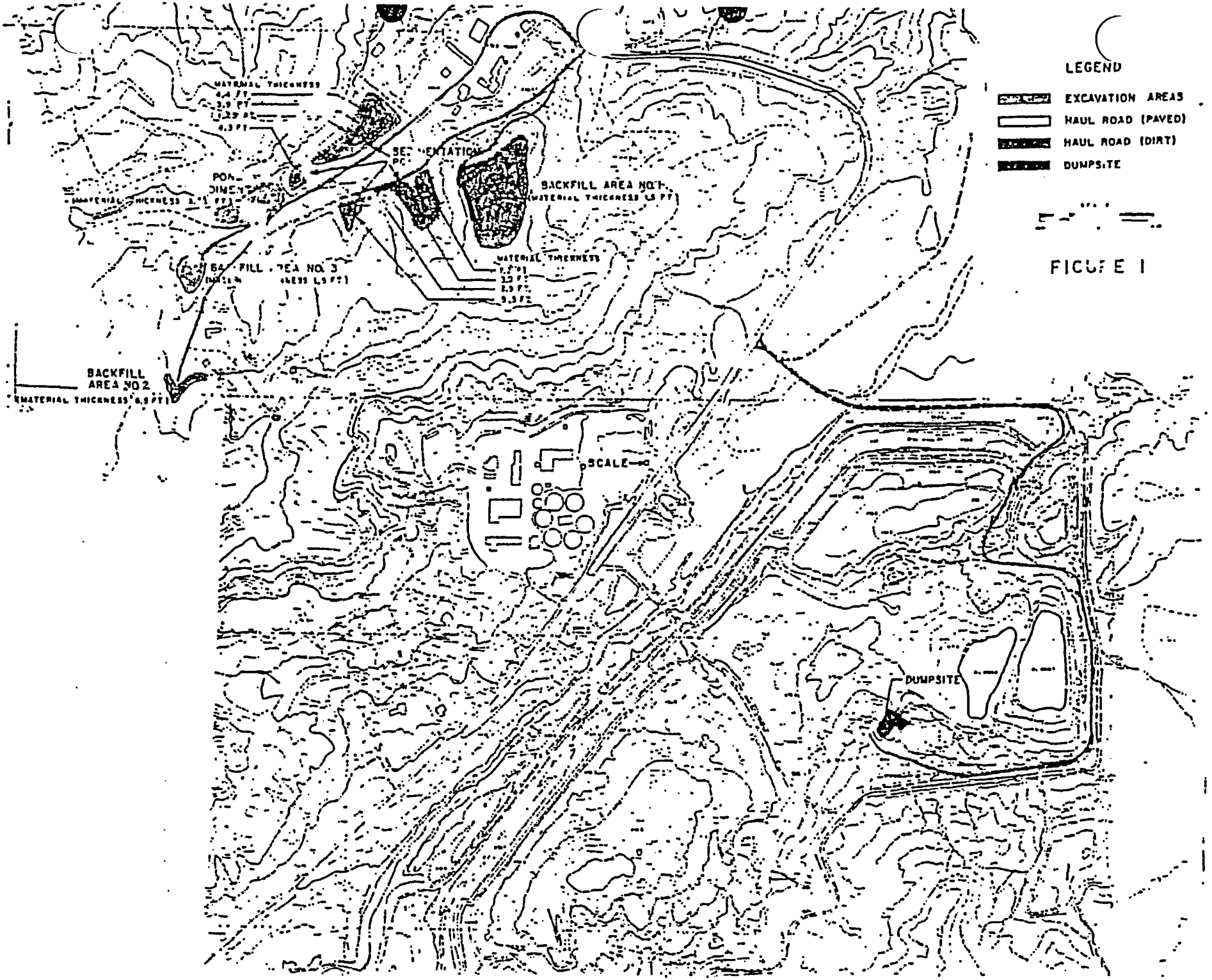
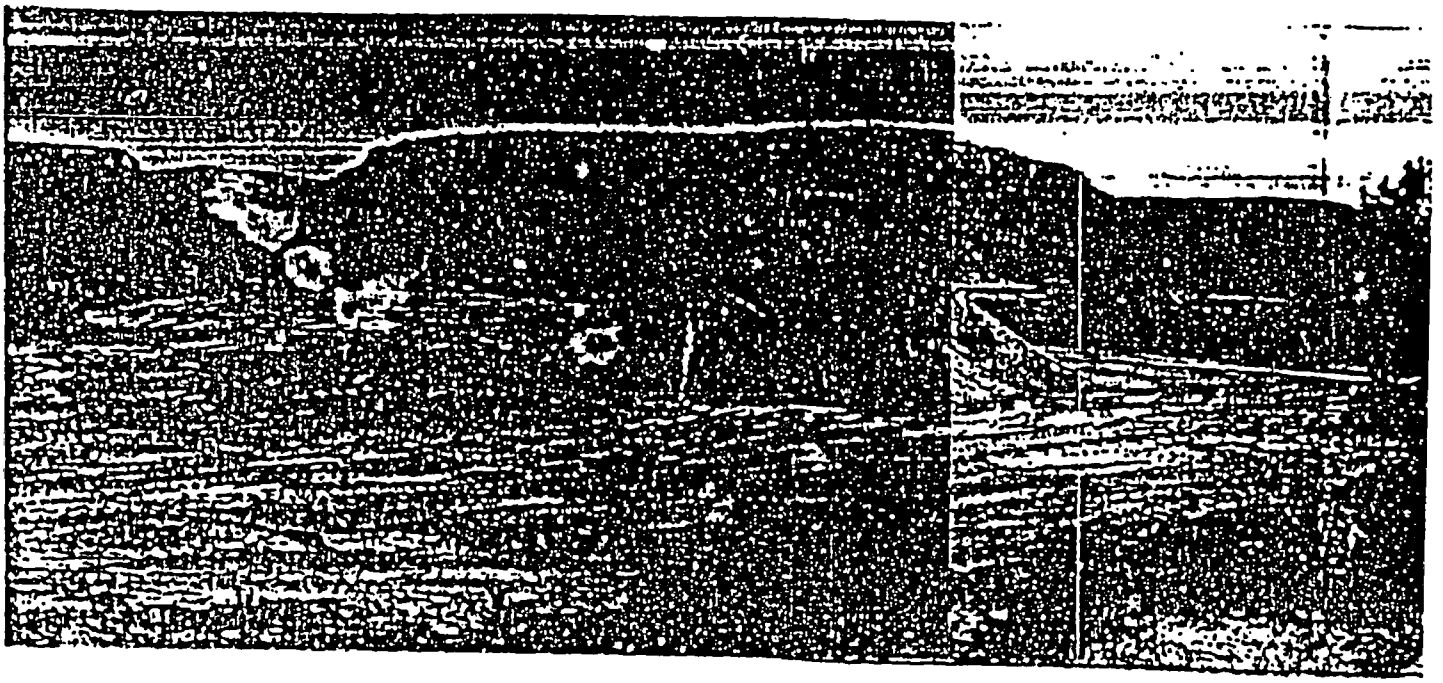
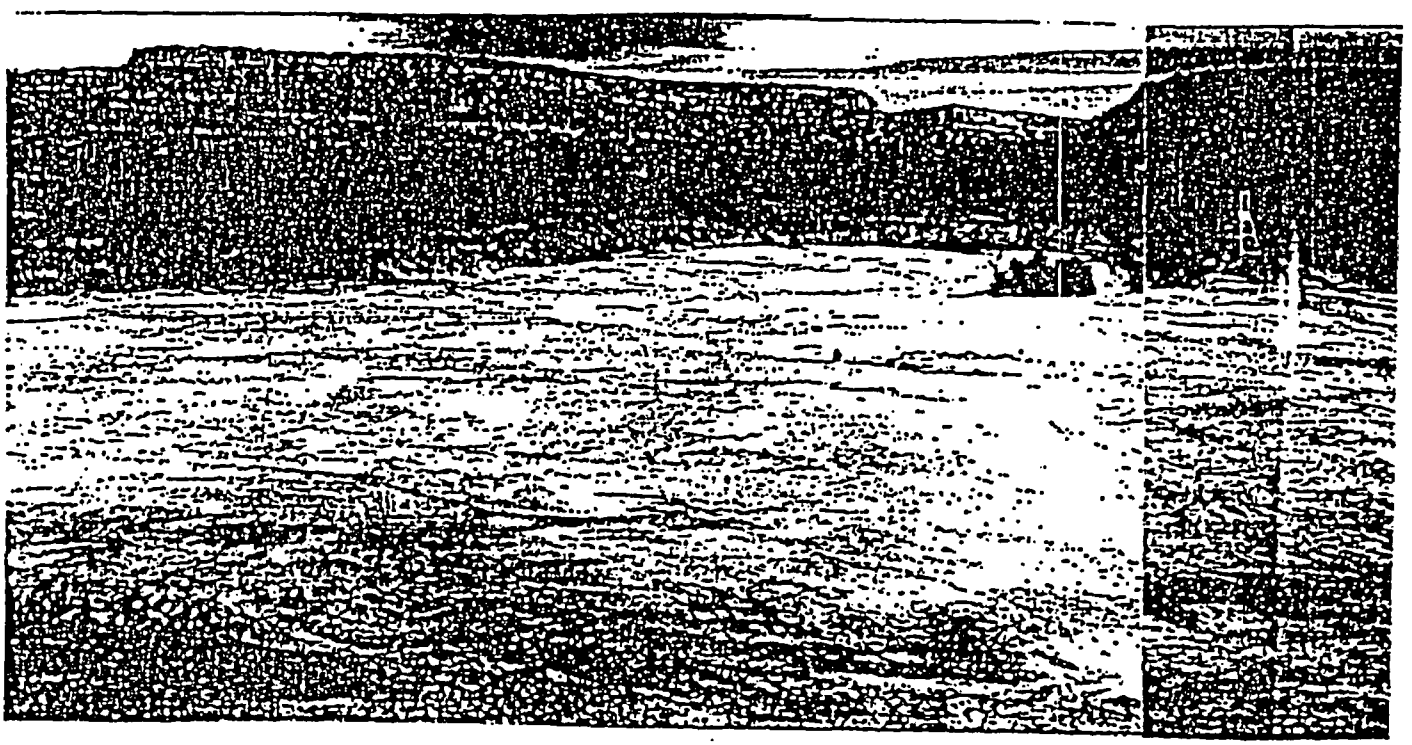

LEGEND
EXCAVATION AREAS
HAUL ROAD (PAVED)
HAUL ROAD (DIRT)
DUMPSITE
BACKFILL AREA NO 1
BACKFILL AREA NO 2
BACKFILL AREA NO 3
SCALE
DUMPSITE

FIGURE 1

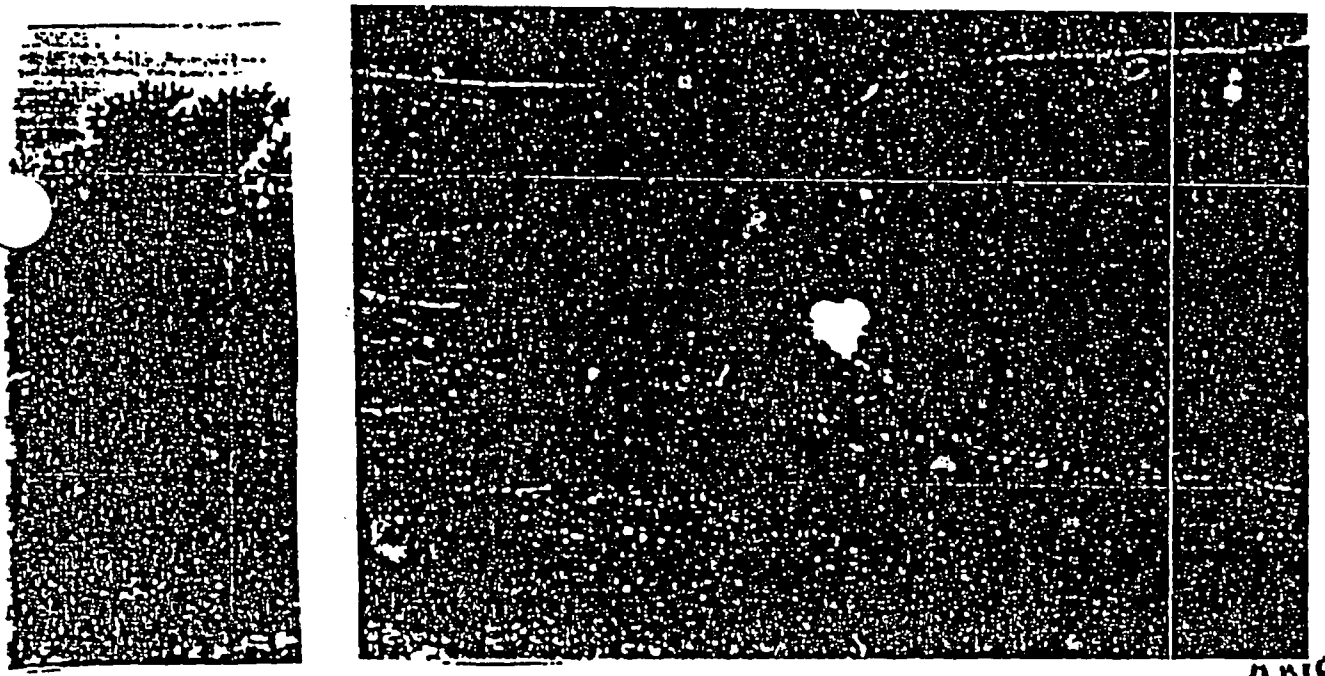


Sandfill #1 area - west yard pre-cleanup.

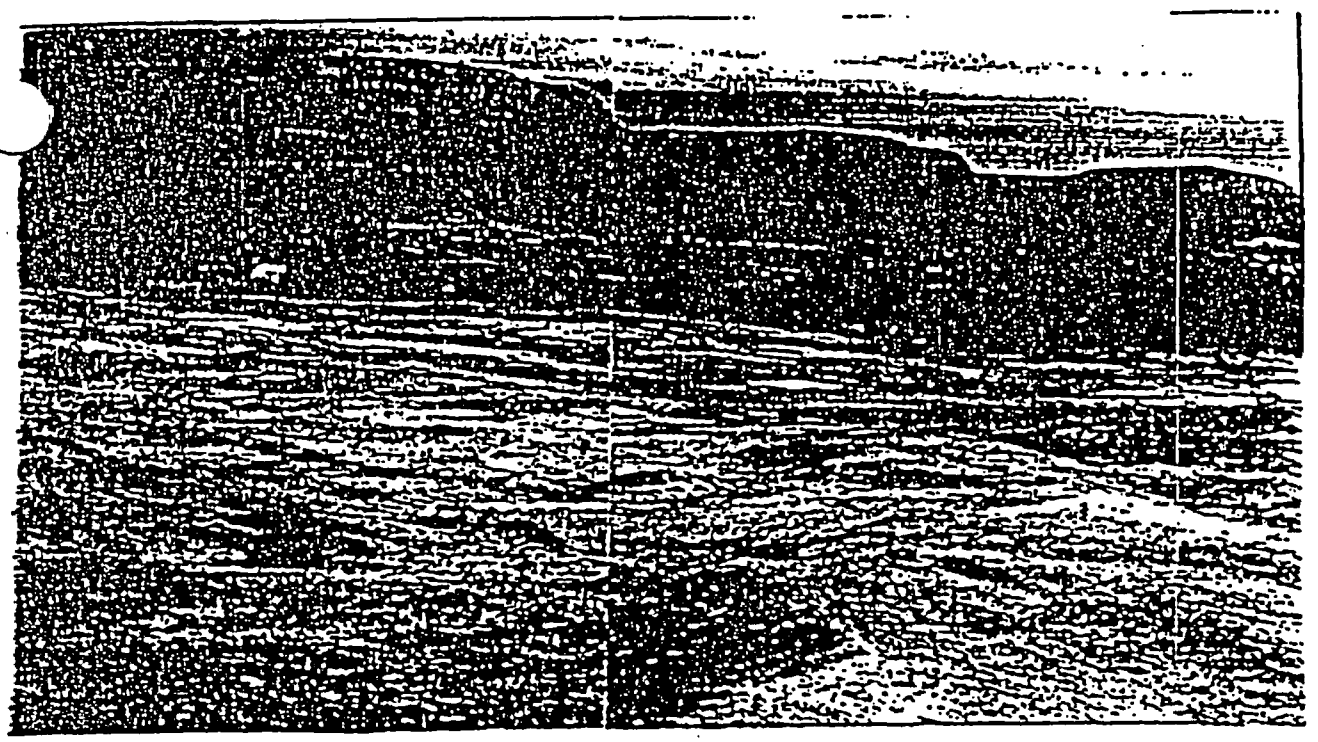


Sandfill #1 - ertire yard are

Figure 2

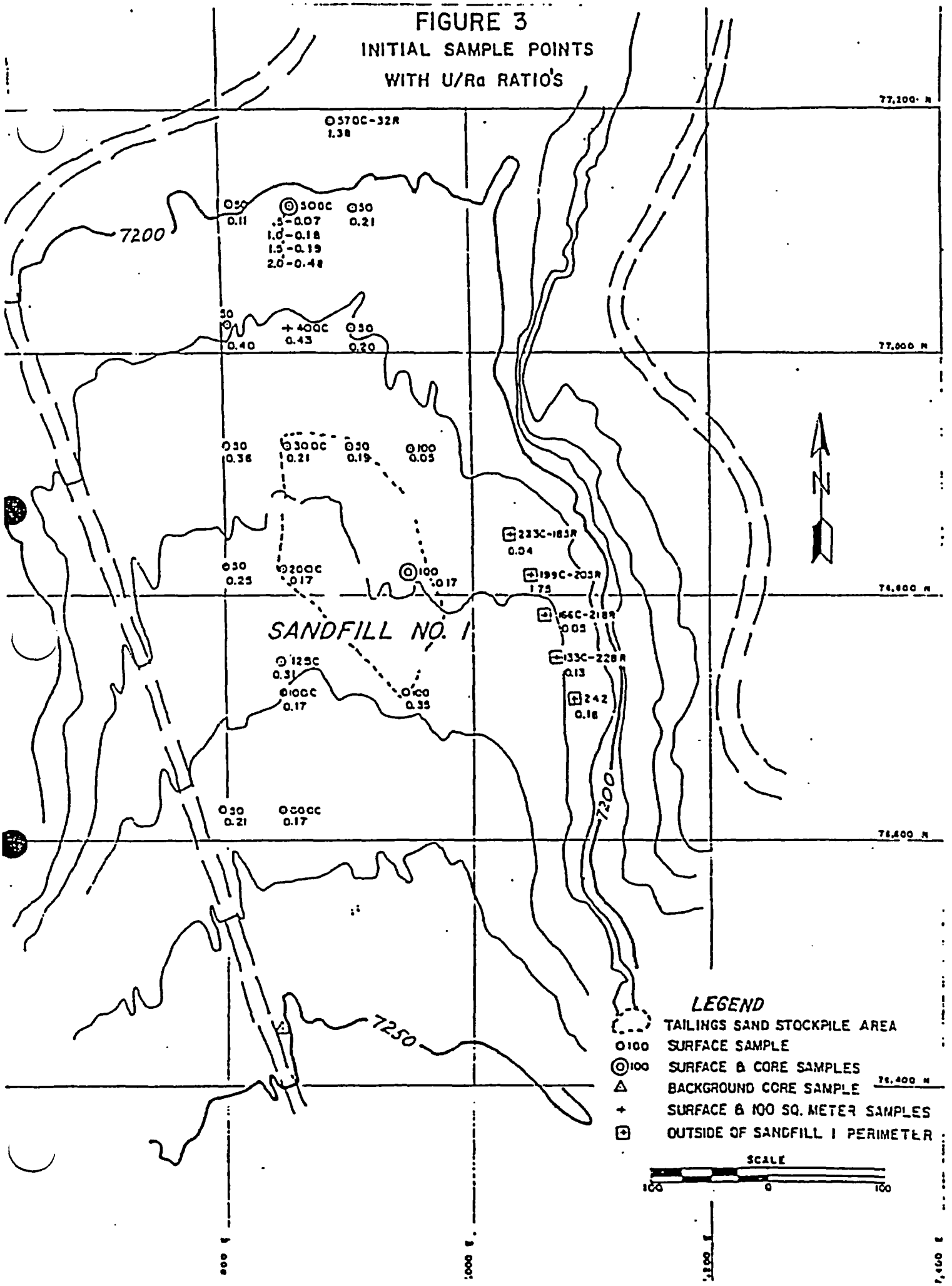


Sandfill #1 area - east yard pre-cleanup.



area post-cleanup.

FIGURE 3
INITIAL SAMPLE POINTS WITH U/Ra RATIO'S



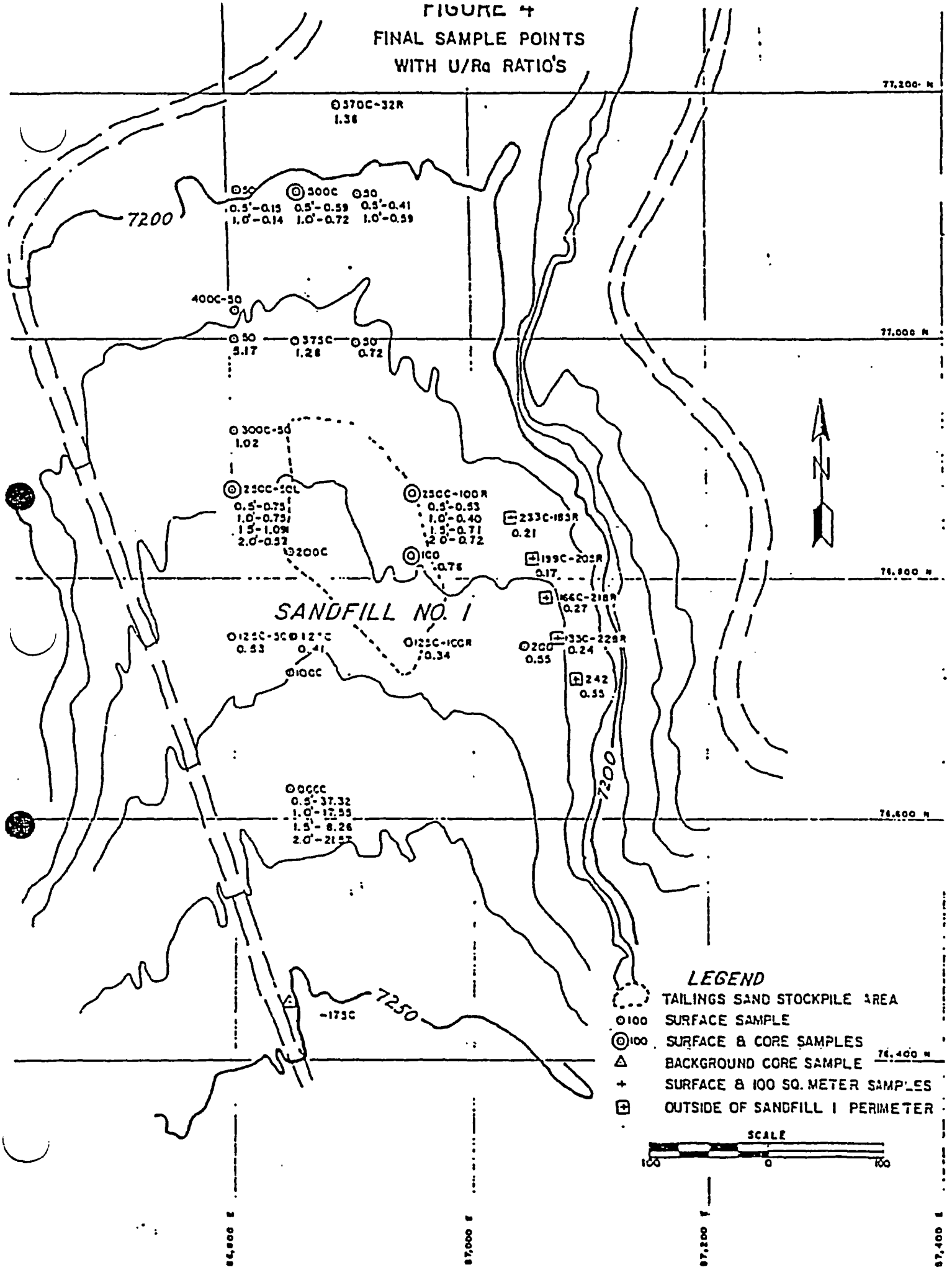
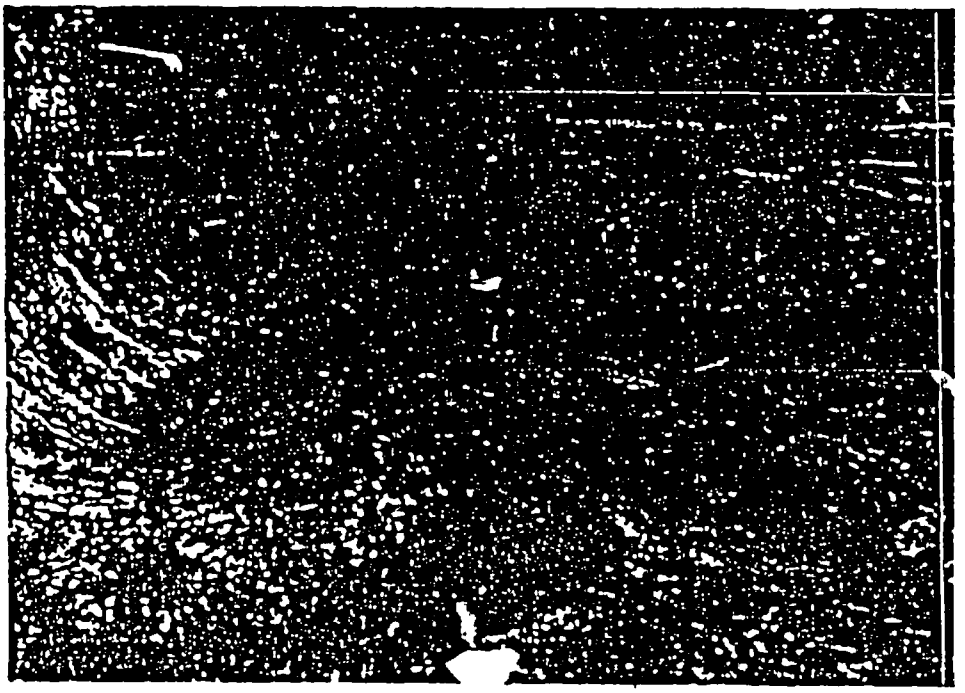


FIGURE 4
FINAL SAMPLE POINTS
WITH U/Ra RATIO'S
77,200 N
77,000 N
76,800 N
76,600 N
76,400 N
7200
7250
370C-32R
1.38
300C
0.5'-0.59
1.0'-0.72
0.5'-0.41
1.0'-0.59
0.5'-0.15
1.0'-0.14
400C-50
50
5.17
375C
1.28
50
0.72
300C-50
1.02
250C-100R
0.5'-0.53
1.0'-0.40
1.5'-0.71
2.0'-0.72
233C-183R
0.21
200C
100
0.76
199C-202R
0.17
166C-218R
0.27
SANDFILL NO. 1
125C-50
0.53
125C-100R
0.34
133C-229R
0.24
200
0.55
242
0.55
100CC
0CCC
0.5'-37.32
1.0'-17.55
1.5'-8.26
2.0'-21.57
175C
LEGEND
TAILINGS SAND STOCKPILE AREA
100 SURFACE SAMPLE
100 SURFACE & CORE SAMPLES
BACKGROUND CORE SAMPLE
SURFACE & 100 SQ. METER SAMPLES
OUTSIDE OF SANDFILL I PERIMETER
SCALE
100
0
100
N
86,800 E
87,000 E
87,200 E
87,400 E

Sandfill #2 pre-cleanup.
(Photo shows sandfill plant area).

Sandfill #2 post-cleanup.

Figure 5



Sandfill #2 yard pre-cleanup.

Sandfill #2 yard post-cleanup.

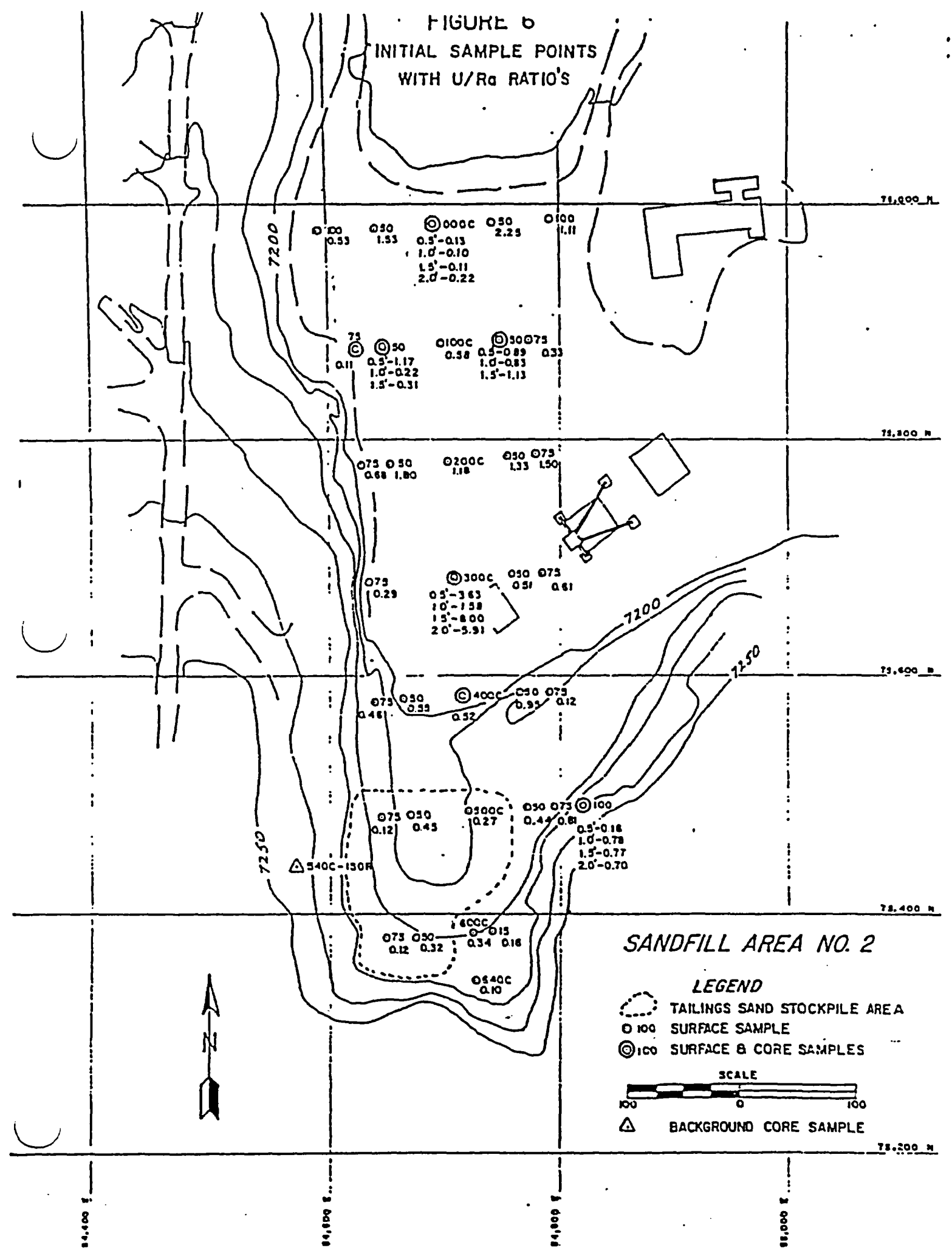
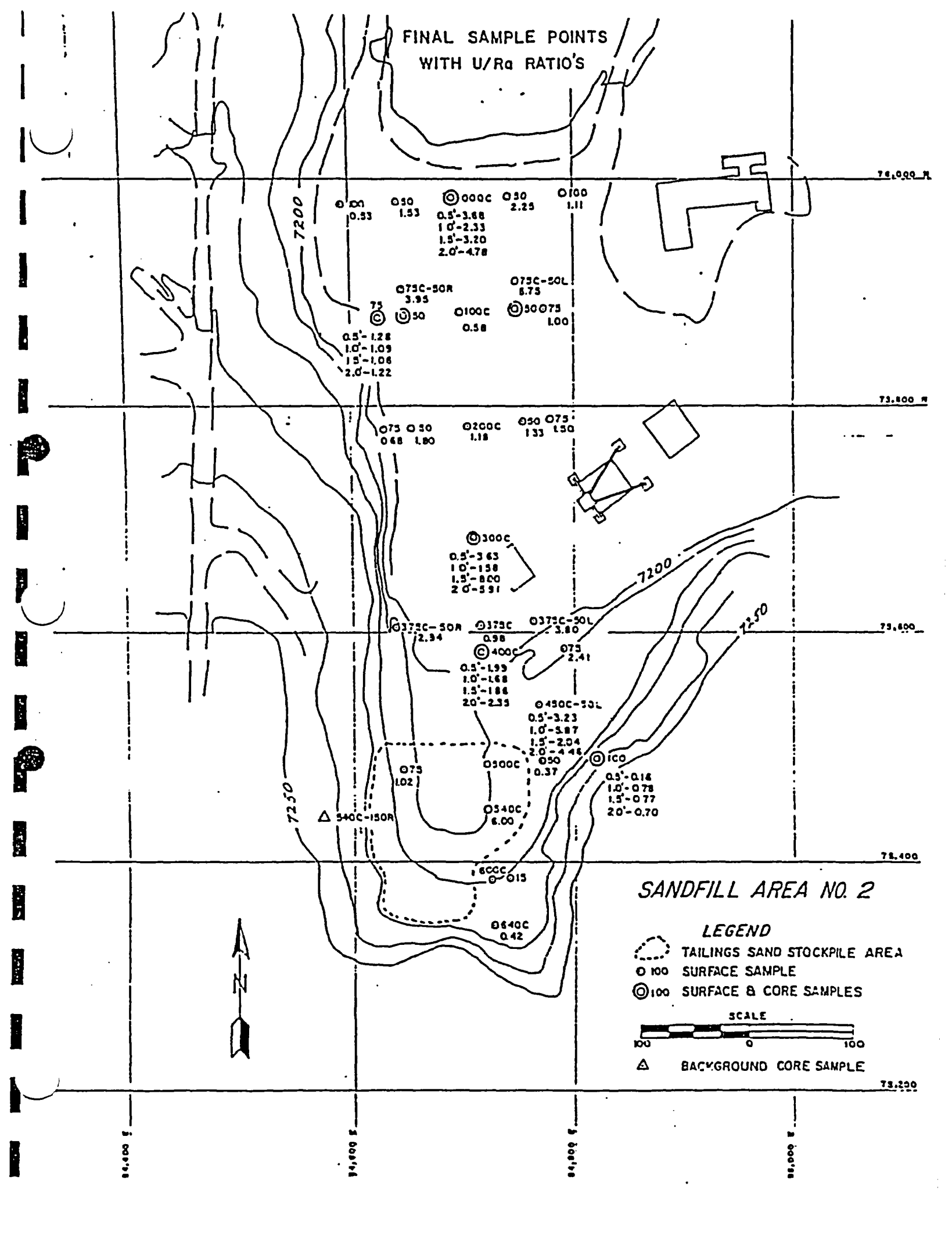
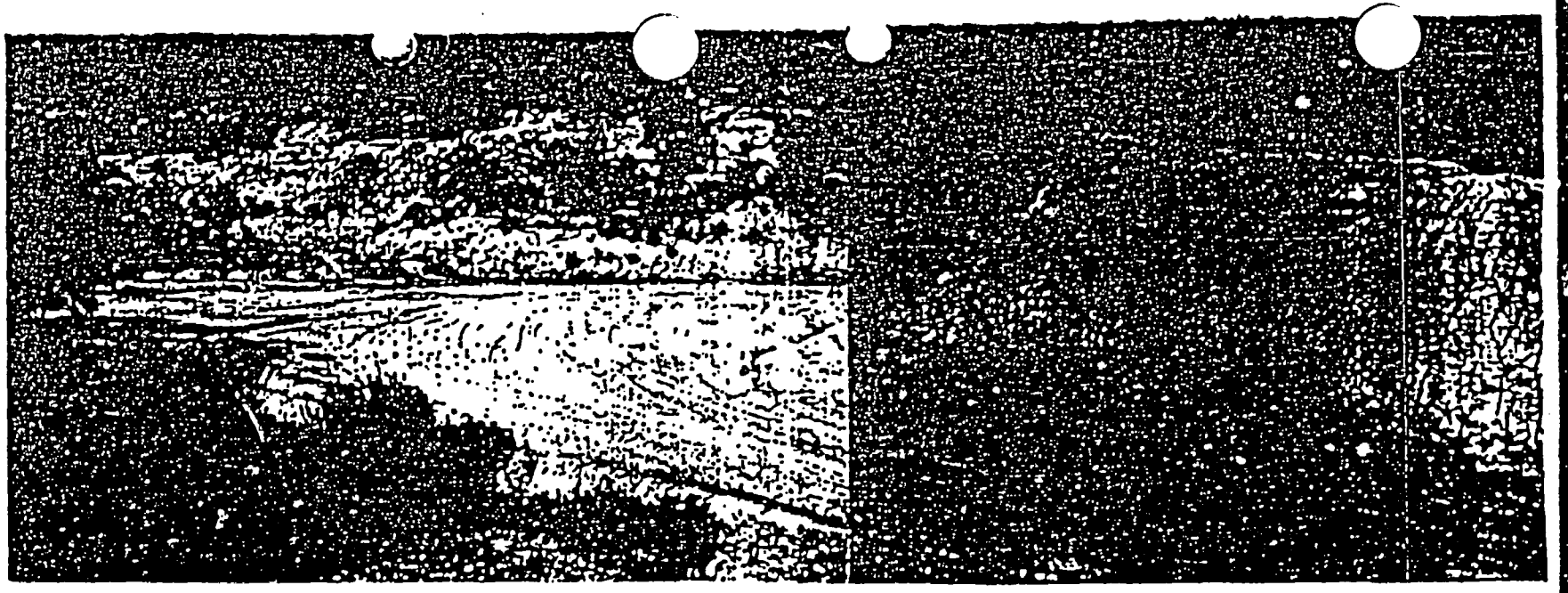
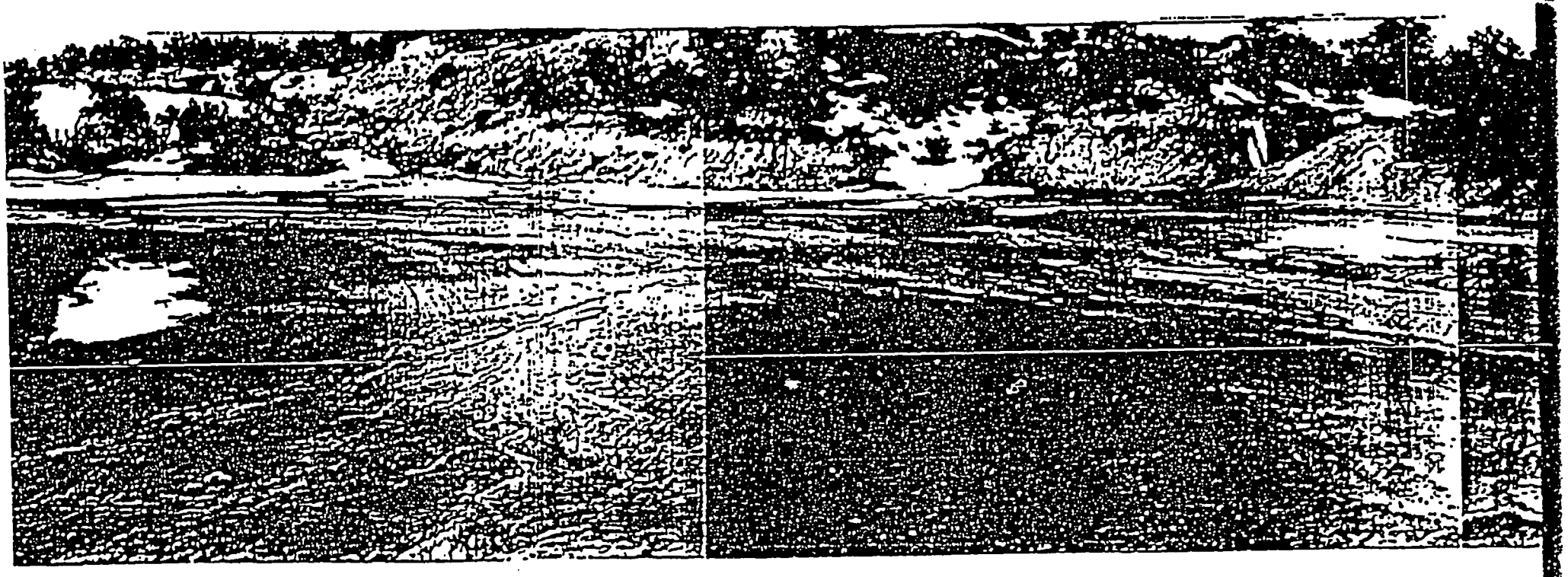


FIGURE 6
INITIAL SAMPLE POINTS
WITH U/Ra RATIO'S
7200
7250
0.100 0.53
0.050 1.53
0.000C 0.5'-0.13 1.0'-0.10 1.5'-0.11 2.0'-0.22
0.050 2.25
0.100 1.11
0.75 0.11
0.050 0.5'-1.17 1.0'-0.22 1.5'-0.31
0.100C 0.58
0.050 0.75 0.5'-0.89 1.0'-0.83 1.5'-1.13 0.33
0.75 0.050 0.68 1.80
0.200C 1.18
0.050 0.75 1.33 1.50
0.75 0.29
0.300C 0.5'-3.63 1.0'-1.58 1.5'-8.00 2.0'-5.91
0.050 0.75 0.51 0.61
0.75 0.050 0.46 0.33
0.400C 0.52
0.050 0.75 0.95 0.12
0.75 0.050 0.12 0.43
0.500C 0.27
0.050 0.75 0.100 0.44 0.81
0.5'-0.16 1.0'-0.78 1.5'-0.77 2.0'-0.70
0.540C-150R
0.600C
0.75 0.050 0.12 0.32
0.15 0.34 0.16
0.540C 0.10
N
SANDFILL AREA NO. 2
LEGEND
TAILINGS SAND STOCKPILE AREA
0 100 SURFACE SAMPLE
◎100 SURFACE & CORE SAMPLES
SCALE
100 0 100
BACKGROUND CORE SAMPLE
75,600 N
75,800 N
76,000 N
76,200 N
84,400 E
84,600 E
84,800 E
85,000 E

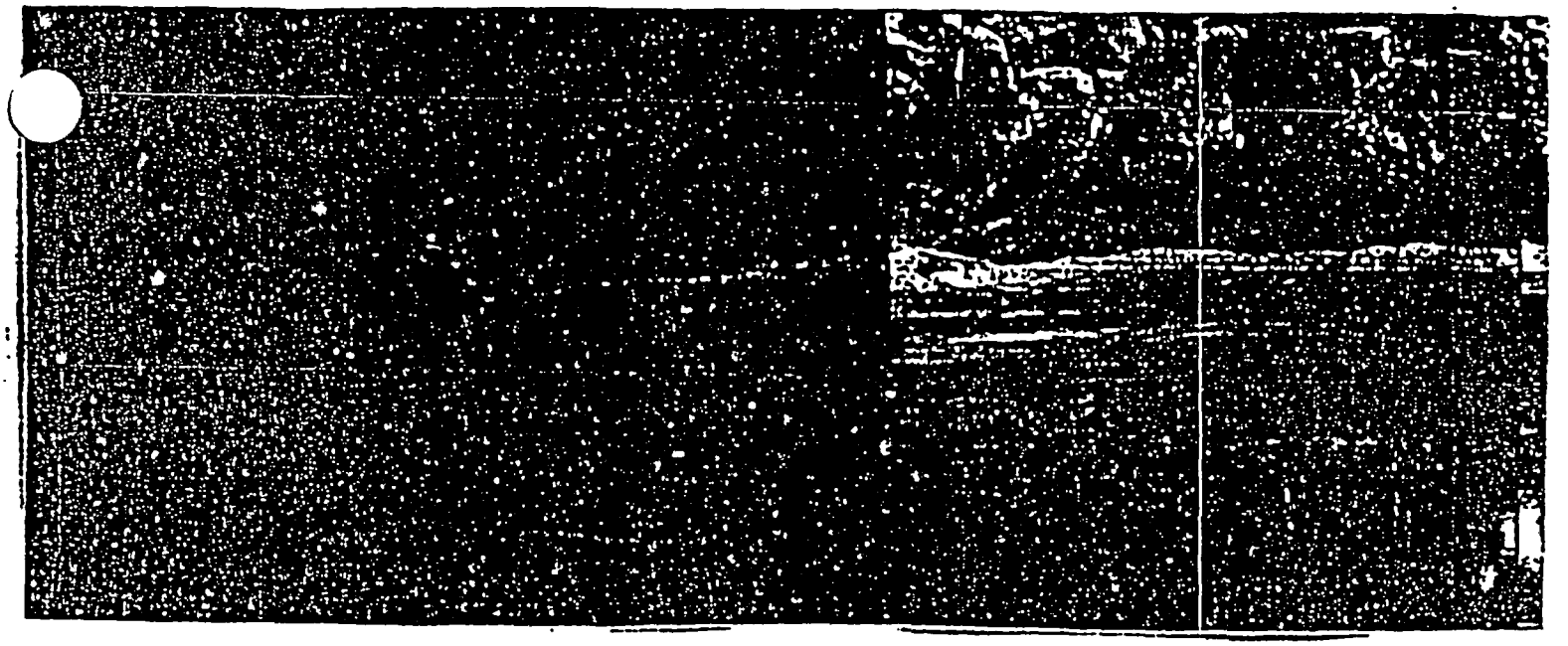

FINAL SAMPLE POINTS
WITH U/Ra RATIO'S
7200
7250
0.53
1.53
0.5'-3.68
1.0'-2.33
1.5'-3.20
2.0'-4.78
2.25
1.11
3.95
5.75
0.58
1.00
0.5'-1.28
1.0'-1.09
1.5'-1.06
2.0'-1.22
0.68
1.80
1.18
1.33
1.50
0.5'-3.63
1.0'-1.58
1.5'-8.00
2.0'-5.91
2.34
0.98
3.80
2.41
0.5'-1.99
1.0'-1.68
1.5'-1.86
2.0'-2.35
0.5'-3.23
1.0'-5.87
1.5'-2.04
2.0'-4.46
0.37
1.02
6.00
0.5'-0.16
1.0'-0.78
1.5'-0.77
2.0'-0.70
0.42
SANDFILL AREA NO. 2
LEGEND
TAILINGS SAND STOCKPILE AREA
SURFACE SAMPLE
SURFACE & CORE SAMPLES
SCALE
100
0
100
BACKGROUND CORE SAMPLE
N



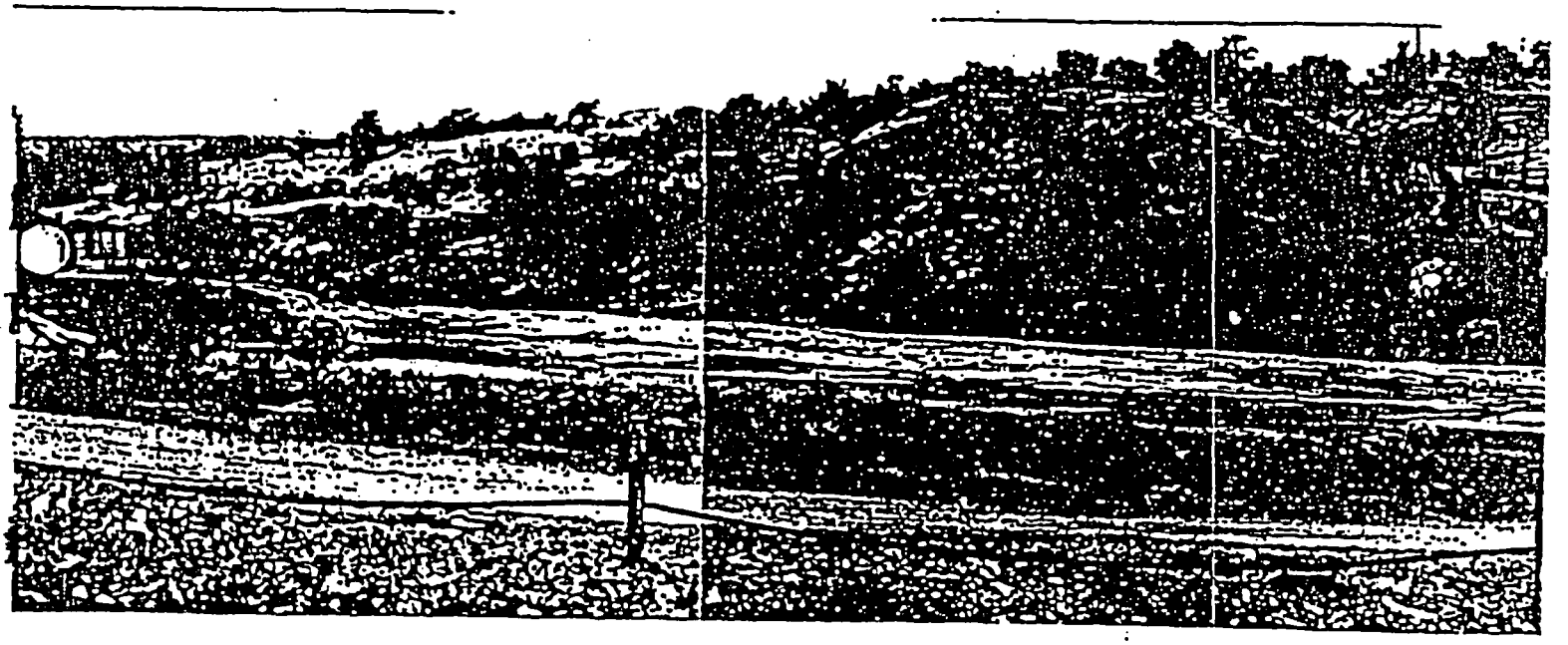
Sandfill #3 pre-cleanup. (Pile on right side of photo is low grade ore).



Sandfill #3 post-cleanup.



Pond Muck P



Pond Muck P

Fi

'ad Pre-cleanup.

Pad Post-cleanup.

Figure 9

FIGURE 10

INITIAL SAMPLE POINTS WITH U/Ra RATIO'S

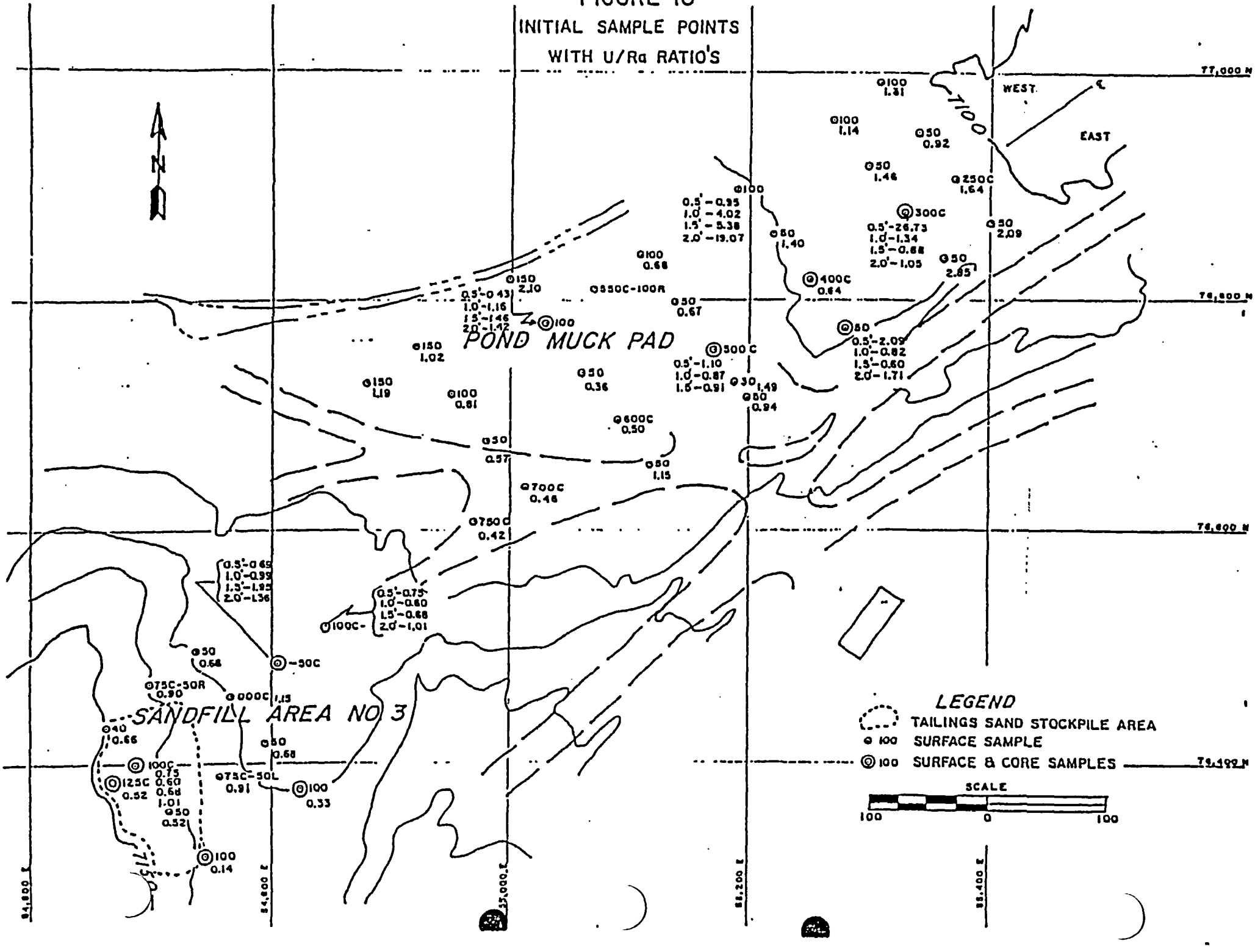
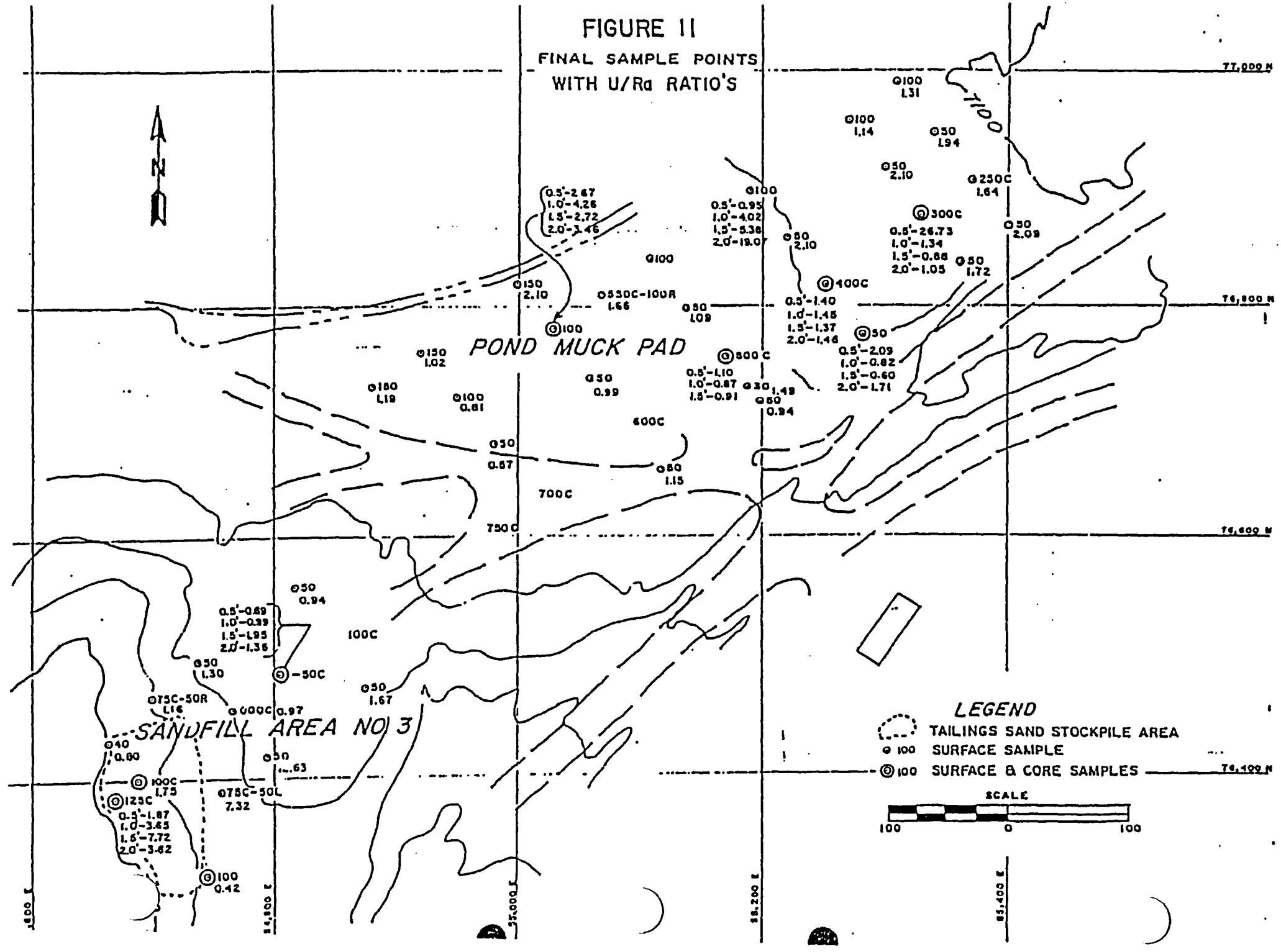
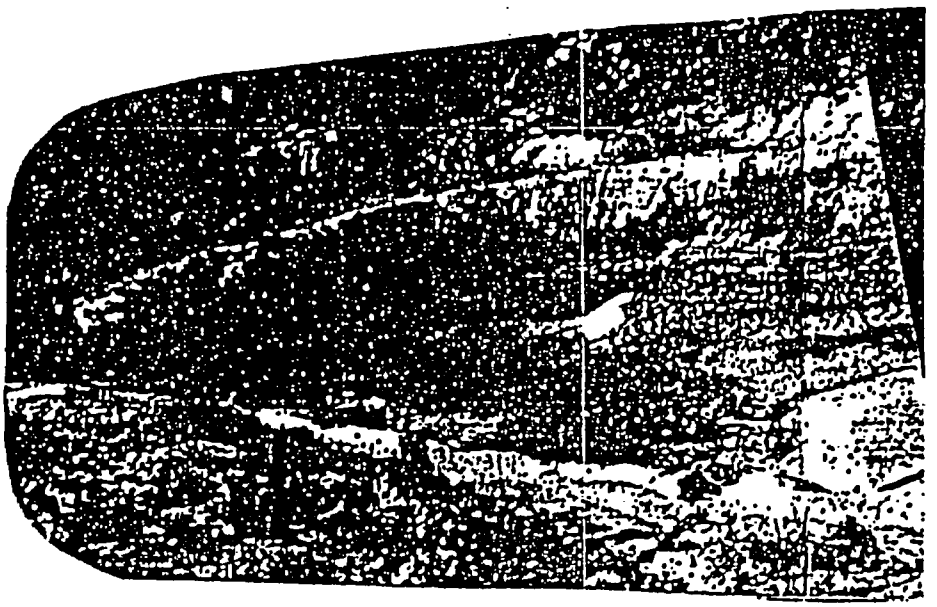


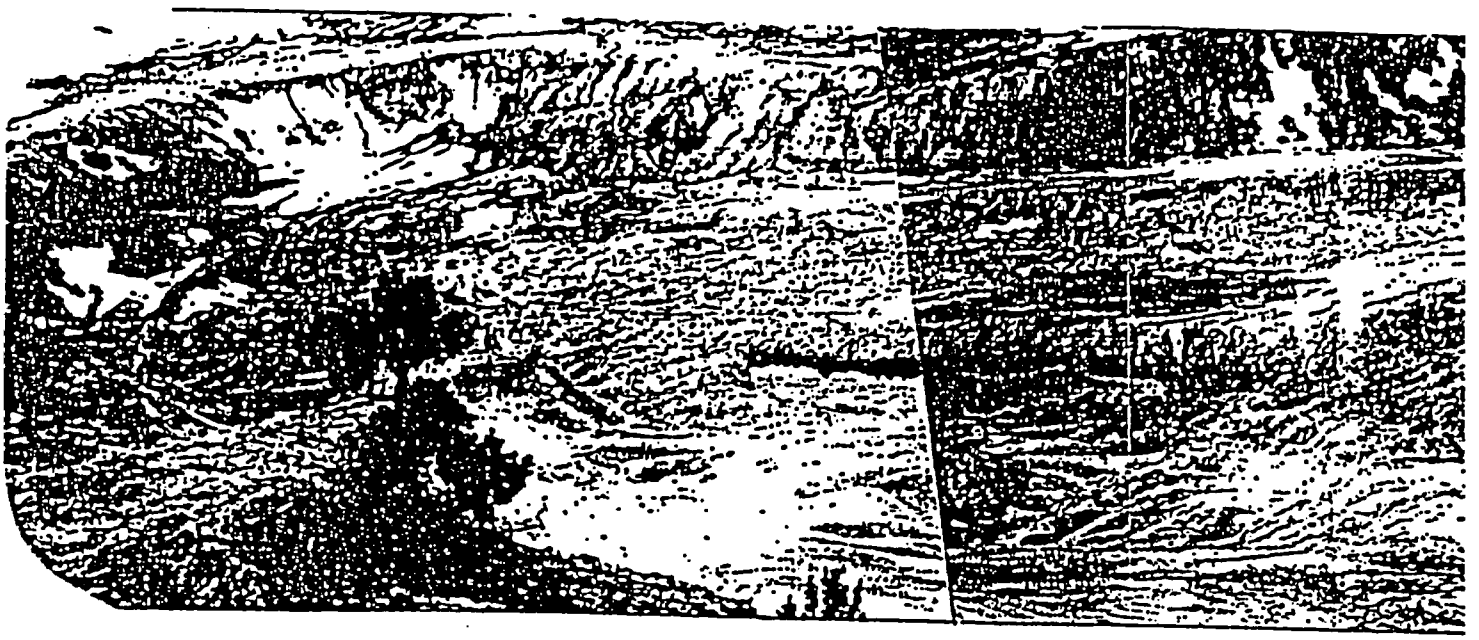
FIGURE 11

FINAL SAMPLE POINTS
WITH U/Ra RATIO'S



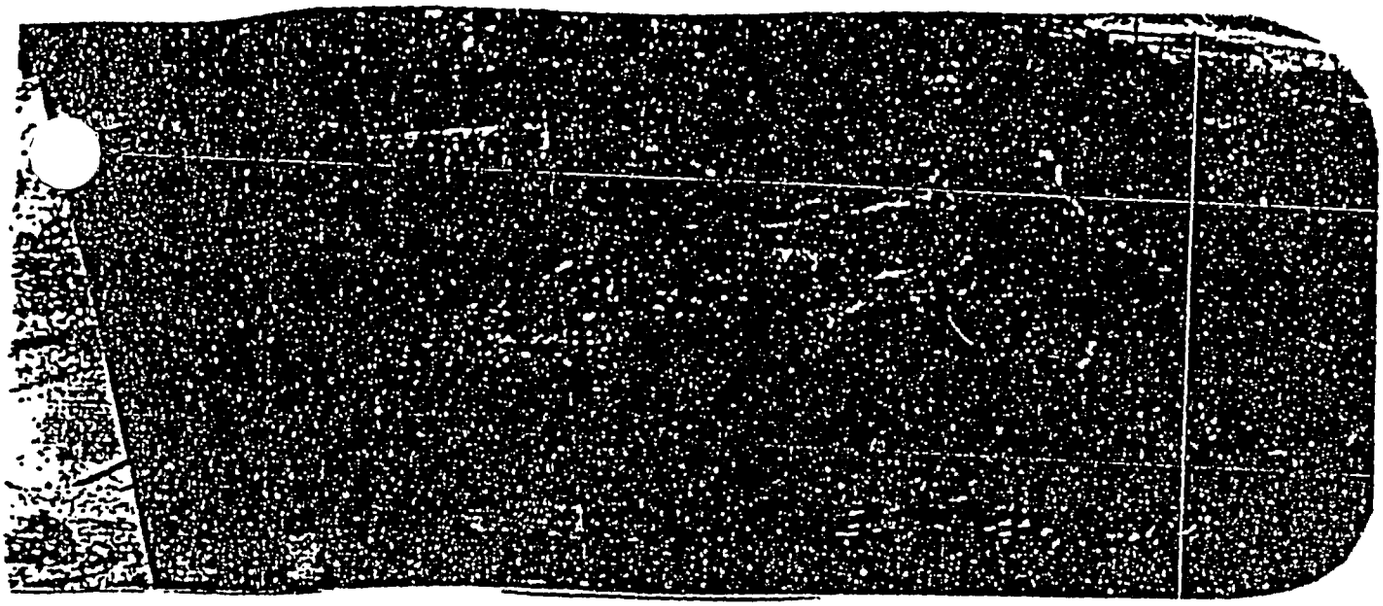


Pond #1



Pond #1 post-clea

Figure 12



Pond #1 pre-cleanup.

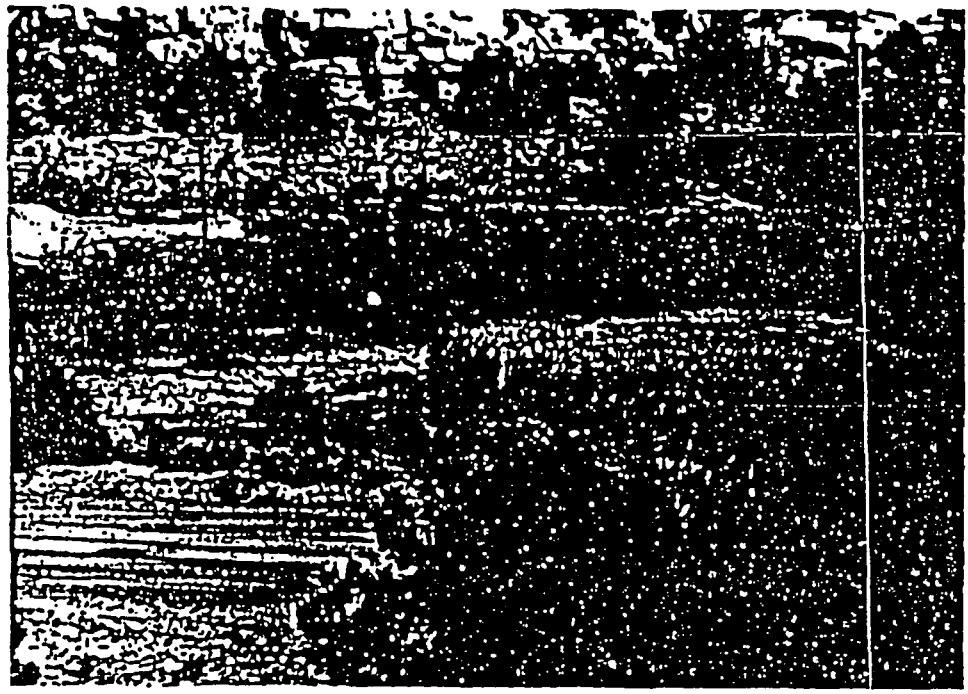
1 post-cleanup.

Figure 12

Pond #2 Pre-cleanup.

Pond #2 Post-cleanup.

Figure 13



Pond #3 Pre-cleanup.

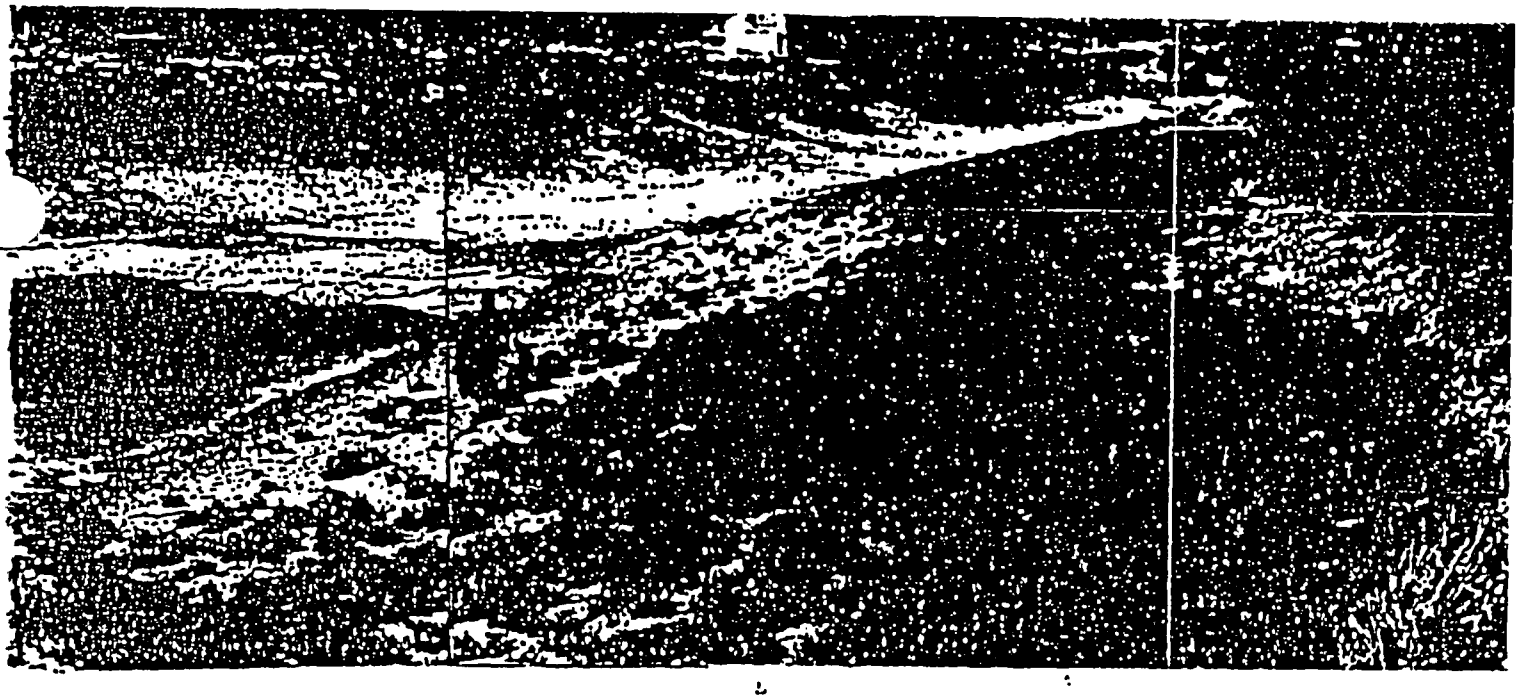
Pond #3 Post-cleanup.

Figure 16

Pond #3A Pre-cleanup.

Pond #3A Post-cleanup.

Figure 17



e-cleanup.

Post-cleanup.

FIGURE 14
INITIAL SAMPLE POINTS WITH U/Ra RATIO'S

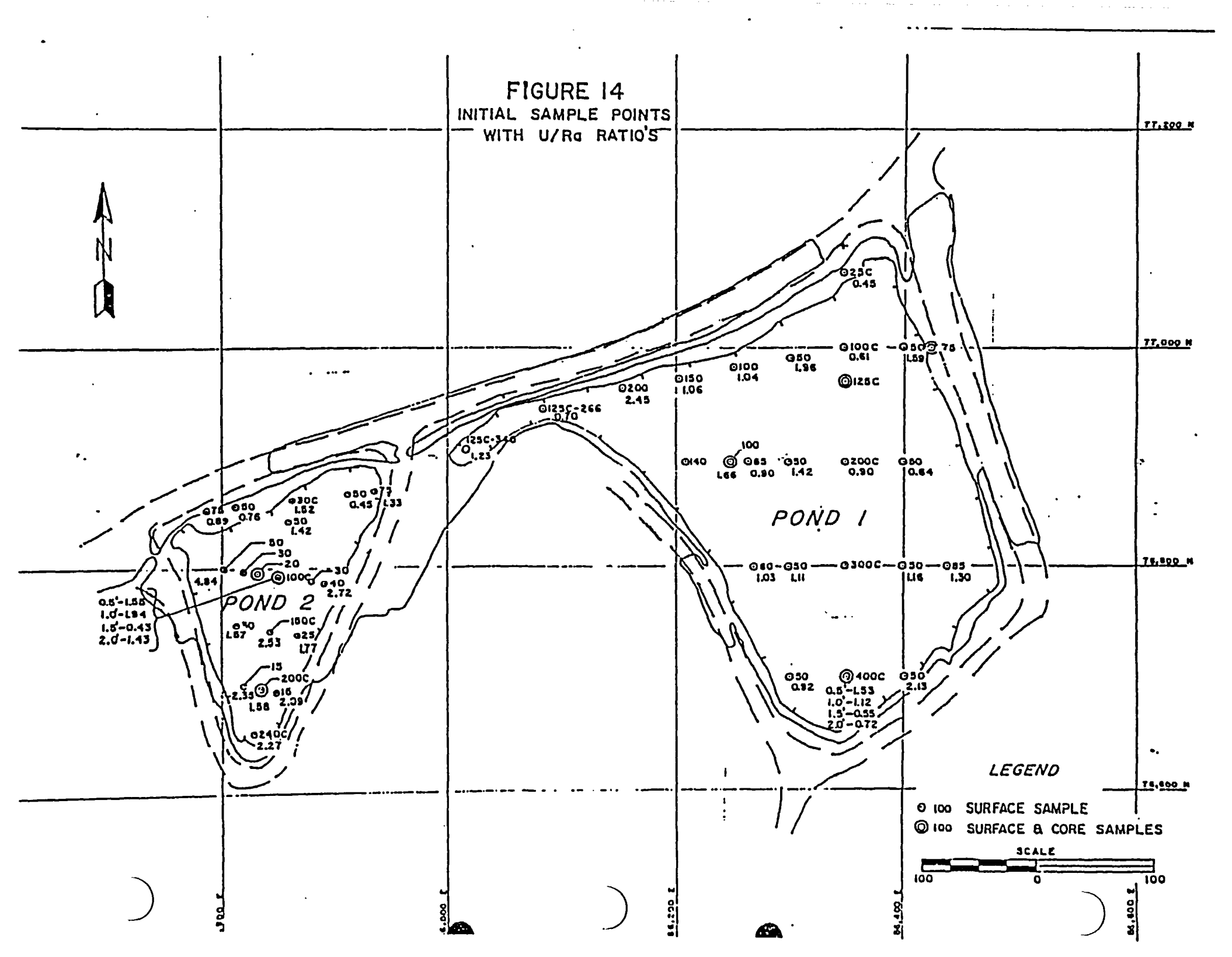


FIGURE 15

FINAL SAMPLE POINTS WITH U/Ra RATIO'S

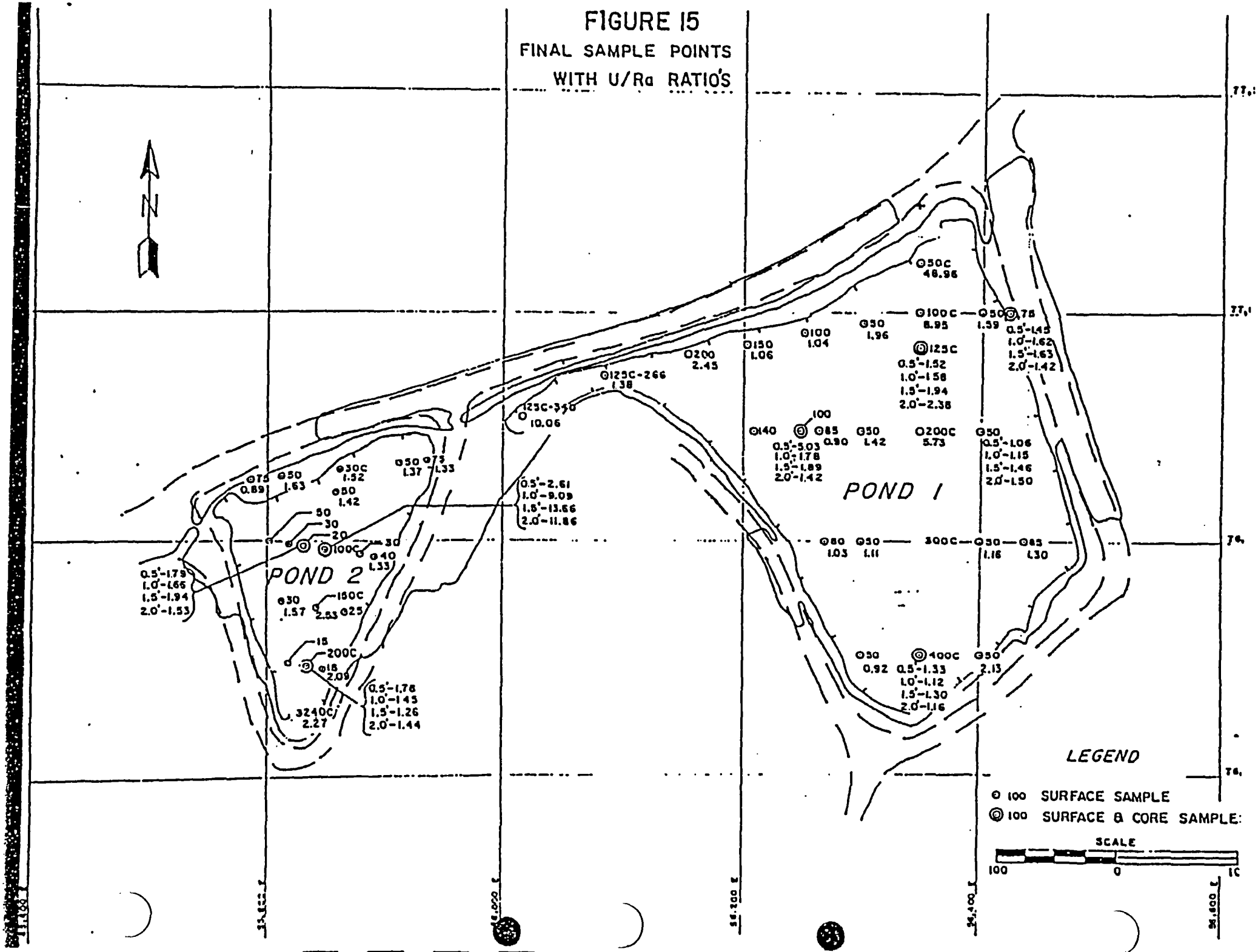


FIGURE 18

INITIAL SAMPLE POINTS WITH U/Ra RATIO'S

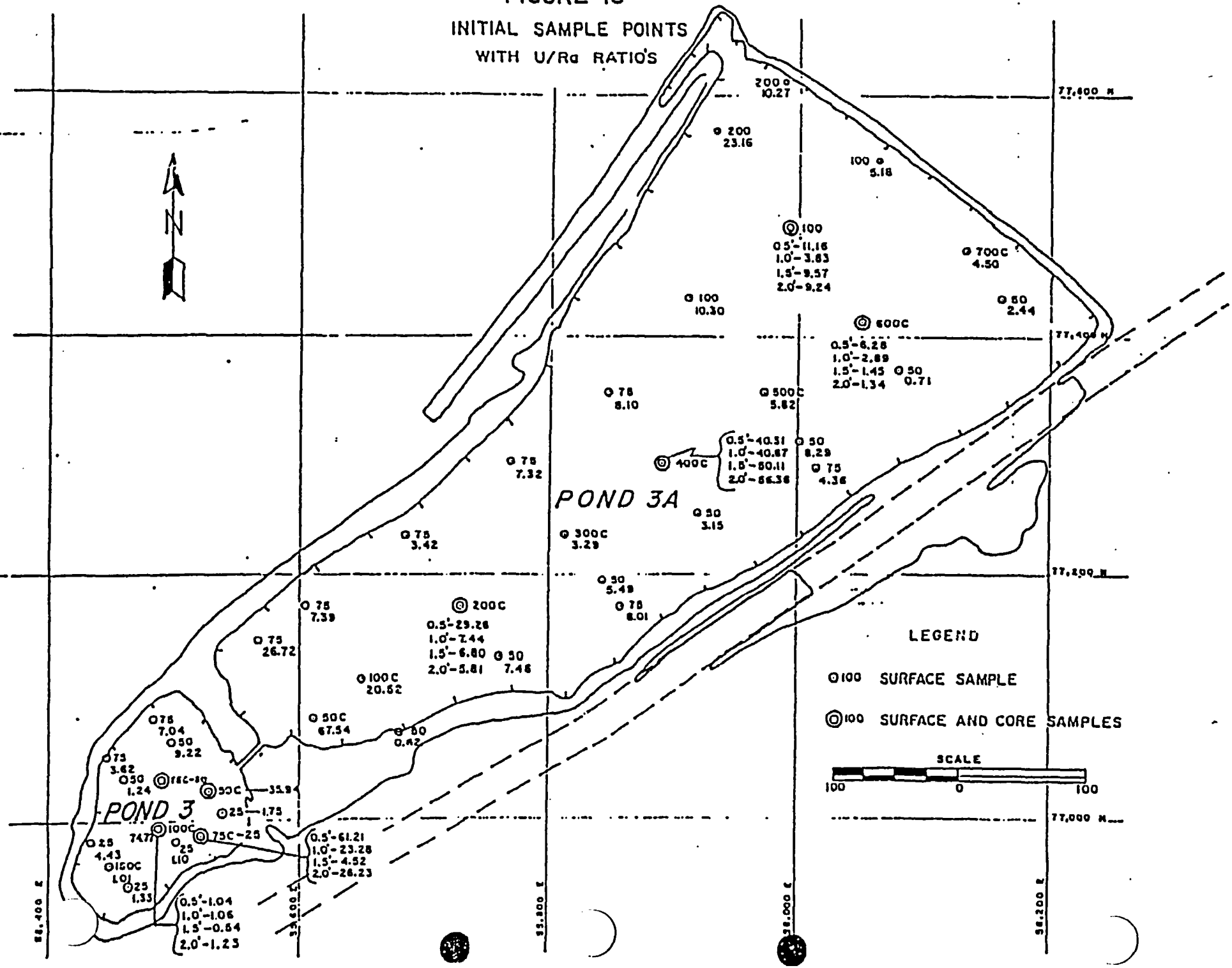
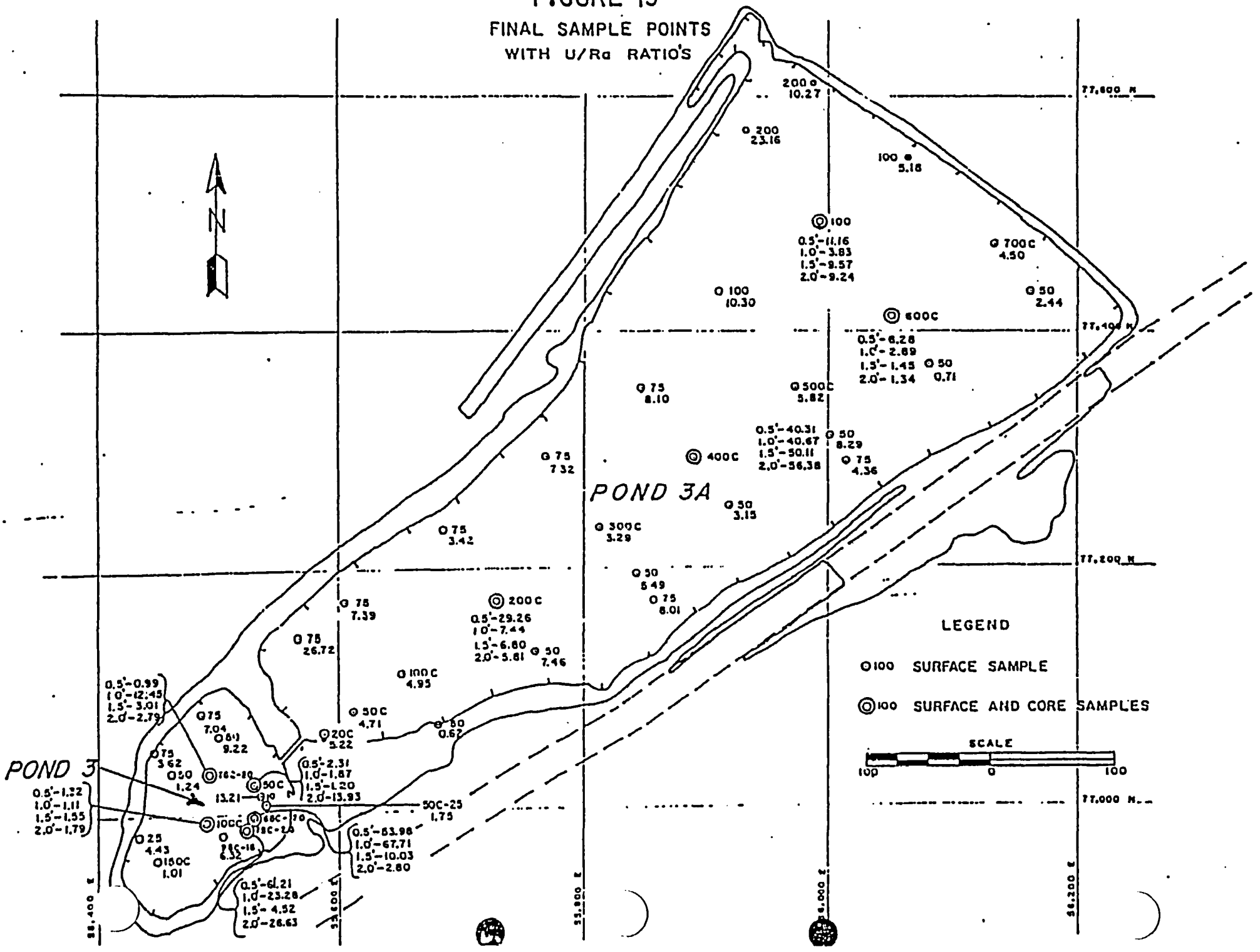


FIGURE 19

FINAL SAMPLE POINTS WITH U/Ra RATIO'S



Weller Attachment 3

NRC Memorandum "Cleanup of Tailings at the Northeast Church Rock Mine"
(October 1989)

PDR

Weller Attachment 3

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
URANIUM RECOVERY FIELD OFFICE
BOX 25325
DENVER, COLORADO 80225

OCT 31 1989

URFO:PJG
Docket No. 40-8907
04008907320E

MEMORANDUM FOR: Docket No. 40-8907

FROM: Pete J. Garcia, Project Manager

SUBJECT: CLEANUP OF TAILINGS AT THE NORTHEAST CHURCH ROCK MINE

Introduction

By letter dated April 27, 1989, United Nuclear Corporation (UNC) submitted a report documenting the cleanup of tailings at the Northeast Church Rock Mine. The report included a discussion of the cleanup methodology used as well as the results of soil sampling conducted to verify the adequacy of cleanup. The cleanup and submittal were in accordance with Condition No. 33 of Source Material License SUA-1475 for UNC's Church Rock mill.

Background

On January 29, 1979, the New Mexico Environmental Improvement Division authorized UNC to utilize coarse sand tailings for backfilling excavated mine stopes at the Northeast Church Rock (NECR) Mine. Tailings sands from the Church Rock tailings pond were stockpiled at three locations near the mine. Rainfall runoff from the stockpile areas was routed to four mine dewatering ponds, where it was treated in an ion exchange circuit prior to discharge under an NPDES permit. Pond sediments were periodically dredged and stored on a muck pad, and eventually transported to the UNC mill for processing.

The three stockpile areas, the four ponds, and the muck pad are the areas which required cleanup due to contamination by tailings. These areas are shown on Figure 1 of the report submitted by UNC. The licensee had initiated cleanup of the area by returning remaining stockpiles of tailings to the tailings impoundment in 1986.

The entire area in the vicinity of the NECR Mine has been heavily impacted by mining operations. Low-grade ore stockpiles and mine waste are located throughout the area. This situation complicates the determination of the extent of cleanup required. Criterion 6 of Appendix A to 10 CFR 40 requires the long-term stabilization of areas containing byproduct material contamination in excess of 5 pCi/g Ra-226 in soil above background. Seven

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background samples taken in the vicinity of the mine were analyzed for Ra-226, with the results shown in Table II of the UNC submittal. The results indicate an average background Ra-226 concentration of about 2 pCi/g, which would require cleanup of areas exceeding 7 pCi/g due to contamination by tailings.

Cleanup Program

Cleanup activities at the minesite were performed in two phases. The first phase consisted of excavation of material based on data obtained from boreholes drilled using truck-mounted and hand-held augers. The boreholes were drilled in all areas requiring cleanup, and gamma probes used to estimate the Ra-226 concentrations at various depths. Although this method could not distinguish between Ra-226 from tailings or non-byproduct wastes, it was used to determine overall initial excavation depths based on elevated Ra-226 concentrations.

The initial excavation resulted in the removal of approximately 1.5 feet of material from the stockpile areas and 1.25 to 7.0 feet from the ponds and muck pad. The areal extent of cleanup was approximately 4 acres for Area 1, 3 acres for Area 2, 1 acre for Area 3, 2.5 acres for the muck pad, and 3 acres for the ponds.

UNC then took soil samples for analysis to determine which areas would require additional excavation. Due to the presence of elevated concentrations of Ra-226 in the low grade ore and mine waste, additional data regarding U-nat concentrations in the tailings and non-byproduct materials was necessary to allow differentiation of the materials. Analysis of samples from six non-byproduct areas at the minesite indicate U-nat/Ra-226 ratios of 1.26 to 1.69, with an average of 1.44. Two tailings samples were also analyzed, resulting in an average U-nat/Ra-226 ration of 0.035. The ratios for the natural materials and the tailings clearly showed the expected difference in equilibrium due to the removal of uranium during the milling process.

To identify areas requiring additional excavation, the licensee used an action level for the U-nat/Ra-226 ratio of 0.75. This value is the average of the values for tailings and non-byproduct materials. Sampling following the initial excavation was conducted using a grid spacing of 50 to 100 feet. Resampling was performed in those areas requiring additional excavation. The equilibrium ratio used by UNC to verify final cleanup was the average tailings value of 0.035. The data from the sampling program following both initial and final excavation is shown on Tables III-XVIII of the report. The sampling locations are shown in the figures accompanying the report. Photographs of the areas showing pre and post cleanup conditions are included with the figures.

Staff Review

The staff review of the data provided by UNC indicates that all U-nat/Ra-226 ratios following final excavation exceeded the verification ratio of 0.035, and the large majority exceeded the action level of 0.75. Further, many of the Ra-226 values were below the value of 7 pCi/g required by Criterion 6.

Based on the equilibrium ratio data, UNC concluded that remaining Ra-226 levels in excess of the Criterion 6 limit result from low grade ore or mine waste. In addition, staff review of the data for areas exceeding 7 pCi/g indicates the U-nat values are significantly higher than the low values which would be expected from tailings. Based on the equilibrium ratio and U-nat data provided by the licensee, the staff concludes that UNC has adequately removed remaining byproduct material from the mine site. No further action is therefore necessary.

Pete J. Garcia Jr.

Pete J. Garcia
Project Manager

Approved by:

Ramon E. Hall
Director

Case Closed: 04008907320E

OCT 3 1 1989

8907/320E/PJG/89/10/26/M

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PGarcia/URFO/db PG 10/31/89

REHall/URFO REH 10/31/89

Weller Attachment 4

UNC Figure 2 - "Site Layout and Performance Monitoring Well Locations" (December 2004)

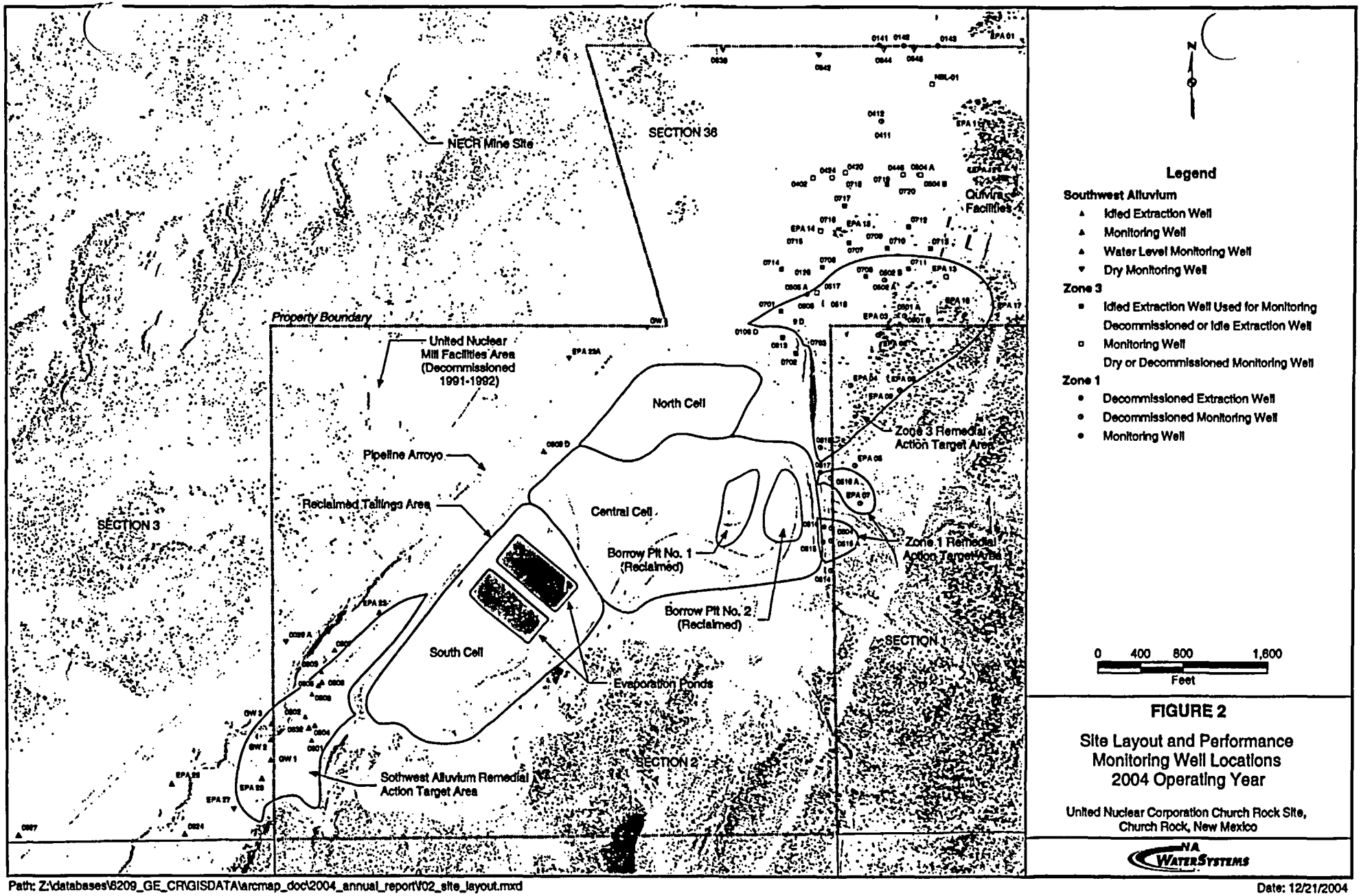

FIGURE 2

Site Layout and Performance Monitoring Well Locations 2004 Operating Year

United Nuclear Corporation Church Rock Site, Church Rock, New Mexico

NA WaterSystems

Path: Z:\databases\6209_GE_CR\GISDATA\arcmap_doc\2004_annual_report\f02_site_layout.mxd

Date: 12/21/2004

Weller Attachment 4

Staff Exhibit 3

Letter to U.S. Nuclear Regulatory Commission from Grace Sam, dated December 14, 1994

 Staff Exhibit 3

December 14, 1994

Secretary
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attention: Docketing and Service Branch

Re: Docket No. 40-8968
Hydro Resources, Inc.

Dear Secretary:

As persons whose interest would be affected by the approval of licenses and leases to construct and operate the Crownpoint Uranium Solution Mining Project ("Project"), we hereby request that a public hearing be held to review the Draft Environmental Impact Statement ("DEIS"). We further request that the period for public comment be extended for good cause as provided for in 10 CFR 2.711(a).

Request for Public Hearing

We are residents of Pinedale, New Mexico and are very concerned that the residents of our community have the opportunity to participate in any decision to allow uranium mining again at Church Rock and at Crownpoint. We own a house within the Pinedale chapter on an allotment owned by Grace Sam. Marilyn Sam is presently building a house on land given to her by her mother, Grace. We live roughly five miles from the Church Rock site, adjacent to the route proposed to transport nuclear materials. In addition, we have various family members who live in the area of the proposed Project including Grace's brother and sister and their families including their spouses, ten children, and 15 grandchildren; two of Grace's other children, Samuel and Lupie, and their families including spouses and five children; and Grace's grandmother's family. The members of our family who are children either attend local schools or will in the near future. We frequently travel on the roads that would be used to transport source and byproduct materials for the proposed Project. We use the area around the proposed Project for recreational and spiritual purposes. We obtain water for drinking and domestic use from the Crownpoint chapter water supply. We periodically eat meat from animals that graze on and around the Church Rock site.

Under the Atomic Energy Act, 42 U.S.C.A. 2239(a), we are entitled to request a hearing prior to the granting of a license for the Project. If the Project is approved as provided for in the DEIS, our interests will be adversely affected in various ways:

- The Project's mining and processing operations threaten the domestic water supply, which we use. The applicant, Hydro Resources, Inc. ("HRI") has not demonstrated that it can or will restore the mined aquifer to pre-mining condition.

- The Project's transportation of contaminated materials by truck over long distances threatens the safety of people living, working, and traveling in the area, including us.

- Disposal of waste water and materials from the Project will threaten the local water supply and the safety of people living and using land near the Project site. This threat was amply demonstrated by the disastrous tailings spill in 1979.

- The Project proposal does not address how existing contamination of the area on and around the Church Rock site will be cleaned up. Approval of the Project as proposed would further delay remedial cleanup measures.

-

- Accidents during mining and processing of the uranium would pose a threat to people present in the area around the Project site. People and animals using would risk radiation contamination and subsequent illness that would extend to those in the area who come in contact with them.

- Approval of the Project would further complicate the jurisdictional dispute between the Navajo Nation, the State of New Mexico, and the federal government. As members of the Navajo Nation, we have an interest in the recognition of the Nation's jurisdiction of the Project site.

To summarize, our areas of concern in the licensing of the Project are the integrity of the local water supply, transportation safety, the disposal of waste water and materials, progress in cleaning up existing contamination of the Project site, the safety of mining and production operations, the radiation effect on people and animals using the area, and the effect on the jurisdictional dispute existing over the Project area.

This request is being filed within 30 days from November 14, 1994, the date of publication of the docket in the Federal Register and is thus considered timely under 10 CFR 2.1205.

Request for Extension of Comment Period

10 CFR 2.711 allows for the extension of time for "good cause." I believe that such good cause exists in this instance. First, although the Notice of Availability of Draft Environmental Impact Statement was published in the Federal Register on November 14, 1994, the DEIS was not easily available in New Mexico until sometime later. Second, the DEIS has not been widely distributed in the affected communities near the Project site. Third, the comment period is coming at a time of presidential transition for the Navajo Nation government that may hinder its ability to comment on behalf of its citizens. Fourth, the

comment period extends over the Christmas holidays when many people who may wish to comment are unavailable to do so. Finally, the DEIS is a long and complicated document, prepared by agencies and a company with tremendous knowledge and resources. The majority of the people most affected by the Project, on the other hand, have scarce economic resources, receive relatively little education, and, for many, speak English only with difficulty. Obtaining meaningful participation from those most affected by the proposed Project is impossible within the very short time now allotted for public comment.

This letter is being mailed to the applicant at Hydro Resources, Inc., 12750 Merit Drive, Suite 1210 LB12, Dallas, TX 75251 and to the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

Sincerely,.

Grace Sam

Grace Sam
P.O. Box 714
Thoreau, NM 87323

Marilyn Sam

Marilyn Sam
P.O. Box 800
Gallup, NM 87323

I can read, write, and speak the English language and can speak and understand the Navajo language. I certify that I have explained the above document to Grace Sam and that she has affirmed that she aggrees to it.

Dated: Dec. 14, 1994 Signed: Marilyn G. Sam

Staff Exhibit 4

Pages 109-115 of Intervenors' Statement of Concerns, dated August 15, 1997

9. HRI Fails to Demonstrate Adequate Air Emissions Control

Petitioners are concerned that the Applicant fails to comply with 10 C.F.R. Part 20 or Criterion 8 of Appendix A to Part 40 in that the license application does not provide adequate measures for maintaining airborne effluent levels within regulatory limits and as low as reasonably achievable ("ALARA"), and that the Applicant has underestimated emissions of radon, yellowcake particulates, lixiviant, or other toxic substances that could result from routine operations or accidents in mining, processing, and transportation. Thus, Petitioners are also concerned that the applicant's equipment is inadequate to protect health in contravention of 10 C.F.R. § 40.32(c), and that issuance of the license would be inimical to the health and safety in violation of 10 C.F.R. § 40.32(d).

a. HRI's "Nearly Zero" Emissions Estimates Are Unsubstantiated

The Applicant has not provided sufficient information about its proposed measures for controlling air emissions to demonstrate that it will use adequate measures for compliance with NRC standards. For instance, the COP states that the most significant potential airborne hazards are Radon-222 borne in the pregnant lixiviant and wastewater streams, and natural uranium in the yellowcake. COP Revision 1.0 at 61, Exhibit 9 submitted herewith; see also FEIS at 2-15 and 4-74. The COP gives virtually no information, however, about measures for controlling radon emissions. Instead, the COP merely states that:

> [a]t various points in the uranium production process, radon gas may be vented to the atmosphere. These points of discharge will depend on the technology used at the plant, and the need to minimize the doses received by workers, and the public.

Id. HRI then goes on to suggest possible points of discharge, asserts that it will vent the radon gas in a way that complies with MILDOS calculations, and states that it will use downflow IX (i.e., "ion exchange") columns and a pressurized system to abate radon exposure to ALARA limits based on the best available technology. Id.

The methods by which these radon emission sources will be controlled suffer from a similar lack of detail. The FEIS describes three main sources of radon emissions: "(1) the resin transfer/process circuit, (2) the process circuit pressure vents, and (3) land application releases." FEIS at 4-74. For instance, the FEIS asserts that HRI has modified the design of the satellite plants and central processing plants "to remove radon source term locations." Id. Radon contained in high concentrations in process and restoration waters would be minimized "by removing radon in intermediate holding tanks using a vacuum pump, compressing the gas, and dissolving it in the lixiviant injection system," where it would "then be recirculated in the mining solution." FEIS at 2-15. This technique of reintroducing high concentrations of dissolved radon into the ore zone is said to be one of an unspecified number of "[e]ngineering modifications" designed by HRI "to eliminate radon dispersion into the environment from wastewater." FEIS at 4-74. Petitioners can find no engineering drawings or specifications or citations to previous operating

experience at other ISL sites in the record supporting the FEIS's assertions about the efficacy of this radon-control approach.

Moreover, the FEIS does not consider the possible effects of maintaining high dissolved radon concentrations within the ore zone on the Applicant's ability to ensure compliance with applicable ground water and drinking water standards during operations and with restoration standards after operations have ended. In the reasonably likely event that dissolved radon concentrations inhibit ground water restoration,[81] reinjection would need to be discontinued or reduced, and radon air emissions would likely be significantly higher than projected by the Applicant.

With respect to uranium emissions, the COP states that the proposed vacuum dryer is designed to be a zero-emission device. COP Revision 1.0 at 62, Exhibit 9 submitted herewith. However, any vacuum device must have some exhaust to work, and that fact is borne out by information in both the COP and FEIS. As COP Revision 1.0 states, the "vapor discharge line from the vacuum pump is vented to the atmosphere." Id. at 39. Moreover, the FEIS calculates that the "very minimal particulate emissions from the drying and packaging areas" of the central processing plant would generate about 0.248 μCi/yr (microCuries per year) in total emissions of

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[81] The dissolved radon-222 concentration in the reinjected lixiviant is reported as 133,000 pCi/L at the Crownpoint and Unit 1 sites. FEIS at 4-74. The range of radon concentrations reported at the Unit 1 site was 22 pCi/L to 1,100,000 pCi/L with a mean concentration of 81,699 pCi/L. FEIS Table 3.16 at 3-32. Petitioners cite these concentrations for comparison purposes only, and do not concede that the data reported in Table 3.16 are accurate.

uranium and its principal decay products.[82]

The success of the vacuum dryer system in reducing particulate levels to "nearly zero releases" (FEIS at 4-86) appears to depend on maintaining uninterrupted operation and maximum (i.e., 99.5 percent) efficiency of a bag filter connected to the vacuum pump. COP Revision 1.0 at 39 and FEIS at 2-15. However, the specifications for this system contained in the application state only that the bag filter "will be designed to recover 99.5 percent of the entering solids" and that the Applicant "estimates the overall particulate removal efficiency of the system to be 99.99 percent." Crownpoint Technical Report at 71-73, Exhibit 14 submitted herewith. The limited information provided fails to demonstrate that the bag filter will achieve 99.5 percent recovery or that 99.99 percent removal efficiency will be achieved.

Given the close proximity of residences to the yellowcake drying equipment at the central processing plant in Crownpoint (see FEIS Figure 4.3 at 4-76), the Applicant must provide sufficient information to evaluate the adequacy of proposed measures for controlling yellowcake releases.

b. HRI's Air Emissions Modeling Uses Inappropriate and Unrealistic Assumptions

The MILDOS computer model, which the Applicant used to model releases, is an inadequate model for assessing whether the Applicant's releases will be in

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[82] FEIS at 4-74. Radionuclides which contribute to that total emission estimate are uranium-238, thorium-230, radium-226 and polonium-210.

compliance with Appendix B and ALARA standards. For example, the MILDOS model is designed for facilities having continuous air releases. The FEIS clearly indicates, however, that air releases will be in batches from the resin transfer/process circuit and process circuit pressure vents attached to lixiviant trunk lines in each of the well fields. FEIS at 2-15 and 4-74. In addition, a large release of radon (an estimated 159 Ci/yr) will occur "immediately prior to land application at the center of Section 12 for . . . restoration flows" from the Crownpoint and Unit 1 sites. Id. at 4-74 and 4-81. The MILDOS model also is inadequate because it fails to take into account significant variables affecting the dose from discontinuous releases, such as weather conditions at the time of release and the height of the release point.

In addition to the deficiencies in the MILDOS model, Petitioners are concerned that some of the assumptions used by the Applicant and Staff to calculate effluent concentrations at the facility boundaries and maximum doses to exposed individuals are not empirically supported or adequately conservative. For instance, the FEIS states that each well field will have 20 pressure vents connected to main trunk lines, and that each vent will discharge for 2 seconds every 5 minutes. FEIS at 4-74. That only 20 vents will be needed at each site appears to be based solely on a 1993 MILDOS report prepared for HRI and referenced nowhere in the COP or FEIS. M.S. Pelizza, HRI, letter to Ramon Hall, NRC, August 10, 1993, transmitting "Addendum to MILDOS Report-Crownpoint," prepared by Eggleston Holmes and Associates, July 25, 1993 (hereinafter "Eggleston MILDOS Report"), submitted

herewith as Exhibit 39 and incorporated by reference.[83] The exact number of vents and their duration and frequency of discharge is especially important at the Unit 1 and Crownpoint sites where residences are located literally next to the well fields. FEIS Figure 4.3 at 4-76.

Additionally, the FEIS gives no basis for the assumption that restoration wastewater will be discharged in the center of Section 12, located at least two miles from the central processing plant and proposed Crownpoint well fields. FEIS at 4-81.[84] This is a nonconservative assumption. The Applicant is reasonably likely to choose a land application site inside Section 12 that is *closest* to the source of effluent (the central processing plant) for convenience. Doing so would effectively move the land application site one-half mile *closer* to residential areas in Crownpoint. This closer proximity to human receptors could have the effect of increasing doses to maximally exposed individuals.

Finally, Petitioners are concerned that the Staff has understated doses to people

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[83] Petitioners note that the 20 vents for each site were "obtained by fitting a four sided polygon to the map of well fields provided by HRI and drawing intersecting lines between opposing corners of the rectangle. This intersection was taken to be the locus of the pressure vents." Eggleston MILDOS Report at Appendix A at 1, Exhibit 39 submitted herewith. The well field design for the Crownpoint mine site used by Eggleston may be different from the design proposed in COP Revision 1.0 at 16 (Exhibit 9 submitted herewith) because of changes made by the Applicant in the Crownpoint project boundary in 1996. FEIS at A-24.

[84] Section 12 of Township 17 North, Range 13 West, is not shown on any map in the FEIS but can be discerned from a close inspection of COP Revision 1.0 Figure 1.1-2 at 6. It is also discussed in § 2.7.2. of COP Revision 1.0 at 43 and in the FEIS at 2-19 and 4-80.

living near the Crownpoint site. The Eggleston MILDOS report states:

> [N]o dosage limits were exceeded for any of the new receptors on a whole body basis. However, bronchial dosages to some near receptors at the main facility were over the 25 mRem/year recommended limit. . . .These results warrant verification by site specific monitoring.

Eggleston MILDOS Report at 1. Even though the Eggleston report asserts that the model upon which these doses are based "is very conservative" (id.), the report's results indicating an exceedance of a maximum dose to the lung of a person living near the plant site in Crownpoint are not acknowledged or even mentioned in the FEIS. In fact, the Eggleston report itself is not referenced. Thus, Petitioners have reason to question why its results were not disclosed and if they would change the doses represented in the FEIS.

In sum, because of the Applicant's unsubstantiated assertions about "zero emissions" from the vacuum dryer system, systematic deficiencies in the MILDOS model, questionable assumptions about input parameters to the model, and failure to disclose relevant information about potential exceedances of the 25-millirem limit, Petitioners are concerned that the Applicant has failed to demonstrate that the issuance of a license would comply with the 10 C.F.R. Part 20 provisions for limiting the total radiation dose to individual members of the public.

Staff Exhibit 5

Excerpts fro NUREG-0706 -
"Final Generic Environmental Impact Statement on Uranium Milling" (September 1980)

Staff Exhibit 5

NUREG-0706
Vol. II

Final Generic Environmental Impact Statement

on uranium milling

Project M-25

Appendices A-F

September 1980

Office of Nuclear Material
Safety and Safeguards
U.S. Nuclear Regulatory Commission

4. ANALYSIS OF BASE CASE IMPACTS

4.1 Radioactivity Releases and Natural Radioactivity

4.1.1 Radioactivity Releases from the Model Mill

Comment: Radium-bearing ore and tailings particles spread by the wind from the mill to the surrounding surface of the ground constitute an appreciable and persistent source of radon which has not been considered. (26, 54)

Response: This omission has been corrected. Please refer to Chapter 5 and Appendix G-1.

Comment: Do the external doses which have been calculated include gamma radiation directly from the tailings pile? What is the significance of this component? (26)

Response: The doses to hypothetical individuals near the mill and tailings do not include a component of direct exposure from radioactivity present in the pile itself. The dose rate directly above the tailings would be substantial, perhaps 0.7 mrem/hr. This would contribute to total occupational exposure of mill workers (see Section 6.2.8.2.7.1), but not to exposure of the general public. Actual measurements at existing piles have clearly demonstrated that, where there has been no substantial movement of radioactivity from the pile by wind action onto the surrounding ground surface, the external dose rate drops to background levels within 100-200 meters from the edge of the pile. This indicates that direct radiation from the pile is inconsequential at greater distances.

Comment: Recent data from ANL and EPA do not support the assumption that 5% of the thorium originally present in the ore finds its way through the acid leach process to the yellowcake. (26)

Response: This information became available after the draft GEIS had been prepared; however, it was considered in preparing this document (see Appendix G-1). The assumed thorium carryover from ore to yellowcake has been reduced from 5% to 0.5%.

Comment: Open trucks hauling ore to the mills are an important contributor to total air contamination from uranium milling, but this source has been ignored in the GEIS. (51, 74)

Response: The omission of sources related to uranium mining, including transport of ore to the mill, throughout most of this document is deliberate, intentional and in accordance with the previously defined and announced scope of consideration (42 FR 13874). The decision was made as a matter of policy. However, contamination from ore hauling would be of about the same magnitude as that which originates from ore storage and transfer at the mill site. This source is included, but is almost insignificant in the base case compared to releases from the yellowcake stack and tailings pile (see Section 9.2). The U.S. EPA has been directed by the Congress (Section 114(c) of the UMTRCA) to prepare a report on the impacts of mining, and recommend actions to deal with such hazards.

Comment: The GEIS is inconsistent in considering the effect of moisture content on radon exhalation from tailings, but ignoring its influence on exhalation from natural soils. (54)

Response: The discussion in Appendix O of radon exhalation from natural soils contains the same explicit acknowledgement of the importance of moisture in determining the exhalation rate as does Appendix G-1 which concerns radon releases from tailings. In neither case does water content appear explicitly in the calculations but, as stated, it has a strong influence on the effective diffusion coefficient of radon through porous media. This subject is addressed in detail in revised Appendix P.

Comment: The ground concentrations of radionuclides presented in Figures G-4.7 thru 4.11 are applicable to what time in the life of the model mill? Are these ground concentrations related to the emission rates listed in Table 5.5? (54)

Response: The concentrations shown in these Figures represent those predicted at the end of fifteen years of mill operation, with annual releases equal to those which are listed in Table 5.5.

APPENDIX A-2. PUBLIC COMMENTS AND STAFF RESPONSES

1. SCOPE OF DOCUMENT

1.1 Geographical Coverage

Comment: Uranium extraction activities are presently under consideration in the eastern U.S., notably in New Jersey and Pennsylvania. Other areas of the U.S. also have natural uranium resources, such as Alaska, Tennessee, New Hampshire, and Florida. Environmental conditions in these areas are markedly different from those studied in the GEIS and should be considered. (6, 13, 25, 98, 99)

Response: The potential for uranium milling in the areas mentioned exists in varying degrees but does not compare with that of the regions studied. In this generic study, typical conditions are evaluated in some detail so that generalities may be established. It is simply not possible, in an undertaking such as this, to explicitly account for every possibility with respect to site variability, even among existing sites. In the locations described by commenters above as having uranium milling potential, the NRC would be the direct licensing agency and would undertake a complete documented evaluation of all site-specific conditions prior to approval of any license application, as described in Section 12.3.10.

1.2 Uranium Mining

Comment: Uranium mining and uranium milling must be considered together because one cannot occur without the other. Any environmental assessment of the impacts of uranium milling cannot purport to be complete without a thorough and detailed analysis of the very large and permanently associated impacts of uranium mining, particularly with respect to radon emissions and groundwater pollution. (Commenters also argue that because of the large associated impacts of uranium mining, it is: all the more important to curtail milling impacts; or, not cost-effective to reduce milling impacts beyond a certain degree). (26, 42, 53, 74, 84, 92, 115, 125)

Response: Early in the initial planning of the GEIS it was recognized that appropriate regulatory control of uranium milling operations was both sorely and rapidly needed, that uranium mining operations delivered large, well-associated, and similar environmental impacts, and that the inclusion of a detailed assessment of mining impacts would significantly retard the development of the needed regulatory controls for uranium milling. Because the NRC has no jurisdictional authority over uranium mining, the inclusion of a detailed evaluation of the impacts of uranium mining associated with uranium milling would be essentially fruitless with respect to providing needed regulatory control. The inclusion of such an assessment would have resulted in significant delay, however, and would therefore have unbeneficially postponed improvement of current regulatory programs with respect to uranium milling. The staff elected, on this basis, to address uranium mining impacts only very generally within the scope of this document. Mining impacts associated with specific proposed uranium milling facilities are evaluated as appropriate, however, within the context of environmental impact statements prepared in support of individual licensing actions.

Although the GEIS does not include a detailed assessment of mining impacts, the U.S. EPA, as directed by the Congress in Section 114(c) of the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), is preparing a report on the potential health, safety, and environmental hazards of uranium mine wastes. This EPA report will contain recommendations for a program to minimize these hazards.

1.3 In Situ Uranium Extraction

Comment: A model in situ facility could be established on the basis of present in situ operations, just as was done for the development of the model mill. Because in situ operations can yield very significant and long-lasting groundwater impacts, and constitutes a large and growing portion of total uranium recovery operations, in situ should be given detailed examination in the GEIS, on an equal basis with conventional milling. At the very least, the GEIS should discuss past experience with in situ operations. (21, 37, 41, 51, 84, 89, 92, 99)

Staff Exhibit 6

SECY-01-0057
"Expansion of NRC Statutory Authority Over Medical Use of Nationally Occurring and Accelerator-Produced Radioactive Material (NARM)" (March 2001)

POLICY ISSUE
INFORMATION

March 29, 2001 SECY-01-0057

FOR: The Commissioners

FROM: William D. Travers
Executive Director for Operations

SUBJECT: PARTIAL RESPONSE TO SRM COMEXM-00-0002 - "EXPANSION OF NRC STATUTORY AUTHORITY OVER MEDICAL USE OF NATURALLY OCCURRING AND ACCELERATOR-PRODUCED RADIOACTIVE MATERIAL (NARM)"

PURPOSE:

To provide the Commission with a response to the request in the second paragraph of Staff Requirements Memorandum COMEXM-00-0002, dated December 5, 2000, by identifying potential areas in which the U.S. Nuclear Regulatory Commission's (NRC) jurisdiction might be adjusted.

BACKGROUND:

The first paragraph of COMEXM-00-0002 approved the drafting of two potential legislative proposals by the Office of the General Counsel (OGC), in coordination with the staff. The first proposal would extend NRC's statutory authority in the Atomic Energy Act to regulate radioactive material to include accelerator-produced material when used for medical purposes. The second proposal would extend NRC's statutory authority to regulate radioactive material to include accelerator-produced material in all applications, but would not include other sources of ionizing radiation such as "machine-produced" radiation (e.g., linear accelerators, x-ray units).

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In the second paragraph of COMEXM-00-0002, the Commission made the following request.

> The staff, in consultation with OGC, should also identify other areas in which NRC's jurisdiction might appropriately be adjusted so as to ensure radioactive materials and other sources of ionizing radiation presenting similar risks are treated similarly (e.g., technologically-enhanced naturally-occurring material). This is not meant to be a resource-intensive effort. The Commission simply wants the potential areas identified so that it can decide whether to draft legislation and enter a consultation process with the States and other Federal agencies similar to that for the accelerator-produced material described in paragraph one.

DISCUSSION:

Radioactive materials and other sources of ionizing radiation can be divided into five classifications.

- Reactor-produced radioisotopes
- Accelerator-produced radioisotopes
- Primordial radioisotopes
- Cosmic-ray-induced radioisotopes
- Machines that produce ionizing radiation

As an introduction to the general subject area and for completeness, Table 1 [Att. 1] provides background information on the four classifications of radioactive material: primordial radioisotopes; cosmic-ray-induced radioisotopes; reactor-produced radioisotopes; and accelerator-produced radioisotopes. This paper will not discuss in any detail the reactor-produced radioisotopes, over which NRC currently has statutory authority, or accelerator-produced radioisotopes, which will be the subject of the response to the first paragraph of COMEXM-00-0002, due later this year. Naturally occurring radioactive material (NORM) includes both primordial and cosmic-ray-induced radioisotopes.

Primordial Radioisotopes. The first classification in Table 1, "Primordial Radioisotopes," includes those isotopes that have been present on earth since the earliest days of the planet, and begins with the decay series for U-238 and Th-232. The radioisotopes in the U-238 and Th-232 decay series are NORM if undisturbed in nature, but after human intervention can become source or byproduct material, over which NRC currently has jurisdiction. The NORM radioisotopes are not currently under NRC authority. On page 2 of Table 1, the remaining primordial radioisotopes are identified. The most notable is K-40, which is a major source of our internal body burden and accounts for 11 percent of the average background radiation to the public [Att. 2, p. 3]. The estimated annual effective dose equivalent from internally deposited radioisotopes (e.g., K-40, Po-210) is 0.40 mSv (40 mrem), while the annual effective dose equivalent from terrestrial radioisotopes is 0.28 mSv (28 mrem) [Ref. 1, p. 58].

Cosmic-Ray-Induced Radioisotopes. The second classification includes cosmic-ray-induced radioisotopes, which are identified in Table 1 on page 4. Since these radioisotopes are induced by widely dispersed, random interactions with cosmic radiation, they are not amenable to regulatory control [Att. 3, p. 7]. The most important cosmic-ray-induced radioisotope is C-14

[Att. 2, p. 6]. The estimated annual effective dose equivalent to the body from the primary cosmic-ray-induced radioisotopes (i.e., H-3, Be-7, C-14, and Na-22) is just over 10 μSv/yr (1 mrem), with essentially the entire dose arising from C-14 [Att. 2, pp. 6-7]. This dose could be compared to the estimated annual effective dose equivalent of 0.27 mSv (27 mrem) received directly by a U.S. resident from cosmic radiation from beyond the earth [Ref.1, p. 58].

TENORM. Technologically enhanced naturally occurring radioactive material (TENORM) is defined to be material whose radioactivity has been increased or concentrated as a result of human intervention. TENORM is a subset of NORM. The Environmental Protection Agency (EPA), in EPA 402-R-00-01 dated June 2000, reported that the amount of TENORM produced annually in the U.S. may be in excess of $1x10^9$ tons. For comparison, the annual amount of low-level waste produced for disposal under the Low-Level Radioactive Waste Policy Amendments Act is less than $1x10^5$ tons.

The majority of TENORM is produced by eight industrial sectors [Att. 2, pp. 24-25]:

- Uranium mining overburden;
- Phosphate waste;
- Phosphate fertilizers;
- Coal ash;
- Oil and gas scale and sludge;
- Water treatment;
- Metal mining and processing (including rare earths and other metals); and
- Geothermal energy production wastes.

In Table 2 [Att. 4], the staff identifies several TENORM waste streams that produce very large quantities of relatively low specific radioactivity. For each waste stream, Table 2 presents the estimated quantity produced each year and the contained concentrations of radioactivity from uranium, thorium, and radium. The more notable waste streams are uranium overburden, phosphate, coal ash, and mineral processing. Table 3 [Att. 5] identifies the occurrence and concentrations of NORM in natural rocks and soil. Tables 2 and 3 allow a comparison between TENORM and NORM concentrations of radioactivity.

At the Federal level, a number of agencies assert authority over some aspect of TENORM. EPA has asserted authority to regulate TENORM based on several statutes, including the Clean Air Act; Uranium Mill Tailings Radiation Control Act; Comprehensive Environmental Response, Compensation, and Liability Act; and Toxic Substances Control Act [Att. 6, p. 7]. Other Federal agencies, such as the Departments of Labor, and Health and Human Services, also have an interest under legislation specific to them. However, although EPA has issued relevant guidance documents, according to Egidi and Carter [Att. 2, p. 56] and the Committee on Evaluation of EPA Guidelines for Exposure to Naturally Occurring Radioactive Materials [Ref.1, p. 246], there are currently no Federal regulations that specifically control TENORM.

States have general regulatory authority to protect the health and safety of their population, and TENORM is one area in which States have asserted such authority. The Conference of Radiation Control Program Directors (CRCPD), a nonprofit professional organization, whose primary membership is made up of individuals in State and local government who regulate the use of radiation sources, has developed model regulations for control and disposal of TENORM for State use. Even though many States consider TENORM to be regulated by their general rules on radiation, some States have specific regulations on the subject. Eleven

States currently have regulations specifically for TENORM - [Att. 2, p. 57; Ref.1, p. 197]. Eight States are considering TENORM regulations - [Att. 2, p. 57].

Machines that Produce Ionizing Radiation. In this section the staff will present a brief overview of some of the machines that produce ionizing radiation, based on readily available information, without conducting a resource-intensive effort. Machines that produce ionizing radiation, include x-ray units, betatrons, cyclotrons, linear accelerators, microtrons, heavy-ion accelerators, neutron generators, and electrostatic accelerators. In Table 4 [Att. 7], the staff identifies various types of particle accelerators. Based on data from the CRCPD, there are at least 650,000 x-ray machines in current use across the country.

Electron accelerators such as betatrons, linear accelerators, and microtrons are used for either electron or x-ray therapy. These machines typically accelerate electrons at energies ranging from 10 to 50 MeV [Ref. 2, pp. 1-4]. There are probably between 3000 and 4000 medical linear accelerators in use across the country. For electron accelerators that operate above 10 MeV, neutrons can be produced through the photonuclear reaction, resulting in additional doses to patients and operating personnel from direct exposure both to neutrons and the resulting residual radioactivity [Ref. 2].

Cyclotrons are used to bombard enriched stable isotopes with particles to produce a variety of different radioisotopes used in medicine or research. Cyclotrons are also used to produce the radioisotopes necessary for positron emission tomography (PET). There are more than 50 PET Centers in operation in the United States. PET involves the injection of a beam of charged particles from a cyclotron into a "black box" containing the stable target, which in turn becomes the activated radioisotope for quick injection into the patient. The black box amounts to a hot chemistry laboratory. The entire system is rather complex and must work together to be successful. Moreover, the PET system is only possible because of close coupling of a cyclotron machine whose radiation produces a relatively short-lived radioisotope and a patient waiting for the diagnostic procedure. If NRC were to regulate PET, it may be that the entire system would have to be controlled [Att. 8, p. 8].

Heavy-ion accelerators are used by industry as ion implanters, primarily to modify the properties of materials. In 1987 there were 3000 heavy-ion accelerators being used in semiconductor fabrication plants. Electrons are created by the interaction of positive ions with component parts of the implanter, which in turn produce x-rays upon decelerating. Resulting dose rates can be 0.5 mrem per hour [Att. 8, p. 7].

Neutron generators are used for preparing short-lived radioisotopes. Over 50 radioisotopes can be produced this way, with the more important medically useful radioisotopes being fluorine-18, bromine-80, and mercury-199m. Neutron generators are also used for neutron therapeutic treatment of cancer. They also have been used for neutron activation analysis, using the conventional Cockcroft-Walton accelerators. In addition, accelerator well-logging devices are used for activation analysis of boreholes, to indicate the type of formations [Att. 8, p. 7].

CONCLUSION:

Consistent with the Commission's direction to identify potential areas, the staff has not attempted to re-analyze the situation, or make recommendations at this time. Moreover, SECY Papers from April and December 1978, March 1988, and September 1992 have made recommendations to the Commission on whether to extend NRC's statutory authority. Attachment 9 provides a short synopsis of the staff's earlier efforts. The staff notes that the information in this paper may be useful to both the Interagency Jurisdictional Working Group on Evaluating the Regulation of Low Concentrations of Uranium and Thorium, that is responding to the Staff Requirements Memorandum for SECY-99-259, and the National Materials Working Group. Moreover, in accordance with COMEXM-00-0002, the Office of the General Counsel, in consultation with the staff, will separately address the Commission's direction regarding accelerator-produced radioactive materials used in medicine and other applications.

COORDINATION:

The Office of the General Counsel has no legal objection to this paper.

/RA/

William D. Travers
Executive Director
for Operations

References:

1. "Evaluation of Guidelines for Exposures to Technologically Enhanced Naturally Occurring Radioactive Materials," National Academy Press, Washington, DC 1999
2. NCRP Report No. 79, issued November 1, 1984
3. McGraw-Hill "Encyclopedia of Science and Technology," Volume 13, 8th Edition, p. 130

Attachments:

1. Table 1 - "Four Classifications of Radioactive Material"
2. NORM and TENORM Producers, Users, and Proposed Regulations by P. Egidi and C. Hull
3. The Regulation of NORM from a Nuclear Decommissioner's Viewpoint, by Shankar Menon
4. Table 2 - "Sources, Quantities, and Concentrations of TENORM"
5. Table 3 - "Occurrence and Concentrations of NORM"
6. Regulatory Initiatives for Control and Release of TENORM by P. Egidi
7. Table 4 - "Particle Accelerators"
8. NUREG-1310, published March 1988
9. "Staff's Earlier Work from the Periods 1976-'78; 1984; 1987-'88; and 1992"

Attachment 1; Table 1 - Four Classifications of Radioactive Material [1]							
1. Primordial Radioisotopes (abundance) (decay mode)	**Half-Life (yrs)**	**Source Material**	**Fertile**	**SNM**	**Mill Tailings [11.e(2)]**	**NORM**	**Notes; e.g., Use of Material**
U-238 Decay Series (99.27%) long-lived isotopes:							
U-238 (α) (Th-234; 24 days, β)	4.47×10^9	Yes	Yes		Yes	Yes	Radiation shield; Penetrator
U-234 (α)	2.46×10^5	Yes			Yes	Yes	
Th-230 (thorium) (α)	7.54×10^4				Yes	Yes	
Ra-226 (radium) (α) (Radon-222; 3.8 days, α)	1.6×10^3				Yes	Yes	
Pb-210 (lead) (β) (Bi-210; 5 days, β)	22.3				Yes	Yes	
Po-210 (polonium) (α)	138 days					Yes	Static eliminator
Pb-206 (lead)	Stable						
U-235 Decay Series (0.7%) Daughters no significant dose	7.1×10^8	Yes		Yes	Yes	Yes	Becomes SNM if enriched
Th-232 Decay Series long-lived isotopes:							
Th-232 (thorium) (α) (100%)	1.405×10^{10}	Yes	Yes		Yes	Yes	Th-Mg Alloy; Welding
Ra-228 (radium) (β)	5.75				Yes	Yes	
Th-228 (thorium) (α) (Ra-224; 3.66 days, α)	1.91				Yes	Yes	
Pb-208 (lead)	Stable						

1. Primordial Radioisotopes, continued (decay mode)	Half Life (yrs)	Source Material	Fertile	SNM	Mill Tailings [11.e(2)]	NORM	Notes; e.g., Use or Material
K-40 (potassium) (β decay) (0.0117%)	1.28×10^{9}					Yes	major internal body burden
V-50 (vanadium) (electron capture) (0.25%)	1.4×10^{17}					Yes	
Rb-87 (rubidium) (β) (28%)	4.75×10^{10}					Yes	earth mantle heat flux
In-115 (indium) (β) (95.71%)	4.41×10^{14}					Yes	
Te-123 (tellurium) (e) (0.91%)	1.0×10^{13}					Yes	
La-138 (lanthanum) (e & β) (.09%)	1.05×10^{11}					Yes	
Ce-142 (cerium) (β) (11%)	5.0×10^{16}					Yes	
Nd-144 (neodymium) (α)(24%)	2.29×10^{15}					Yes	
Sm-147 (samarium) (α) (15%)	1.06×10^{11}					Yes	
Sm-148 (α) (11%)	7×10^{15}					Yes	
Sm-149 (α) (14%)	2.0×10^{15}					Yes	
Gd-152 (gadolinium) (α)(0.2%)	1.08×10^{14}					Yes	
Hf-174 (hafnium) (α) (0.16%)	2.0×10^{15}					Yes	
Lu-176 (lutetium) (β) (2.6%)	3.78×10^{10}					Yes	meteorite dating
Os-186 (osmium) (α) (1.58%)	2.0×10^{15}					Yes	
Re-187 (rhenium) (β) (62.6%)	4.35×10^{10}					Yes	
Pt-190 (platinum) (α) (0.01%)	6.5×10^{11}					Yes	
Pb-204 (lead) (α) (1.4%)	1.4×10^{17}					Yes	
Pa-231 (protactinium) (α)	3.27×10^{4}					Yes	

1. Primordial Radioisotopes, decay chain missing from the earth due to short half-lives	**Half Life (yrs)**	**Source Material**	**Fertile**	**SNM**	**Mill Tailings [11.e(2)]**	**NORM**	**Notes;** e.g., Use of Material
Am-241 (americium) (α)	432.2						
Np-237 (neptunium) (α)	2.14×10^6						
U-233 (uranium) (α)	1.59×10^5						
Th-229 (thorium) (α)	7880						
Ra-225 (radium) (β) (Ac-225)	15 days						
Rn-221 (radon) (α)	25 minutes						
Rn-217 (α)	0.54 millisecond						
Po-213 (polonium) (α)	4.2 μ second						
Bi-209 (bismuth) (stable)	$> 2 \times 10^{18}$						

2. Cosmic-Ray-Induced Radioisotopes (decay mode)	**Half Life (yrs)**	**Source Material**	**Fertile**	**SNM**	**Mill Tailings [11.e(2)]**	**NORM**	**Notes;** e.g., Use of Material
H-3 (tritium) (β)	12.33					Yes	thickness gauge
Be-7 (beryllium) (e capture)	53 days					Yes	
Be-10 (β)	1.51×10^{6}					Yes	
C-14 (carbon) (β)	5.73×10^{3}					Yes	thickness gauge, tracer, determination of age
Na-22 (sodium) (e)	2.6					Yes	
Si-32 (silicon) (β)	172					Yes	
P-32 (phosphorus) (β)	14 days					Yes	
P-33 (β)	25 days					Yes	
S-35 (sulfur) (β)	87 days					Yes	
Cl-36 (chlorine) (β)	3.01×10^{5}					Yes	thickness gauge
Cl-39 (β)	55 minutes					Yes	

3a. Reactor-Produced Radioisotopes; Activation Products Used in Medicine (decay mode)	Half Life (yrs)	Source Material	Fertile	SNM	Mill Tailings [11.e(2)]	NORM	Notes; e.g., Use of Material
C-14 (carbon) (β)	5.73×10^3						urea halobacter pylori test
P-32 (phosphorus) (β)	14 days						medical procedures, inter-vascular brachytherapy
Co-60 (cobalt) (β)	5.27						teletherapy, brachytherapy, interstitial and intracavitary cancer therapy
Sr-89 (strontium) (β)	50.5 Days						palliative treatment
Sr-90 (β)	28.8						brachytherapy, treatment of superficial eye conditions
Y-90 (yttrium) (β)	64.1 hours						micro-sphere brachytherapy
Tc-99m (technetium) (IT, β)	6 hours						imaging
Pd-103 (palladium) (e)	17 days						brachytherapy, interstitial cancer therapy
I-125 (iodine) (e)	59.4 days						brachytherapy, interstitial cancer therapy
I-131 (β)	8.02 days						hyperthyroidism, thyroid cancer
Xe-133 (xenon) (β)	5.2 days						lung studies
Cs-137 (cesium) (β)	30.1						brachytherapy, interstitial and intracavitary cancer therapy
Ir-192 (iridium) (β)	73.8 days						brachytherapy, interstitial cancer therapy
Au-198 (gold) (β)	2.7 days						brachytherapy, interstitial cancer therapy

3b. Reactor-Produced Radioisotopes; (% remaining 20 years post irradiation)	Half Life (yrs)	Source Material	Fertile	SNM	Mill Tailings [11.e(2)]	NORM	Notes; e.g., Use of Material
H-3 (tritium) (β) (0.09%)	12.33						tracer
Co-60 (cobalt) (β, β) (0.23%)	5.27						density gauge, β radiography
Ni-63 (nickel) (β) (0.13%)	100.1						thickness gauge
Kr-85 (krypton) (β) (0.83%)	10.8						
Sr-90 (strontium) (β) (14.65%)	28.8						
Y-90 (yttrium) (β) (14.65%)	64.1 hours						
Sb-125 (antimony) (β) (0.04%)	2.76						
Cs-134 (cesium) (β) (0.08%)	2.06						
Cs-137 (β) (23.15%)	30.1						
Ba-137m (barium) (β) (21.90%)	2.5 minutes						
Pm-147(promethium)(β)(0.18%)	2.62						
Sm-151 (samarium) (β) (0.12%)	90.0						
Eu-154 (europium) (β) (0.84%)	8.59						
Eu-155 (β) (0.17%)	4.76						
Pu-238 (plutonium) (α) (1.26%)	87.7						
Pu-239 (α) (0.12%)	2.41×10^4			Yes			
Pu-240 (α) (0.18%)	6.56×10^3						
Pu-241 (β) (19.25%)	14.35			Yes			
Am-241 (americium) (α)(1.08%)	432.2						x-ray fluorescence analysis
Cm-244(curium) (α) (0.96%)	18.1						

4. Accelerator-Produced Radioisotopes (decay mode)	**Half Life (yrs)**	**Source Material**	**Fertile**	**SNM**	**Mill Tailings [11.e(2)]**	**ARM**	**Notes;** e.g., Use of material
C-11 (carbon) (positron)	20 minutes					Yes	lung uptake & metabolism, prostrate tumor localization, positron tomography
N-13 (nitrogen) (positron)	10 minutes					Yes	pancreatic scan, brain scan, positron tomography
O-15 (oxygen) (positron)	2 minutes					Yes	brain scan, shunt detection, positron tomography
F-18 (fluorine) (positron)	110 minutes					Yes	bone uptake, brain scan, chemotherapy, metabolism, positron tomography
Na-22 (sodium) (positron)	2.60					Yes	extra-cellular water
Mg-28 (magnesium) (β)	20.9 hours					Yes	
P-32 (phosphorus) (β)	14 days					Yes	medical procedures
P-33 (β)	25 days					Yes	palliative treatment
Ar-37 (argon) (e)	35 days					Yes	total calcium measurement
K-43 (potassium) (β)	22 hours					Yes	myocardial imaging
Sc-49 (scandium) (β)	57 minutes					Yes	
Mn-52 (manganese) (e)	5.6 days					Yes	
Fe-52 (iron) (positron)	8.3 hours					Yes	
Co-56 (cobalt) (e)	77.3 days					Yes	tumor localization
Co-57 (e)	272 days					Yes	vitamin B-12 measurement, tumor imaging calibration, x-ray fluorescence analysis, simulated tumors

4. Accelerator-Produced Radioisotopes, continued	**Half Life (yrs)**	**Source Material**	**Fertile**	**SNM**	**Mill Tailings [11.e(2)]**	**ARM**	**Notes; e.g., Use of Material**
Co-58 (cobalt) (e)	71 days					Yes	intestinal absorption studies
Cu-62 (copper) (positron)	9.7 minutes					Yes	radiopharmaceuticals
Cu-67 (β)	61.8 hours					Yes	studies of Wilson's disease
Ga-67 (gallium) (e)	3.26 days					Yes	lung scan, bowel scan, parotid gland uptake (Sjogren's syndrome), cardiac scanning
Ga-68 (e)	68 minutes					Yes	brain scan, positron emission tomography for cerebral hemo-dynamics
As-74 (arsenic) (e)	18 days					Yes	brain tumor localization
Br-77 (bromine) (e)	57 hours					Yes	
Kr-77 (krypton) (positron)	74 minutes					Yes	brain scan, positron tomography
Rb-81 (rubidium) (e)	4.6 hours					Yes	myocardial imaging
Rb-82 (positron)	1.3 minutes					Yes	imaging, positron tomography
Rb-84 (e)	33 days					Yes	radiopharmaceuticals
Sr-87m (strontium) (isomeric transition)	2.8 hours					Yes	bone scan, index of bone growth
Y-87 (yttrium) (e)	80 hours					Yes	parent of Sr-87m
Tc-97m (technetium) (IT)	91 days					Yes	imaging
Pd-103 (palladium) (e)	17 days						brachytherapy, interstitial cancer therapy
In-111 (indium) (e)	2.8 days					Yes	cisternography, tomography, tagged platelets, tagged lymphocytes

4. Accelerator-Produced Radioisotopes, continued	Half Life (yrs)	Source Material	Fertile	SNM	Mill Tailings [11.e(2)]	ARM	Notes; e.g., Use of Material
I-123 (iodine) (e)	13 hours					Yes	thyroid studies, imaging, labeled fibrinogen for in-vivo identification of thrombophlebitis
I-125 (e)	59 days					Yes	bone mineral analysis, interstitial treatment of cancer, uptake studies
Xe-127 (xenon) (e)	36 days					Yes	cardiac studies, blood-flow studies, pulmonary function studies
Cs-129 (cesium) (e)	32 hours					Yes	myocardial imaging
Cs-131 (e)	9.7 days					Yes	thyroid scanning
Dy-157 (dysprosium) (e)	8 hours					Yes	bone tumor localization
Ir-190 (iridium) (e)	11.8 days					Yes	
Au-195 (gold) (e)	186 days					Yes	
Hg-197 (mercury) (e)	64 hours					Yes	brain and kidney scanning
Tl-199 (thallium) (e)	7.4 hours					Yes	cardiac scanning
Tl-201 (e)	73 hours					Yes	cardiac scanning
Pb-203 (lead) (e)	52 hours					Yes	detection of malignant melanoma
Bi-204 (bismuth) (e)	11 hours					Yes	soft tissue scanning
Bi-206 (e)	6.24 days					Yes	soft tissue scanning

[1]Data from online data base, Table of the Nuclides, linked to web site for Brookhaven National Laboratory at http://www.dne.bnl.gov/CoN/index.html

Attachment 4; Table 2 - Sources, Quantities, and Concentrations of TENORM [Att. 2,3]				
Source Waste Stream	Quantity/Yr (kg)	U Concentration (Bq/kg)	Th Concentration (Bq/kg)	Ra Concentration (Bq/kg)
Uranium overburden	$3.8x10^{10}$	$1.8x10^{3}$	990	920
Phosphate:	$5.0x10^{10}$	bkgd - $3.0x10^{3}$	bkgd - $1.8x10^{3}$	400 - $3.7x10^{6}$
Phosphogypsum	$4.8x10^{10}$	bkgd - 500	bkgd - 500	900 - $1.7x10^{3}$
Slag	$1.5x10^{9}$	800 - $3.0x10^{3}$	700 - $1.8x10^{3}$	400 - $2.1x10^{3}$
Scale	$4.5x10^{6}$	*	*	$1.1x10^{3}$ - $3.7x10^{6}$
Phosphate fertilizers	$4.8x10^{9}$	740 - $2.2x10^{3}$	37 - 180	180 - 740
Coal Ash:	$6.1x10^{10}$	100 - 600	30 - 300	100 - $1.2x10^{3}$
Fly Ash	$4.4x10^{10}$	*	*	*
Bottom Ash	$1.7x10^{10}$	*	*	*
Petroleum Production:	$2.6x10^{8}$	*	*	bkgd - $3.7x10^{6}$
Scale	$2.5x10^{7}$	*	*	bkgd - $3.7x10^{6}$
Sludge	$2.3x10^{8}$	*	*	bkgd - $3.7x10^{3}$
Petroleum Processing:	*	*	*	Pb-210 & Po-210
Refineries	*	*	*	>$4.0x10^{3}$
Petrochemicals	*	*	*	> $4.0x10^{3}$
Gas Plants	*	*	*	Pb-210 & Po-210
Water Treatment:	$3.0x10^{8}$	*	*	100 - $1.5x10^{6}$
Sludge	$2.6x10^{8}$	*	*	100 - $1.2x10^{3}$
Resins	$4.0x10^{7}$	*	*	300 - $1.5x10^{6}$
Mineral Processing:	$1.0x10^{12}$	6 - $1.3x10^{5}$	8 - $9.0x10^{5}$	< 200 - $1.3x10^{5}$
Rare Earths	$2.1x10^{7}$	$2.6x10^{4}$-$1.3x10^{5}$	$9.0x10^{3}$ - $9.0x10^{5}$	$1.3x10^{4}$ - $1.3x10^{5}$
Zr, Hf, Ti, Sn	$4.7x10^{8}$	6 - $3.2x10^{3}$	8 - $6.6x10^{5}$	300 - $1.8x10^{4}$
Alumina	$2.8x10^{9}$	400 - 600	500 - $1.2x10^{3}$	300 - 500
Cu & Fe	$1.0x10^{12}$	< 400	< 400	< 200
Geothermal Waste	$5.4x10^{7}$	*	*	400 - $1.6x10^{4}$
Paper Mills	*	*	*	> $3.7x10^{3}$

* means data are not available

1 Bq = 27 pCi; 1 kBq = 27 nCi; 1 Mbq = 27 μCi; 1 μCi = 37 kBq; 1 mCi = 37 Mbq; 1 Ci = 37 GBq

Attachment 5; Table 3 - Occurrence and Concentrations of NORM [Ref.1]						
Material	K-40		Th- 232		U-238	
	% of total K	Bq/kg	ppm	Bq/kg	ppm	Bq/kg
Igneous Rock:						
Basalt (crustal)	0.8	300	3-4	10-15	0.5-1	7-10
Mafic	1.1	300	2.7	10	0.9	10
Salic	4.5	1400	20	80	4.7	60
Granite (crustal)	› 4	› 1000	17	70	3	40
Sedimentary rocks						
Shale	2.7	800	12	50	3.7	40
Sandstones						
Clean quartz	‹ 1	‹ 300	‹ 2	‹ 8	‹ 1	‹ 10
Dirty quartz	2	400	3-6	10-25	2-3	40
Arkose	2-3	600-900	2	‹ 8	1-2	10-25
Beach sands	‹ 1	‹ 300	6	25	3	40
Carbonate rocks	0.3	70	2	8	2	25
All rocks	0.3-4.5	70-1400	2-20	7-80	0.5-4.7	7-60
Continental crust	2.8	850	10.7	44	2.8	36
Soil	1.5	400	9	37	1.8	22

Attachment 7; Table 4 - Particle Accelerators [Ref. 3]		
Accelerator Type	Particle Accelerated	Energy Level
Electrostatic Accelerators:		
Tandetron	p, d, α, & heavy ions	to 3 MV
Cockcroft-Walton	p, d, α, , e, & heavy ions	to 4 MV
Dynamitron	p, d, α, , e, & heavy ions	to 4 MV
Tandem Van de Graaff	p, d, α, , e, & heavy ions	to 20 MV
Tandem pelletron	p, d, α, , e, & heavy ions	to 26 MV
Vivitron	p, d, α, , e, & heavy ions	to 35 MV
Time-Varying Field Accelerators:		
Microtron	e^-	to 200 MeV
Sector or isochronous cyclotron	p, d, & α heavy ions	to 590 MeV (p) to 90 MeV/amu
Superconducting cyclotron	heavy ions	200 MeV/amu
Synchrotron (weak focusing)	p, e heavy ions	1-6 Ge (p) 2 GeV/amu
Alternating-gradient synchrotron	p, e^+ heavy ions; mass 12-197 heavy ions; mass 12-208	10-900 GeV (p) 11.4 GeV/amu 160 GeV/amu
Linear Accelerators:		
Heavy ion linear accelerator	p, d, α, & heavy ions	to 30 MeV/amu
Linear accelerator	p	50-800 MeV
CEBAF recirculating superconducting linear accelerator	e^-	0.5-4 GeV
Electron linear accelerator	e^+, e^-	6 MeV - 50 GeV
Colliding-Beam Storage Rings:		
Electron storage ring	e^+, e^-	0.3-100 GeV (CM)
Proton storage ring	pp	14 TeV (CM)
Proton-antiproton storage ring collider	(pp^{-1})	1.8TeV (CM)

Note:

p = proton; d = deuterium; α = alpha particle; e^- = electron; e^+ = positron;
amu = atomic mass unit;
pp = two proton beams; (pp^{-1}) = proton & antiproton beam; CM = center of mass

Staff Exhibit 7

Attachment 9 to SECY-01-0057

ATTACHMENT 9

STAFF'S EARLIER WORK FROM THE PERIODS 1976-'78; 1984; 1987-'88; and 1992

In January 1976, in response to requests from the 25 Agreement States, NRC established a Task Force to review the question of whether to bring Naturally Occurring and Accelerator- Produced Radioactive Material (NARM) under NRC's jurisdiction. The Task Force recommended [Encl. 1] that the Commission seek legislative authority to:

A. License and regulate NARM in any activity:

- That is part of, or in support of, the nuclear fuel cycle regulated by NRC;
- Where: (a) NARM is manufactured; (b) NARM is incorporated into sources or devices subject to licensing; or (c) NARM is used in the same manner as radioactive materials subject to NRC regulation;
- Where NARM is introduced into products intended for distribution to persons exempt from licensing; and
- Involving the management of NARM wastes that result from licensed activities.

B. Extend authority under Section 274 of the Atomic Energy Act to relinquish authority to regulate NARM to Agreement States and other States having existing regulatory programs for NARM that are determined to be adequate to protect the public and compatible with NRC's program.

The Task Force identified several Federal agencies with some statutory authority over NARM.

- Food and Drug Administration of the Department of Health, Education, and Welfare
- Consumer Product Safety Commission
- U.S. Environmental Protection Agency
- Occupational Safety and Health Administration of the Department of Labor
- Energy Research and Development Administration
- Department of Transportation
- U.S. Postal Service
- Customs Service
- Federal Trade Commission
- National Bureau of Standards
- Department of Interior
- Department of Defense

The Task Force recommended that NRC seek legislative authority to regulate NARM because these materials present significant radiation exposure potential and current controls are fragmentary and non-uniform at both State and Federal levels. Task Force recommendations were presented to the Commission in SECY-78-211 [Encl. 2] in April 1978. The Commission did not take any action, and asked the staff to resubmit the paper for reconsideration after addressing questions about the magnitude of NARM over-exposures, compatibility of the proposed NRC regulatory authority with other agencies, and other issues. In December 1978, staff responded to these questions with SECY-78-667 [Encl. 3], which also contained several conflicting positions. On the one hand, staff continued to recommend that NRC seek legislative authority over NARM.

On the other hand, the Director of the Office of Nuclear Material Safety and Safeguards recommended that NRC:

- Forward the Task Force findings to the Congress, Federal agencies, and State Governors;
- Offer to assist others in developing model control programs; and
- Review NARM control programs after several years to determine further appropriate NRC action.

Moreover, the Executive Director for Operations stated that there are three major issues to be considered in determining what action should be taken:

- Risk to public health and safety;
- Scope and cost of regulatory control; and
- Federal regulatory conflict and NRC's role.

In October 1984 the staff published NUREG-0976 [Encl. 4], entitled "Regulation of Naturally Occurring and Accelerator-Produced Radioactive Materials - An Update." This report presented a review of the status of use and regulation of NARM. For State regulation of NARM, the staff reported that in the 27 Agreement States NARM was regulated in the same manner as byproduct, source, and special nuclear material. In the 23 non-Agreement States, 5 States had NARM licensing programs, 2 States had voluntary or partial licensing programs, and 16 States had at least an initial registration requirement. All Agreement States and 14 non-Agreement States inspected NARM users. Four non-Agreement States conducted partial inspections, while five States did not inspect NARM users. The report concluded that the then currently fragmentary control of NARM leads to licensee confusion and a real potential for excessive radiation exposure to workers and the public.

In March 1988 the staff published NUREG-1310, entitled "Naturally Occurring and Accelerator-Produced Radioactive Materials - 1987 Review." This report presented a review of NARM sources and uses as well as incidents and problems associated with those materials. A review of previous Congressional and Federal agency actions on radiation protection matters, in general, and on NARM, in particular, was provided to develop an understanding of existing Federal regulatory activity in ionizing radiation and in control on NARM. In addition, State controls over NARM were reviewed. Specific questions were examined in terms of whether NRC should seek legislative authority to regulate NARM. The assessment of these questions served as the basis for developing and evaluating several options. The evaluation of the options led to two recommendations. This report was the basis for a subsequent SECY Paper.

In SECY-88-64 [Encl. 5] in March 1988, the staff presented recommendations to the Commission on the issue of whether NRC should seek legislative authority to regulate NARM. This paper noted that the quantities and concentrations of NARM form a continuum in the human world, and the potential hazards of NARM form a continuum ranging from background to potentially significant ones in all facets of life. Thus, any effort to control the risks from NARM calls for an integrated control program to ensure that the dominant hazards are appropriately addressed, without undue attention to the lesser hazards. This paper also reported that Congress had already vested jurisdiction over NARM in the Environmental Protection Agency; Consumer Product Safety Commission; Department of Health and Human Services; and Department of Labor. Moreover, for State regulation of NARM, the paper reported that the 29 Agreement States regulated discrete

sources of NARM in the same manner as Atomic Energy Act material. In the 21 non-Agreement States, 4 States had NARM licensing programs, 2 States had voluntary or partial licensing programs, and 14 States had registration programs, leaving 1 State, Montana, with nothing. All Agreement States and 14 non-Agreement States inspected NARM users. Four non-Agreement States conducted partial inspections, where as five States did not inspect NARM users. To clarify the issue of whether NRC should regulate NARM, the staff presented eight questions.

- Is there a national problem with NARM?
- Are there currently integrated Federal controls over NARM?
- Would NRC regulation of NARM overlap other Federal agencies' programs?
- Are the States' controls over NARM adequate?
- Is NARM a Federal, State, or professional responsibility?
- Would Congress consider NRC responsible for controlling NARM hazards?
- What are the resource implications?
- Would NRC responsibility for NARM regulation change the nature of NRC?

This SECY Paper concluded with two recommendations.

- Refer the issue of NARM regulation to the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC), for the purposes of developing an integrated policy and agency assignments on NARM, in particular, and ionizing radiation, in general, in those situations where agency jurisdictions overlap (e.g., Federal regulatory programs involving health care activities).
- Inform the Governors of the States not within the "Conference of Radiation Control Program Directors (CRCPD) Recognized NARM Licensing States" program that NRC is not seeking legislative authority to regulate NARM because such regulation is a responsibility of the States, and because other Federal agencies already have jurisdiction over most facets of NARM hazards; urge those Governors to take the necessary actions and to assign appropriate resources to become recognized NARM Licensing States.

In the Staff Requirements Memorandum for SECY-88-64, dated July 20, 1988, the Commission approved letters to the President's Science Advisor (who was the chair of the Federal Coordinating Council for Science, Engineering, and Technology that administratively created CIRRPC), and CRCPD. These letters referred the issue of Federal regulation of NARM to CIRRPC.

In SECY-92-325 [Encl. 6] in September 1992, the staff reevaluated and reported to the Commission on the public health and safety significance of discrete sources of NARM, and evaluated whether legislation extending NRC's jurisdiction to include NARM was necessary or desirable. This paper concluded that:

- The Commission should not seek legislative authority to extend its jurisdiction over the regulation of discrete NARM;
- Further NRC efforts related to discrete NARM should focus on assisting EPA in its efforts to apply the Toxic Substances Control Act to NARM and be conducted pursuant to the NRC-EPA Memorandum of Understanding dated March 16, 1992; and
- The NRC should inform the CRCPD, by letter, that the Commission will not seek legislative authority to regulate NARM, and indicate Commission support of the ongoing CRCPD program.

In the Staff Requirements Memorandum for SECY-92-235, dated October 15, 1992, the Commission did not object to the staff position to not seek legislative authority over NARM, instructed the staff to so inform CRCPD by letter, and asked the staff to assist EPA in their efforts to address NARM under the Toxic Substances Control Act.

In September 1996 in Direction-Setting Issue 7 [Encl. 7], the staff identified options for the Commission's consideration for whether to continue to regulate or to revise its oversight of the medical uses of nuclear byproduct materials. The issue paper discussed five options.

- Expand NRC's regulatory responsibility to include x-ray, accelerators, and NARM.
- Continue the ongoing program, with improvements.
- Decrease oversight of low-risk activities with continued emphasis of high-risk activities.
- Discontinue regulation of all medical activities, except sealed sources and devices.
- Discontinue the materials program.

At that time, the Commission favored a combination of the second and third options. But in implementing the third option, the Commission wanted to use a risk-informed performance-based approach.

To summarize the staff's earlier work, SECY Papers from April and December 1978, March 1988, and September 1992 have made recommendations to the Commission on whether to extend NRC's statutory authority. On each occasion the result has been that the Commission did not seek to expand its statutory authority to include NARM.

Enclosures:

1. NUREG-0301, "Regulation of Naturally Occurring and Accelerator-Produced Radioactive Materials - A Task Force Review," published July 1977
2. SECY-78-211, "Final Recommendations of the Task Force on Regulation of Naturally Occurring and Accelerator-Produced Radioactive Materials," April 1978
3. SECY-78-667, "NRC Action on NARM Task Force Recommendation," December 1978
4. NUREG-0976, "Regulation of Naturally Occurring and Accelerator-Produced Radioactive Materials - An Update," published October 1984
5. SECY-88-64, "Naturally Occurring and Accelerator-Produced Radioactive Materials," March 1988
6. SECY-92-325, "Characterization of Discrete NARM and Evaluation of the Need to Seek Legislation Extending NRC Authority to Discrete NARM," September 1992
7. Strategic Assessment Issue Paper, Direction-Setting Issue 7 - Materials/Medical Oversight, September 1996

Staff Exhibit 8

"Evaluation of EPA's Guidelines for Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM)" (June 2000)

United States Environmental Protection Agency | Air and Radiation (6608J) | EPA 402-R-00-01 June 2000

Evaluation of EPA's Guidelines for Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM)

Report to Congress

Executive Summary

In reports accompanying the appropriations bills for the Departments of Veterans Affairs, Housing and Urban Development, and Independent Agencies for Fiscal Years 1996 and 1997, Congress requested the EPA arrange for the National Academy of Sciences (NAS) to conduct a study examining the basis for EPA's guidance on technologically enhanced naturally occurring radioactive material (TENORM). EPA was to submit the completed NAS study to Congress, along with Agency's own report on what it would do to implement the NAS's recommendations, including EPA's plans to revise its TENORM guidance documents. This report has been prepared to satisfy that requirement regarding TENORM.

In January 1999, the NAS published its report entitled, "Evaluation of Guidelines for Exposures to Technologically Enhanced Naturally Occurring Radioactive Materials." In this report, the NAS Committee found that there are differences in TENORM guidelines among federal agencies and others. The Committee found that these differences in guidelines represent differences in policies for risk management rather than differences in the technical evaluation of TENORM.

Although the NAS Committee found that most of the relevant and appropriate scientific information has already been incorporated into current TENORM guidelines, many of the Committee's recommendations point to areas where new information would be useful. For example, the Committee recommended further investigation of the varying chemical and physical forms of TENORM, and the development of better techniques to distinguish discrete TENORM levels from background radiation levels. EPA is already working in many of the areas the Committee cited for additional technical information.

EPA recognizes that there are differences in TENORM regulations and guidance documents among organizations. EPA intends to take into consideration the significance of TENORM risks to the public and the environment to determine which TENORM wastes should be addressed first and what actions, if any, should be taken in response to potential risks. EPA is working in virtually all areas of the NAS Committee's recommendations. In areas where EPA is not currently engaged, the Agency acknowledges the recommendations of the NAS. EPA will consult, as appropriate, with federal, state and other organizations involved with radiation protection issues as we progress toward TENORM solutions.

Evaluation of EPA's Guidelines on Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) Report to Congress

Introduction

Over the past 20 years, EPA and other federal as well as state government agencies, industries, and other organizations have identified an array of naturally occurring materials that, because of human activity, may present a radiation hazard to people and the environment. These materials are known generally as technologically enhanced naturally occurring radioactive materials, or TENORM.[1] In general terms, TENORM is material containing radionuclides that are present naturally in rocks, soils, water, and minerals and that have become concentrated and/or exposed to the accessible environment as a result of human activities such as manufacturing, water treatment, or mining operations. In its report,[2] the Committee on Evaluation of EPA Guidelines for Exposure to Naturally Occurring Radioactive Materials, of the National Academy of Sciences and National Academy of Engineering (the "NAS Committee" or "the Committee") defines TENORM as *"any naturally occurring material not subject to regulation under the Atomic Energy Act whose radionuclide concentrations or potential for human exposure have been increased above levels encountered in the natural state by human activities"* (p. 19). Much TENORM contains only trace amounts of radiation and is part of our everyday landscape. Some TENORM, however, contains very high concentrations of radionuclides that can produce harmful exposure levels. EPA is concerned about TENORM because of this potential for harmful exposure to humans and the environment.

In reports accompanying the appropriations bills for the Departments of Veterans Affairs, Housing and Urban Development, and Independent Agencies for Fiscal Years 1996[3] and 1997,[4] Congress requested that EPA arrange for the NAS to conduct a study examining the basis for EPA's TENORM and radon guidance. EPA was to submit the completed NAS study to Congress, along

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[1]Before 1998, the term used for these materials was "Naturally Occurring Radioactive Materials" ("NORM"). Based on more current industry and regulatory practice, the term "TENORM" now is considered more appropriate. We use "TENORM" throughout this report.

[2]Committee on Evaluation of EPA Guidelines for Exposure to Naturally Occurring Radioactive Materials, National Research Council of the National Academy of Sciences and National Academy of Engineering, "Evaluation of Guidelines for Exposures to Technologically Enhanced Naturally Occurring Radioactive Materials," 1999. Citations to this NAS Committee's report appear in parenthesis containing page citations.

[3]H.R. Rep. No. 104-384, p. 77 (1995).

[4]S. Rep. No. 104-318, p. 69 (1996).

with the Agency's own report on what it would do to implement the NAS's recommendations, including EPA's plans to revise its TENORM guidance documents. This report has been prepared to satisfy that requirement regarding TENORM. In February 1998, the NAS released the BEIR VI report entitled "Health Effects of Exposure to Radon." This new report is the most definitive accumulation of scientific data on indoor radon. The Agency is in the process of reviewing whether the BEIR VI findings warrant any changes in EPA's radon policy and will be issuing a separate Report to Congress on this issue.

Background

TENORM is found in a wide variety of waste materials, some raw mineral ores, and in trace amounts in some consumer products where molecules of radionuclides may be bound to specific minerals used in the manufacturing process (zircon, for example, contains minute quantities of uranium and thorium and used widely as a glaze for ceramics and metal molds). The radionuclide Radium-226, a decay product of uranium and thorium with a radiation decay half-life of 1600years, commonly is found in TENORM materials and wastes and is the principal source of radiation doses to humans for natural surroundings. While normally occurring in soils of the United States[5] at concentrations ranging from less than 1 to slightly more than 4 picocuries per gram (pCi/g, where picocuries are a measure of radiation content in a material), Radium-226 in TENORM materials can occur in concentrations ranging from undetectable amounts to as much as several hundred thousand pCi/g. In comparison, EPA has issued guidance[6] that recommends that radioactively contaminated soils should be cleaned up so remnant radium concentrations are 5 pCi/g or less. Uranium, thorium and potassium radionuclides and their daughter products are also commonly found in TENORM wastes.

Total amounts of TENORM wastes produced in the Untied States annually may be in excess of 1 billion tons.[7] Nuclear Regulatory Commission (NRC) staff calculations show that the disposal the

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[5]Myrick, T., Berven, B., and Haywood, "Determination of Concentrations of Selected Radionuclides in Surface Soil in the U.S.," in Health Physics Journal, Vol. 45, no.3, pp. 631-642, 1983.

[6]U.S. EPA, 1998, Memorandum on Use of Soil Cleanup Criteria in 40CFR Part 192 as Remediation Goals for CERCLA Sites, Signed by Stephen T. Luftig, Director, Office of Emergency and Remedial Response, and Larry Weinstock, Acting Director, Office of Radiation and Indoor Air. Directive No. 92000.4-25, February 12, 1998.

[7]S. Cohen and Associates, Inc., 1993, Preliminary Risk Assessment of Diffuse NORM Wastes, Prepared for U.S. EPA under contract No. 68D20155, May 1993. (EPA will not be finalizing this report. Instead, the Agency will be issuing a series of technical reports on a waste-specific basis. These reports will include the most current information on the waste.)

annual production of TENORM in industrial landfills could easily exceed $100 billion.[8] In many cases, relatively low levels of radiation occur in large volumes of material that contain the TENORM. This situation causes a dilemma because of the high cost of disposing of radioactive waste in comparison with (in many cases) the relatively low value per ton of the product from which the TENORM is separated. In addition, relatively few landfills or other licensed disposal locations can accept radioactive waste. However, TENORM materials exempt from NRC regulation are routinely disposed of without being labeled "radioactive material." Also, large quantities of TENORM are currently undisposed and may be found in many of the thousands of abandoned mine sites around the nation.[9]

Table 1, in Appendix A, provides a range of reported concentrations, and average concentration measurement in some cases, of TENORM in various wastes and materials. This table is not a comprehensive list, as TENORM radiation is known to occur in many other materials; however, it should provide a relative sense of the hazards posed by these particular radioactive substances.

NAS Committee's Report

In the conference report accompanying H.R. 2099, the FY 1996 appropriations bill for the Department of Veterans Affairs and Housing and Urban Development, and Independent Agencies, the conferees included the following language:

> The conferees direct EPA to enter into and arrangement with the National Academy of Sciences to investigate and report on the scientific basis for EPA's recommendations relative to indoor radon and other naturally occurring radioactive materials (NORM). The Academy is to examine EPA's guidelines in light of the recommendations of the National Council of Radiation Protection and Measurements and other peer-reviewed research by the National Cancer Institute, the Centers for Disease Control, and others. The Academy shall summarize the principal areas of agreement and disagreement among these bodies and shall evaluate the scientific and technical basis for any differences that exist. EPA is to submit this report to the appropriate committees of the Congress with 18 months of the date of the enactment of this act, and state its views on the need to revise the guidelines for radon and NORM in light of the Academy's evaluation. The agency also shall explain the technical and policy basis for such views.[10]

EPA entered into an agreement with the NAS on March 31, 1997, to respond to the

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[8] New Jersey Department of Environment Protection, Commission on Radiation Protection, Soil Remediation for Radioactive Materials Proposed New Rules: N.J.A.C. 7:28-12, DEP Docket Number 11-99-06-697.

[9] S. Cohen and Associates, Inc. 1989, Radiological Monitoring at Inactive Surface Mines, report prepared for the U.S. Environmental Protection Agency, February, 1989.

[10] H.R. Rep. No. 104-384, at 77 (1995).

congressional requirement and reported the signing of the agreement to the Appropriations Committee as requested in 1997. The NAS Committee published its study in January 1999. EPA's transmittal to Congress of the NAS Committee study, along with this report by EPA, fulfills the legislative requirements discussed above.[11]

The purpose of the NAS Committee's study was to investigate the scientific and technical bases for EPA's TENORM guidelines. Congress instructed that, as part of its investigation and report, the NAS Committee "summarize the principal areas of agreement and disagreement among [EPA and other organizations] and ...evaluate the scientific and technical basis for any differences that exist."[12]

The NAS Committee's charge included examining the following issues:

1) ***Whether the differences in the guidelines for TENORM developed by EPA and other organizations are based upon scientific and technical information, or on policy decisions related to risk management.***

2) ***If the guidelines developed by EPA and other organizations differ in their scientific and technical bases, what are the relative merits of the different scientific and technical assumptions?***

3) ***Whether there is relevant and appropriate scientific information that has not been used in the development of contemporary risk analysis for NORM.***

The NAS examined and compared the existing guidelines for TENORM developed by EPA and other organizations concerned with radiation protection. These other organizations include the Department of Energy, the Nuclear Regulatory Commission, the National Council on Radiation Protection and Measurements, the International Commission on Radiological Protection, the International Atomic Energy Agency, the Commission of European Communities, and the Health Physics Society. The NAS also reviewed guidelines published by the individual states.

NAS Committee's Conclusions

The NAS Committee made the following conclusions in response to the charge elements:

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[11] The NAS report also presents an evaluation of the guidelines for indoor radon. The Committee found that this evaluation was relatively straightforward because the guidelines for the indoor radon exposure situation are well defined and the primary task for the Committee was to evaluate whether the differences among the various guidelines have a scientific and technical basis. This report does not address indoor radon guidelines because we are in the process of reviewing the NAS BEIR VI report and plan to send a report to Congress indicating whether the BEIR VI findings warrant any changes in EPA's policy on radon.

[12] H.R. Rep. No. 104-384,p. 77 (1995).

(1) Whether the differences in the guidelines for TENORM developed by EPA and other organizations are based upon scientific and technical information, or on policy decisions related to risk management.

The NAS Committee conducted a comprehensive review of guidance and regulations, developed by regulatory and advisory organizations, for indoor radon and other TENORM substances. The Committee found that "*differences in the guidelines for TENORM developed by EPA and other organizations are based essentially on differences in policy judgements for risk management*" (pp. 4-5, 215-217).

The NAS Committee also found that the information used to evaluate risk from ionizing radiation arising from TENORM and other (generally man-made) sources of ionizing radiation was, and should be, the same. The risk assessment methods for TENORM are not different from methods used for assessing risk from other sources of ionizing radiation because absorbed dose (or risk) depends on radiation type (e.g., alpha, beta, gamma) and its energy, not the source. The NAS found that all of the organizations use epidemiological data developed from radon exposures of underground miners as the basis for risk assumptions involving indoor radon (p. 219). All the organizations also used the epidemiologic data gained from studies of Japanese atomic-bomb survivors, as extrapolated to the low doses of concern in environmental exposures, as the basis for TENORM guidelines, other than indoor radon (p. 219). Finally, all organizations that developed guidelines for TENORM accepted a linear, no-threshold dose-response relationship at low levels of exposure (p. 244).

(2) If the guidelines developed by EPA and other organizations differ in their scientific and technical bases, what are the relative merits of the different scientific and technical assumptions?

The Committee found this question to be moot, because the differences between current EPA risk assessment methods and those used by other organizations were not substantially different, and did not have a significant influence on the development of TENORM guidelines (p.6).

(3) Whether there is relevant and appropriate scientific information that has not been used in the development of contemporary risk analysis for NORM.

The NAS Committee identified research needs that could improve EPA's understanding of TENORM. It did not, however, find "*a substantial body of relevant and appropriate scientific information that has been used in the development and implementation of contemporary risk analysis for TENORM for purposes of developing and implementing guidelines*" (p.243).

Risk Management Issues

The NAS Committee was not tasked with, nor initially concerned with, evaluating nonscientific risk management issues such as cost and policy judgements. However, because the NAS found that

the bases for the differences in the various agencies, TENORM guidelines rested primarily on these factors, rather than on scientific or technical factors, it identified important policy judgements that influenced the development of TENORM guidelines. The NAS did not, however, evaluate the merits of these policy judgements. These judgements vary from organization to organization because of policy decisions that may be based, in part, on congressional requirements or judicial decisions (pp. 145-146).

In its evaluation of the guidelines developed for TENORM by EPA and other organizations, the NAS Committee determined that, though all the guidelines and standards it evaluated were developed to protect individuals and populations from harmful effects of ionizing radiation, because of different statutory mandates, risk management approaches, and exposure situations, and expectation of consistency among these standards would be inappropriate. Each organization bases its radiation protection standards on the organization's judgements regarding several critical policy issues. These judgements include decisions about acceptability of the risk, achievability of the risk reduction, transference of existing guidelines to other exposure situations, and other risk management considerations. The following is a summary of the NAS discussion of these risk management issues.

Acceptability of Risk

The NAS concluded that different judgements on the maximum acceptable risk to the public have led to different risk management approaches. These approaches reflect in part the fundamental differences in each organization's statutory and judicial mandates, particularly a requirement to set a regulatory limit such as a standard that must be met, versus a regulatory goal that can be relaxed based on considerations embodied in other guidelines. Another critical difference dictated by statute is the applicability of the guidelines to either a specific environmental media (e.g., air) or pathway (e.g., drinking water), or a more extensive all-media, all-pathways limit. The NAS noted that a single source and exposure pathway standard would not be expected to be consistent with an all-source-and-exposure pathway standard. Further, the NAS noted that the doses and risks for the highest exposed individuals generally will be higher than those for average individuals in the population (pp. 8-10).

Achievability of Risk Reduction

The NAS noted in its report that EPA's judgement on the achievability of reducing the risk to public health considers the available technologies to control or reduce releases of radionuclides into the environment (p. 92). Organizations incorporate such judgements into regulations and guidance documents, depending on each organization's risk management approach. The organization's definition (or judgement) of achievable risk reduction depends largely on the application of the principle that exposures of individuals and populations should be as low as reasonably achievable (ALARA). An organization may incorporate the results of an ALARA application indirectly into a regulation in the standard setting process itself - as is the case for many EPA standards in setting a regulatory goal. Alternatively, the appropriate regulatory authority may require ALARA, in practice, to be carried out directly, in addition to the regulatory limit. For example, the Committee noted that "*compliance with the [ICRP's and NCRP's] primary dose limit of 1 mSv (100 mrem) per year for all controlled*

sources combined does not, by itself, provide acceptable radiation protection of the public, because doses should be reduced as far below the primary dose limit as practicable" (p. 93).

In spite of the differences in risk management approaches, and the consequent substantial differences in implied risk associated with the different guidelines (implied health risks vary over several orders of magnitude), the Committee concluded that "*[t]he principle that exposures should be maintained ALARA, economic and social factors being taken into account, appears to be the most important factor in determining risks actually experienced for any controllable exposure situation*" (p. 247). Therefore, to the extent that the ALARA objective is applied consistently to all exposure situations, all guidelines would be consistent with regard to the risks actually achieved, even though the risks that are ALARA can depend significantly on the particular exposure situation. The Committee also noted that, using the ALARA process, "*[t]here is not a priori reason to expect risks judged reasonably achievable for one exposure situation (such as releases from operating nuclear facilities) to be consistent with risks judged reasonably achievable for a different situation (such as radioactive waste disposal).*" (p.148) Finally, the Committee concluded that the current differences in approach for radiation risk management, though confusing, do not result in important differences in public health protection. However, "*continued attention to the factors that affect radiation dose and risk for specific TENORM situations is crucial for consistently protective, cost-effective radiation control.*" (p.247)

Although there are significant differences in radiation protection standards developed by the Federal agencies, the NAS Committee concluded that these differences do not result in important differences in public health protection; it is also important to note that in some cases the differences are for legitimate reasons. For example, NRC regulates its licensees under the ADA, for the most part on a site-by-site basis under the "umbrella" of an upper-bound dose limit, which is based on international and national recommendations from the ICRP and NCRP. The limit is coupled with the required application for procedures and engineering controls to reduce the potential public doses to levels that are ALARA. EPA, in its primary role as a standards-settings agency, regulates under the authority of both the AEA and environmental statues. EPA regulates by class of facility or source, pollutant, or environmental medium. In setting its standards, EPA generally establishes a goal, often mandated by legislation, and considers technological feasibility, costs, and other factors in determining levels to be achieved in practice. Although not required, EPA aims for consistent regulatory policy concerning standards for radionuclides and chemicals.

Transfer of Existing Guidelines

The Committee found that another important factor in the development of standards or guidelines for TENORM is an organization's judgement about transferability of existing standards/guidelines to other exposure situations. As the NAS stated. "*[t]he committee strongly cautions against generalizing numerical guidance derived for a specific situation to another situation without sufficient thought as to the applicability to the new circumstance.*" "*[Because] many sources of TENORM have mineralogical characteristics and processing histories,...and*

therefore, have different radon-emanation coefficients, leachability, and bioavailability." (p. 246) The NAS recommended that organizations limit the transfer of standards or guidelines by the degree to which the physical and chemical properties and projected exposure pathways of the TENORM are substantially similar to those considered for existing guidelines. Exemption levels should consider the physical characteristics of a site, the extent of the TENORM source, and the projected land use.

Regulations and Guidelines

The NAS Committee noted that EPA has developed standards under several different environmental laws for the regulation of TENORM, including the Clean Air Act (CAA), the Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Committee found, however, that "*neither EPA, which has primary responsibility for setting federal radiation standards, nor any other federal agency with responsibility for regulating radiation exposures has developed standards applicable to all exposure situations that involve TENORM. Instead, federal regulation of TENORM is fragmentary, and many potentially important sources of public exposure to TENORM are not regulated by any federal agency*" (p. 246).

<u>Recommendations on Additional Research Needs</u>

The NAS identified a number of areas in which it recommends that EPA conduct additional research and study regarding TENORM. A discussion of these recommendations, and EPA's responses, follows.

Recommendation: **EPA'S ASSESSMENTS OF RISKS FROM TENORM SHOULD INCLUDE ASSESSMENTS OF EXISTING BACKGROUND RADIATION LEVELS**

EPA's Response:

The NAS Committee emphasized the importance of considering exposure to TENORM in the context of natural background radiation levels (p. 248). The Committee concluded that background radiation levels are highly relevant to TENORM regulation because the radionuclides in TENORM are identical to the radionuclides in nature. The NAS Committee urged EPA to include in our assessment of TENORM-related risks an assessment of existing background radiation and the risks that this radiation contributes to overall risks from radiation exposure. It noted that "*[a]rguments concerning small differences in the target regulatory level at small fractions of the natural background tend to pale into insignificance in comparison with natural background levels and their local and regional variations*" (p. 248). The Committee also stated that, "*[a]s a practical matter, the implications of [the] existing levels and [the] variability of natural radionuclide concentrations and doses received by humans should receive careful consideration in the*

regulation of TENORM" (p.248).

EPA agrees that the levels of background radiation need to be considered in the assessment of TENORM. EPA's radiation regulations limit the amount of radiation above background because the radiation is controllable or was placed there by man and should be controllable, unlike radioactive materials not generated by man. There are numerous studies of background exposure dose and risk (e.g., NCRP Report 94, "Exposure of Populations in the US and Canada from Natural Background Radiation" and the National Research Council's, "Risk Assessment of Radon in Drinking Water").

Guidance has also been developed to help in the process of demonstrating compliance when background radioactivity is present and is variable. An example of this guidance is the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) which is used to characterize contaminated sites. EPA will continue to take into account these important background and radioactivity studies in developing TENORM guidance and regulations.

Recommendations: EPA SHOULD DEVELOP BETTER TOOLS FOR DISTINGUISHING DISCRETE TENORM FROM BACKGROUND

EPA Response:

Because of the importance that the NAS Committee placed on the role of background radiation in the regulation of TENORM, it recommended that EPA develop better tools for distinguishing discrete TENORM from background radiation levels. Because TENORM radionuclides are ubiquitous in the environment, the NAS Committee expressed concern that the inability to distinguish TENORM from background radiation levels could result in unnecessary or over-broad regulation. The Committee argued, and EPA agrees, that it makes little or no sense to require cleanup of TENORM to levels below those that would exist naturally at a particular location (p.95). This issue is especially important in regards to mining sites because these sites often have background radiation levels that are higher than non-mining sites (p.95).

Data from the National Uranium Resource Evaluation (NURE), state geological surveys, and nuclear power plants databases provide reliable estimates of background radiation for the United States. EPA is incorporating information on background levels of radiation into all aspects of its evaluation of TENORM risks and potential disposal solutions. EPA will include discussions of background radiation in the comprehensive source-specific reports that it will develop for TENORM wastes and products.

A number of private entities, are working to develop detection equipment that can provide more accurate instantaneous field radiation level measurements, on the order of what the NAS Committee recommended, than can the equipment currently available. Regardless of the tools developed for measuring these low levels of radiation, however, EPA's principal concern is still the control of man-made and TENORM sources of radiation.

Recommendation: **EPA SHOULD EXAMINE FURTHER THE CHEMICAL FORMS AND PHYSICAL STRUCTURES OF TENORM AND SHOULD DEVELOP A MORE COMPREHENSIVE SYSTEM TO DOCUMENT THE VARIOUS USES AND DISPERSAL OF TENORM**

EPA Response:

The NAS Committee noted that, "*TENORM present[s] unique problems because of their large volumes and widespread occurrence in industrial products, byproducts, and wastes. The physical, chemical, and radiological properties of TENORM vary widely.*" (p.74)

EPA agrees with the Committee's conclusions about the complexity of TENORM, and for this reason EPA already is working to establish a comprehensive means of documenting significant aspects of TENORM associated with various waste streams or products. EPA will conduct this documentation in cooperation with interested stakeholders, including representatives of state and local governments, industries and non-governmental and other entities. As previously mentioned, these reports will compile the most relevant information on the amount and location of waste, the associated risks, the varying physical structures and chemical forms, current disposal techniques, and applicable guidelines and regulations. The reports will build on efforts conducted across the Agency on specific industries, wastes and products.

For example, through EPA's ongoing field projects, the Agency is gathering new information about TENORM wastes in uranium overburden and in-situ leach operations. EPA also is fostering relationships with the organizations at the forefront of these issues. Through this network of organizations, EPA will be able to continue to build on its comprehensive documentation of TENORM data issues. Once EPA releases a technical report on a particular type of TENORM, the Agency intends to invite a variety of stakeholders to review the report and provide input. At meetings with these stakeholders, EPA expects to gather information on the most appropriate approaches to dealings with the waste hazards, risks, and disposal issues.

Recommendation: **EPA'S EXPOSURE ASSESSMENTS SHOULD CONSIDER TENORM'S BIOAVAILABILITY, LEACHABILITY, AND RADON EMANATION RATES**

EPA Response:

The NAS Committee suggested that EPA consider TENORM's bioavailability, leachability, and radon emanation rates in our assessments of the effects of exposure to TENORM (p.245). The NAS noted the potential importance of these factors in developing TENORM guidelines, and urged us to study them further in order to understand them better (p.245). The Agency is considering these factors, and many others, in our field studies and risk assessment modeling discussed above. EPA will also take them into account its future efforts in to determine how best to address that risks associated with TENORM.

Recommendation: **EPA'S RISK ASSESSMENTS SHOULD INCLUDE CONSIDERATION OF EXPOSURE TO NON-RADIOACTIVE CHEMICAL AGENTS**

EPA Response:

The NAS Committee urged EPA to include in our analysis of risks from exposure to TENORM the effects of the hazardous chemical agents commonly found in combination with TENORM. The development of an understanding of the relationship of the risks posed by mixed hazardous and radioactive wastes is one of the most complex and difficult issues facing the Agency as it tries to address the combined risks to human health and the environment from both radioactive and hazardous materials and wastes. Despite the difficulties associated with always achieving risk harmonization, it is a particularly desirable objective in the TENORM arena because many TENORM-containing wastes are, or have the potential to be, mixed wastes.[13]

Complete harmonization of the risks from hazardous and radioactive substances is particularly difficult to achieve under some statues. For example, the Atomic Energy Act (AEA)[14] authorizes EPA to establish generally applicable standards to protect human health and environment that are based on dose limits or calculations of risk. In contrast, the statute that regulates hazardous wastes, the Resource Conservation and Recovery Act (RCRA)[15], uses either a technology-based, a risk-based or a dose-based, approach to hazardous waste management depending on the situation. Because of these differences in the statutory approaches to protection of human health and the environment, it is extremely difficult to make direct comparisons of the relative protection these statues and their associated regulations provide. However, under other EPA statutes, risks have been harmonized between TENORM and chemicals. The CERCLA and SDWA address TENORM within the same risk management scheme as chemicals, thus accomplishing risk harmonization. The Agency will continue to work on identifying and resolving differences in chemical and radiation risk assessment and management.

Recommendation: **BECAUSE FEDERAL REGULATION OF TENORM IS FRAGMENTARY, GUIDANCE FOR TENORM SHOULD FOCUS ON SPECIFIC PROCESSES; INDUSTRIES; WASTE**

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[13] Mixed wastes are wastes that contain both hazardous and radioactive constituents.

[14] 42 U.S.C. §§ 2011-2296 (1994). The radioactive materials subject to regulation under the AEA include source material, and byproduct material. The definition of "TENORM" used by the Committee in the Evaluation specifically excludes AEA-regulated materials. (p.19)

[15] 42 U.S.C. §§ 6901-6992k (1994).

EPA Response:

The NAS Committee expressed concern that there are no standards that cover all exposure situations that involve TENORM, instead there is a patchwork of inconsistent state and federal regulations. The Committee also expressed concern that the current fragmented federal regulatory framework does not completely cover some important sources of exposure to radiation from TENORM (p.246).

Despite its concerns regarding the fragmented nature of current federal regulation of TENORM, the NAS Committee recognized that development and implementation of a single, uniform national standard would be difficult and should not be expected (p.10). As discussed above, the NAS Committee noted that, although a uniform national standard for TENORM exposure is desirable in order to achieve complete protection from TENORM- related hazards, development of such a standard probably is not possible for a variety of reasons, including differences in statutory and judicial mandates, the primary bases for guidelines, guideline applicability (because of the tremendous variations in the potential sources and forms of TENORM), the population groups of primary concern, and the consideration of the varying levels of natural background radiation (p.246). EPA agrees with the NAS Committee that, while a single uniform national standard for TENORM is desirable, it probably is impossible to craft such a standard because of the tremendous variations in the sources and physical forms of TENORM. Therefore the Agency has focused its efforts on identifying the most potentially problematic sources of the exposures from TENORM and responding accordingly to them.

Further, the NAS Committee advised against applying guidance created to address one specific situation to another situation: "*considerable caution is warranted in transferring standards expressed in terms of activity concentrations* of radionuclides from one exposure situation to another." (p.231). The Committee also stated that it "*generally supports the idea that standards for different exposure situations should be consistent to the extent reasonable, particularly standards expressed in terms of risk or dose.*" (p. 231). The Committee "*strongly caution[ed] against generalizing numerical guidance derived for a specific situation to another situation with sufficient thought as to the applicability [of the numerical guidance] to the new circumstance*" (p.246). For this reason EPA believes that federal guidance or regulation on a source-specific basis is useful to ensure that consistent protection is provided across all states.[16]

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[16] The Conference of Radiation Control Program Directors (CRCPD) has issued model regulation which attempts to cover all TENORM. This approach departs from NAS recommendation. EPA believes it could lead to inconsistent regulation if states choose to modify the model regulation before adoption. EPA will continue to work with CRCPD and states to ensure consistent protection of human health.

EPA is addressing environmental problems relating to TENORM on a specific, rather than on a general basis. The Agency does not anticipate using single board approach for addressing all potential sources of exposure to TENORM. Rather, EPA anticipates taking a more focused approach to addressing environmental and public health concerns from discrete TENORM problems. As the NAS Committee suggested, there are several approaches EPA could take to address the potential public health problems associated with exposure to TENORM. Because of the tremendous diversity in the sources of potential exposure to TENORM, it may be appropriate for the Agency to address this potential exposure from several perspectives. Initially, EPA is developing technical scoping reports on TENORM that are industry or source specific. EPA may use these reports in the future to inform our TENORM policy.

EPA coordinates its radiation protection activities within 15 other federal agencies such as the NRC, the Department of Energy, and the Department of Health and Human Services on the Interagency Steering Committee on Radiation Standards (ISCORS). EPA will continue to coordinate its TENORM activities with other government agencies through the ISCORS TENORM Subcommittee, which EPA chairs.

Recommendation: EXPOSURE AND DOSE OR RISK ASSESSMENTS USED TO DEVELOP STANDARDS SHOULD BE REASONABLY REALISTIC

EPA Response:

The NAS Committee recommended that, in developing standards for exposure to the various types of TENORM, EPA should use exposure and dose risk assessments that are "reasonably realistic" (p.245). The Committee defined "reasonably realistic" as "*not..*

.intended to greatly overestimate or underestimate actual effects for the exposure situation of concern" (p.245).

EPA agrees with the Committee's recommendations that TENORM risk assessments be "reasonably realistic." For EPA, "reasonably realistic" assessments will include a range of potential exposure scenarios for the maximally exposed individual. EPA will document the choices that make for the exposures scenarios. EPA will consult with ISCORS on the development of "reasonably realistic" scenarios for exposure to radiation from TENORM.

Recommendation: THE USE OF STYLIZED METHODS OF EXPOSURE IS APPROPRIATE

EPA Response:

The NAS Committee stated that it is appropriate for us "*to develop stylized methods of exposure and dose risk assessments for assumed reference conditions, provided that the*

assumed conditions are reasonably representative of the exposure situations of concern" (p.245). Stylized methods of exposure are particularly useful in situations involving radionuclides because of the uncertainties involved with making projections of the probabilities of events' occurrences over extremely long time periods. Typically, stylized methods of exposure utilize extreme scenarios. Despite this fact, however, the NAS determined that the use of such methods is appropriate in analyses of potential TENORM exposures. For example, TENORM contains some of the same long-lived level radioactive waste. These radionuclides will persist for the same amount of time in any amount of waste, regardless of their concentration levels. Therefore, as the NAS Committee stated, it is appropriate to utilized stylized methods of exposure as a means of predicting the effects of possible future human exposure to TENORM-containing materials.

EPA will follow the NAS Committee's recommendation to use stylized methods of exposure for appropriate scenarios when EPA evaluates both the radiation hazards and potential disposal options for TENORM. EPA has experience using this approach in other projects involving the management of radioactive wastes; however, the Agency also is committed to examining TENORM issues on a individualized basis by waste or product.

Recommendation: IT IS REASON TO TRUNCATE RISK ASSESSMENT IN TIME

EPA Response:

The NAS Committee concluded that, though there are arguments both for and against EPA's current practice of setting an outer limit on time frames for risk assessments, it is reasonable for EPA to set such limits *"for the purposes of establishing standards and demonstrating compliance"* (pp. 230-31). The Committee also concluded that the selection of an appropriate time at which to truncate risk assessments is "largely a matter of judgement" involving "a considerable degree of arbitrariness," the existence of which the regulatory agencies should acknowledge (p.231).

The Committee recommended that *"calculations of future risks should be carried out at least to the time of maximum projected effects, regardless of when they occur, even if the results are not used in establishing standards or in demonstrating compliance"* (p.231). The Committee concluded that *"presentation of the full range of information about future risks should add value to risk assessment, even if not all the information is used in decision-making"* (p.231).

EPA agrees that both technical and policy considerations can be the basis for time frames used to set standards or judge compliance. The Agency also agrees that information may be gained by extending risk assessments. This information sometimes is useful in exploring options, even if the information is not used directly in setting standards.

<u>EPA Approach To TENORM</u>

TENORM is particularly challenging problem because many industries generate it in varying amounts. Moreover, generation of TENORM occurs in a wide variety of materials and locations. Although EPA and others already have learned much about TENORM, we still do not understand fully all the potential radiation risks it presents to humans and the environment. EPA will continue to better understand the potential problems associated with TENORM and to develop effective ways to protect humans and environment from harmful exposure to the radiation in these materials.

EPA's TENORM strategy focuses on developing a program to address the diversity of TENORM's physical and chemical forms, and the issues associated with regulating these materials. We envision that this comprehensive strategy will enable EPA to effectively identify and address the most important issues concerning TENORM exposure. Of course, execution of this strategy is subject to the availability of resources.

EPA is pursuing a for-pronged approach to the problem.

1. **Study and report on TENORM sources to determine what's in the wastes and how much risk the waste pose.**

EPA is studying TENORM sources in the United States to learn which aspects of the problem, including health and environment risks, are unique to a given source and which are common across all sources. The results of these studies will appear as a series of reports on individual sources. Each report will contain information on the:

- ¥ generation of TENORM by source;
- ¥ volumes of the TENORM generated annually, and unreclaimed volumes;
- ¥ physical and chemical characteristics of the TENORM;
- ¥ ways that people could be exposed to specific TENORM sources;
- ¥ potential effects of exposure to TENORM
- ¥ how the sources are handled or disposed of;
- ¥ current guidelines or regulations; and
- ¥ ways the sites are reclaimed for safety and radiation protection.

This effort will result in a source-by-source synthesis of all the currently available information on TENORM. As the NAS Committee recommended, these source-specific reports will document TENORM's physical and chemical forms and disposal options. The reports also will discuss the influence of background radiation on the analysis of TENORM.

2. **Identify and study existing TENORM sites to assemble a nation-wide view of the potential problems associated with TENORM: where the wastes are, what's in them, and the risks they present.**

This effort consists of a variety of field projects that will give EPA more information on the sources, characteristics and risks of TENORM. These field projects will expand knowledge of

TENORM uses and disposal and the physical and chemical characteristics of the TENORM. In addition, the field projects will establish contacts between EPA and individuals who produce or manage TENORM industries, wastes, and products.

3. **Develop and provide education and guidance for safely and economically cleaning up and disposing of TENORM wastes.**

EPA will provide guidance to those who deal with TENORM cleanup and disposal problems.

Studies of existing TENORM sites will give us information we need to select appropriate methods for estimating risks from these sites, the best ways to clean up the sites, and the most economical ways to dispose of the TENORM.

On the basis of technical scoping reports on TENORM wastes and products, as well as stakeholder meetings, public hearings, and other mechanisms, EPA will identify the principal problems and issues for each source of TENORM. Using this information, we will make decisions on the most appropriate response to TENORM-related exposures. These responses could range from developing industry and public oriented educational materials on radiation protection from TENORM hazards; to developing guidance; to promulgating regulations, if necessary, for providing for safe and economically viable means to treat and dispose of the wastes.

4. **Work with other organizations that are confronting the problem of TENORM, including states, tribes, other federal agencies, industry and environmental groups, and international organizations.**

Because of the variety of TENORM sources and exposure scenarios, working with a variety of organizations is integral to EPA's TENORM strategy. EPA is focusing on coordinating TENORM activities with states, tribes, federal agencies, industry, environmental, and international organizations to enhance data and information sharing, to combine TENORM resources, and to avoid duplicative efforts.

EPA already is building the foundation for working with these groups through a variety of ongoing projects. As a result of these projects, EPA recognizes the need for community education on radiation exposure. For example, a need for education on radiation exposure has also been identified by Navajo community leaders and educators. Both EPA and the Navajo community agree that children and adults need to be aware of the hazards from living and working near contaminated uranium mining sites. These communities all want to know how to minimize their exposure.

EPA also is working with other federal agencies through the NORM Subcommittee of the Interagency Steering Committee on Radiation Standards, to develop guidance and disposal options for TENORM. Agencies also work directly together, outside the ISCORS framework, on specific issues. For example, on March 19, 2000, the NRC required its staff to initiate discussions with EPA and the

States to assess their willingness to assume responsibilities for regulating materials containing less than 0.05% uranium and/or throium (SECY-99-259). EPA will continue to engage directly with appropriate Federal agencies when addressing a specific source of TENORM.

Working with these organizations from the beginning will help EPA develop the appropriate public education, guidance, regulations and disposal options for TENORM. Input from these groups from problem identification to education and solutions will be essential to the success of any TENORM strategy.

Conclusions

In summary, the NAS Committee found that there are differences in TENORM guidelines among federal agencies and others. The Committee found that those differences in guidelines represent differences in policies for risk management rather than differences in the technical evaluation of TENORM (p. 243). EPA intends to incorporate most of the recommendations of the NAS Committee.

Although the NAS Committee found that most of the relevant and appropriate scientific information has already been incorporated into current TENORM guidelines, many of the Committee's recommendations point to areas where new information would be useful. For example, the Committee recommended further investigation of the varying chemical and physical forms of TENORM, and the development of better techniques to distinguish discrete TENORM levels from background radiation levels. As noted previously, EPA is already working in many of the areas the Committee cited for additional technical information.

EPA recognizes that there are differences in TENORM regulations and guidance documents among organizations. EPA intends to take into consideration the significance of TENORM risks to the public and the environment to determine which TENORM wastes should be addressed first and what actions, if any, should be taken in response to the potential risks. EPA is working in virtually all areas of the NAS Committee's recommendations. In areas where EPA is not currently engaged, the Agency acknowledges the recommendations of the NAS. EPA will consult, as appropriate, with federal, state and other organizations involved with radiation protection issues as we progress toward TENORM solutions.

Appendix A - Table 1, TENORM Materials and References

As a comparison to background levels, radium 226 concentrations in soils of the U.S. are shown at the top of the table.

TENORM Material	Range of Radioactivity Concentrations, Radium 226		
	Low	Average	High
Soils of the United States[1]	0.2	1.1	4.2
Uranium Mining Overburden[2]	3	3.0	low hundreds
Uranium In-Situ Leach Evaporation Pond Solids[3]	300	-	3,000
Phosphate Ore (Florida)[4] Phosphogypsum[5] Phosphate Fertilizer[6]	7	17.3-39.5 11.7-24.5 5.7	6.2-53.5 36.7 21
Coal Ash[7] -Bottom Ash Fly Ash	1.6 2	3.5-4.6 5.8	7.7 9.7
)leum (oil and gas) Produced Water[8] Pipe/Tank Scale[9]	0.1 pCi/l <0.25 pCi/g	- <200 pCi/g	9000 pCi/l >100,000 pCi/g
Water Treatment Sludge[10] Treatment Plant Filters[11]	1.3 pCi/l -	11 pCi/l 40,000 pCi/g	11,686 pCi/l -
Rare Earths[12] Monazite Xenotime Bastnasite	5.7	-	3,244
Titanium Ores[13] Rutile Ilmenite Wastes	3.9 - - -	8.0 19.7 5.7 12	24.5 - - -
Zircon[14] Wastes	- 87	68 -	- 1300
Aluminum[15] (Bauxite) Ores Product Wastes	4.4 - -	- 0.23 3.9-5.6	7.4 - -
Copper Wastes[16]	0.7	12	82.6
Geothermal Energy Waste Scales[17]	10	132	254

cates data are not available

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