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Ms. Elaine Brummett
Division of Waste Management - NMSS
U.S. Nuclear Regulatory Commission
Two White Flint North T7-J09
11555 Rockville Pike
Rockville, MD 20852

DOCKET NO.
40-8905

SUBJECT: REPORT OF CONFIRMATORY ACTIVITIES FOR THE QUIVIRA MINING COMPANY-AMBROSIA LAKE FACILITY WINDBLOWN TAILINGS DECOMMISSIONING PROGRAM, GRANTS, NEW MEXICO (DOCKET NO. 40-8905; RFTA NO. 99-041)

Dear Ms. Brummett:

Enclosed is the subject report for the Quivira Mining Company-Ambrosia Lake Facility in Grants, New Mexico. This report provides the results of the on-site confirmatory activities that personnel from the U.S. Nuclear Regulatory Commission (NRC) and the Enviromental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education performed during the period November 8 through 10, 1999. These activities included a review of the licensee's overall decommissioning program combined with independent confirmatory surveys. Site methods for remediating windblown tailings, performing radiological surveys, collecting and analyzing samples, and managing and documenting data were reviewed. Surveys consisted of gamma surface scans and soil sampling of selected remediated windblown tailings, evaporation pond, and background areas. These activities were conducted in order to assist the NRC in determining whether the licensee's decommissioning program is adequate to demonstrate compliance with the decommissioning criteria.

If you have any questions, please direct them to me at (865) 576-5073 or Eric Abelquist at (865) 576-3740.

Sincerely,

Timothy J. Vitkus
Survey Projects Manager
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TJV:klp

Enclosure

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REPORT OF CONFIRMATORY ACTIVITIES FOR THE QUIVIRA MINING COMPANY-AMBROSIA LAKE FACILITY WINDBLOWN TAILINGS DECOMMISSIONING PROGRAM GRANTS, NEW MEXICO

Provided below is the report for the confirmatory activities for the Quivira Mining Company-Ambrosia Lake Facility, Grants, New Mexico (Figures 1 and 2). These activities generally followed the checklist listed below. This checklist was originally provided to and approved by the NRC in a October 29,1999 correspondence entitled *Proposed Site-Specific Decommissioning Inspection Plan for the Quivira Mining Company-Ambrosia Lake Facility, Grants, New Mexico.* The major elements of which included the following six areas:

1.0 GENERAL

2.0 IDENTIFICATION OF CONTAMINANTS AND GUIDELINES

3.0 FINAL STATUS SURVEY PROCEDURES AND INSTRUMENTATION

4.0 ANALYTICAL PROCEDURES FOR SOIL SAMPLES

5.0 FINAL STATUS SURVEY RESULTS

6.0 MISCELLANEOUS

The following NRC Inspection Procedures were used for guidance, in part, during this inspection:

- MC 1230 Quality Assurance Program for Radiological Confirmatory Measurements
- MC 2560 Decommissioning Inspection Program
- MC 2602 Decommissioning Inspection Program for Fuel Cycle Facilities and Materials Licensees
- MC 2801 11e.(2) Byproduct Material Disposal Site and Facility Inspection Program
- Procedure 83890 Closeout and Inspection Survey
- Procedure 87654 Uranium Mill Site Decommissioning Inspection

Portions of the following documents were used for guidance during this inspection:

- NUREG/CR-5849 Manual for Conducting Radiological Surveys in Support of License Termination
- NUREG-1575 Multi-Agency Radiation Survey and Site Investigation Manual

1.0 GENERAL

1.1 Review the past operational radiological surveys that were used to demonstrate radiological control of the uranium mill site. Are there any records of spills or other releases of yellowcake? If so, do the records adequately document the cleanup of these releases of material? [Note: The scope of this inspection did not include the uranium mill facility itself or the adjacent area, as the mill remains in standby status.]

- Interviews of the site personnel indicated the greatest potential for spills outside of the uranium mill facility, which was not included as part of the inspection, was from the raffinate pipelines leading to the storage ponds. There were no known releases of materials from these pipelines. Furthermore, the licensee states in their October 19, 1999 Windblown Program information package that "By the end of 1982 nearly 31 million tons of tailing solids had been deposited at the site since startup and no failures allowing discharge of radioactive material outside the restricted area have occurred".

1.2 Review the results of characterization surveys for justification of the classification of evaporation ponds # 4 through 10 and windblown tailings areas as affected or unaffected.

Data reviews and discussions with the licensee determined the following relative to characterization and site classification:

- The licensee did not formally designate areas of the site as affected or unaffected. The site was essentially classified based on being either a windblown area, a pond area or the uranium mill area. Numerous ponds exist on the site with Ponds 1, 2, and 3 comprising the main disposal areas for tailings. Ponds 4 through 10 were all used as evaporation ponds for the clear tailings liquids and are contaminated. In 1987, the licensee initiated site characterization and decommissioning by performing μR meter surveys and soil sampling to identify site areas with elevated gamma exposure rate levels or elevated Ra-226 concentrations in soil. The identified areas were then remediated. Pond 8 was remediated during this initial phase and following the NRC's approval of the cleanup in 1988, the pond was backfilled.

- In 1998, the licensee further characterized the site when they performed a gamma survey of windblown areas to the northeast, east and southeast portions of the site. This gamma survey involved the use of a system combining vehicle-mounted NaI scintillation detectors and a global positioning system (GPS). Prior to using this system, a gamma count rate to Ra-226 concentration in soil correlation was developed. Gamma count rate ranges using this correlation were color-coded and plotted on a site map. Locations in excess of the 1998 gamma count rate to Ra-226 soil concentration correlation were considered contaminated and are currently being remediated. The licensee has not completed the remediation of the Pond 7. Pond 8 was remediated, as discussed above, to the subsurface Ra-226 cleanup criteria and backfilled; however, because the licensee has not adequately addressed

the differences between the NRC's and the licensee's previous split sample results and apparently inadequate 1987 procedures, questions remain as to the adequacy of the remediation relative to the actual residual Ra-226 and Th-230 concentrations. Pond 9 remains active in support of the groundwater remediation that is ongoing. Pond 10 was backfilled without the NRC's approval of the cleanup (i.e. at the licensee's risk); final status survey data were not available for Pond 10 at the time of this inspection. To date, the licensee has been unable to successfully remediate Ponds 4 and 5 due to groundwater intrusion. The licensee also indicated that these two ponds may be used in the future to support mill activities.

1.3 Review the specific procedures that were used to remediate windblown contamination. Consider the potential for incomplete remediation based on these remedial action techniques—particularly the potential for the remedial actions to produce areas of localized contamination. What was the procedure for performing and documenting these remedial action support surveys?

- Remediation techniques that were observed appeared to be standard procedures used at other uranium mill facilities for the remediation of contaminated soil within windblown areas. Heavy equipment was used and involved graders pushing soils into windrows which were then picked up using scrapers. Walkover gamma surveys of the remediated areas were then performed using the backpack-mounted NaI/GPS system. The data that was generated from this system, as discussed in Item 1.2 for the 1998 characterization, consisted of the gamma count rate data generated every two seconds and later, color-coded and displayed on a computer-generated site map.

1.4 Determine if any contamination was spread outside of remediated areas either during transport of material or as a result of remedial actions spreading contaminated material to previously unaffected areas. Review the transportation routes for moving the windblown materials to the tailings pile. Has the licensee documented that these transportation routes have been adequately surveyed? Similarly, review the results for areas that are adjacent to remediated windblown tailings areas (buffer zones).

- Transport routes have been surveyed and the data, consisting of the color-coded gamma count rate data previously discussed, clearly show that areas of residual activity in excess of the gamma action level exists along the transport routes. The licensee's representative indicated that the transport routes would be remediated once the windblown areas were completed. For the buffer zone areas, the licensee has relied upon the 1998 gamma correlation characterization data to provide documentation of these areas radiological status. There was no detailed information provided on any followup walkover surveys combined with some limited amount of verification soil sampling that either had been or would be performed. The NRC representative requested that maps illustrating buffer zones with the corresponding gamma count rates and Ra-226 concentrations be included in the licensee's windblown tailings (decommissioning) final status report.

2.0 IDENTIFICATION OF CONTAMINANTS AND GUIDELINES

2.1 Review the site and process history and characterization results and determine if there are any areas of possible uranium or thorium contamination in addition to the primary contaminant—Ra-226.

- Process reviews and discussions with the licensee representatives showed that Th-230 is a contaminant within the soil of several of the storage ponds. Uranium contamination has been noted, particularly in a windblown area where runoff from an adjacent mine had caused contamination and along the former haul roads. Other possible areas of uranium contamination were within the uranium mill boundaries.

2.2 If areas with uranium or thorium contamination were identified, have they been adequately investigated? Of particular note, evaluate the data for the remediated ponds. Determine whether additional analysis of samples is necessary to perform this evaluation should available data not provide acceptable confidence.

- Th-230 contamination is known to exist within the ponds, but has not been adequately addressed by the licensee at this time. As a result, archived samples were selected for confirmatory analysis and independent samples were collected for analysis. The NRC representative also requested that the licensee collect adequate Th-230 data for Ponds 4 through 8 and 10 and concurred that a cost-benefit analysis could be developed for those areas with subsurface Th-230 contamination that will be transferred to DOE.

2.3 The soil guideline for Ra-226 (above background) is in terms of depth distribution—i.e., 5 pCi/g averaged over the top 15 cm and 15 pCi/g for any 15 cm layer below the top 15 cm. Has the gamma correlation to Ra-226 concentration adequately accounted for the depth dependency of the Ra-226 guideline? Determine whether post-remedial action surveys identified additional Ra-226 contamination at depths greater than the surficial 15 cm. Of particular note, evaluate the survey records for those areas that have been remediated and backfilled, and are therefore inaccessible for thorough confirmatory surveys.

- The data that were provided for review did not show that depth dependency had been addressed. It is unknown if the licensee has collected subsurface soil samples from windblown areas. Some subsurface sampling has been performed in the pond areas. These limited results showed that Th-230 concentrations often increased with depth up to 4 to 8 feet deep, but that elevated Ra-226 concentrations were not present at these subsurface depths .

3.0 FINAL STATUS SURVEY PROCEDURES AND INSTRUMENTATION

3.1 Ensure that adequate surveys of presumably unaffected areas have been performed. These areas are primarily associated with a 100 to 250 foot buffer zone around each excavated area.

- The licensee completed gamma scans—using the vehicle-mounted system—of the windblown areas and buffer zones in 1998. However, the NRC's review of the information continues, and as such, a determination had not been made if the size of the buffer zones were adequate or if a sufficient number of data points have been collected.

3.2 Determine whether the licensee has performed sufficient background sample analyses to adequately assess the true background level and its variability. Evaluate appropriateness of locations selected for background sampling.

- The licensee provided an area topographical map showing 27 background sampling locations and the corresponding analytical result. Locations were evaluated for possible influence on the Ra-226 variability from nearby uranium mining operations or from ore haul roads. Several locations were identified as possible outliers. The licensee also indicated that several samples collected due south of the site came from an area that varied geologically from the windblown area and therefore may not have been representative. The licensee has been requested to reexamine the data and eliminate locations that are not representative of true background. In addition, samples were collected from three off-site locations for independent analysis (Figure 3). Results are provided in Table 1. These locations were intended as representative "background" locations. However, evaluation of the data identified a difference between the uranium concentrations and the concentrations of the uranium daughters, Ra-226 and Th-230. The potential therefore exists that the soil in this area has been influenced by contamination. In a natural background state, the concentrations between the three radionuclides would be expected to be relatively equal. The radionuclide concentrations in these samples ranged from 4.4 to 7.1 pCi/g for Ra-226, 5.8 to 10.0 pCi/g for Th-230 and 1.7 to 2.5 pCi/g for U-238.

3.3 Evaluate the correlation data for correcting gamma radiation data from NaI scintillation detectors to soil concentration, particularly the number of analytical samples that were used to verify these correlations. In addition, were these correlation factors reexamined by the licensee as the surveys progressed and additional data became available. Determine the magnitude of the uncertainty in the correlation factor—evaluate the impact of the correlation factor uncertainty on the uncertainty in the assumed Ra-226 concentration.

- The initial 1987 Ra-226 gamma correlation data were determined to be unreliable for distinguishing background Ra-226 concentrations from background plus either the 5 pCi/g surface or 15 pCi/g subsurface Ra-226 guidelines. Evaluation of the recent correlation data showed that the best fit mean of the data used may not provide adequate assurance that cleanup criteria have been met without supplementing the data with a statistically significant number of verification samples.

- The NRC's review of the correlation identified portions of the data had been generated using a different technique than what was to be used during final status surveys. When these data points were eliminated from the correlation, the gamma count rate that corresponded to the Ra-226 guideline decreased.

3.4 Review both the walkover and vehicle/GPS survey procedures to ensure consistency between the methods used to establish the gamma radiation count rate to the Ra-226 concentration correlation. Factors evaluated should include scan speed and detector to surface distance.

- Discussions with the licensee and review of the correlation data showed that detector to source distance was maintained consistently at 18 inches above the surface for each type of survey method. Review of the procedures identified sections where additional information should be provided. Recommendations included verifying that the scan minimum detectable concentration was adequate to detect Ra-226 concentrations near the cleanup level, validating the adequacy of the number of gamma measurements per 100 m^2 area, and procedures for documenting scan speeds, detector height, computer calculations, and data management.

3.5 Review the instrumentation operational checkout requirements and verify that the instrumentation satisfied these parameters when used.

- The review of the operational checkouts showed that background and source check counts fell within the established ranges and therefore satisfied the operating parameters of the instrument.

3.6 Determine if the licensee investigated or otherwise addressed all gamma measurements that exceeded the derived gamma guideline when using either the gamma walkover or vehicle/GPS method. Were the licensee's follow-up actions appropriate when measurements exceeded the gamma guideline?

- Areas identified on the site map, which illustrated the 1998 vehicle drive-over gamma correlation data, that exceeded the current action level had either recently or were in the process of being remediated at the time of this inspection. The licensee had only recently acquired the equipment and therefore initiated the final status walkover surveys of these newly excavated areas. Small area maps showing the color-coded gamma walkover results for these areas were reviewed. These maps showed anomalies that the licensee indicated would be investigated. Additionally, observations in the field showed that the licensee had marked out numerous locations in recently excavated areas for additional investigations.

3.7 Evaluate the methodologies used for soil sampling and compositing. Review data sets for selected grid blocks where potential residual contamination was detected during surface scans. Determine if the sampling methods used were appropriate, in both the number of samples obtained and the locations selected for sampling, so that average residual activity within selected 100 m^2 areas was accurately represented.

- The licensee had only recently initiated the collection of final status survey samples. It was not apparent from discussions with the licensee that a consistent methodology was used for sample collection. Additionally, requests were made to review the post-remedial action soil results and it was not apparent that the licensee could readily produce an organized data package showing the results. It was indicated that a spreadsheet with these data was available, but that the only way to identify final status data was by looking at the date a given sample was collected. The licensee was also asked to justify why only one sample, rather than a multi-point composite sample, was collected from some grids.

4.0 ANALYTICAL PROCEDURES FOR SOIL SAMPLES

4.1 Review both the licensee's and any contract laboratory's analytical procedures for radiological analyses—particularly the analysis of soil samples by gamma spectrometry. Specifically:

- Evaluate the lab's sample preparation techniques—geometries used for gamma spectrometry on soil samples, ingrowth period for Ra-226 progeny, etc.

- Evaluate appropriateness of the calibration, efficiency determination, daily checkout, and background correction.

- Review the protocol the lab uses to interpret the gamma spectrometry results, particularly the radionuclide photopeaks used to identify various contaminants.

- Review the laboratory QA/QC procedures, including duplicates, blanks, and matrix spikes. Determine the frequency of analysis for each of the QC checks. Determine whether the lab participates in some sort of cross-check or performance evaluation program, such as that offered by EML and EPA.

  - The review of the licensee's initial submittal (December 7, 1987) identified numerous previously documented issues with the analytical procedures. Limited reviews during this inspection compared the licensee's analytical results to those of an independent laboratory, which showed acceptable results.

  - Procedure reviews and discussions with the licensee showed that the licensee's analytical method uses the Ra-226 daughter's, Bi-214, 0.609 MeV photopeak to quantify Ra-226. Past experience has shown that reliance on this photopeak may result in an underestimation of the Ra-226 activity concentration due to summing losses. The licensee's practice of counting

samples prior to an adequate period for radon daughter in-growth may also contribute to an underestimation of sample activity. Typically, if an approach such as this—i.e. without processing samples and allowing in-growth—is used, a technical basis document is prepared that provides a conservative correction factor, developed empirically, to adjust the radionuclide concentration in order to avoid underestimating activity. See also Items 6.4 and 6.5 for related information.

- Additional reviews of the licensee's analytical program are planned for future inspections.

4.2 Review the QA results for analysis of Ra-226 in soil samples. Have appropriate acceptance criteria been implemented for the comparison of sample data? Have any discrepancies in sample data been investigated and resolved, and adequately documented?

- The licensee discussed their acceptance criteria during the inspection and were requested to document this information in a formal procedure. The licensee committed to providing this information in the final status survey (soil decommissioning) report.

5.0 FINAL STATUS SURVEY RESULTS

5.1 Review survey results for those areas where investigations have been conducted. If initial survey data have been replaced or supplemented as a result of the investigation, ensure that the replacement data are annotated in the final report. The annotation is intended to alert the reviewer that the initial data were replaced and that follow-up activities such as additional remediation were performed.

- A small set of data was reviewed and the determination made that there were no annotations as to what the gamma count rates were at these investigation areas. Additionally, it appeared that multiple samples had been collected from some of these areas and the reviewer was unable to independently determine if the gamma criteria had been exceeded.

5.2 Review survey results for selected areas and review the data for compliance with procedures and the final survey plan. Were measurements of sufficient quality and frequency to provide accurate representation of the radiological status, were boundaries accurately determined between affected and unaffected areas, and were personnel who performed the survey adequately trained?

- Complete data packages had not been assembled at the time of inspection. The licensee provided for review a copy of the 1998 vehicle drive-over survey map, a walkover map of one area where the new GPS/backpack system was used, and a map showing recent soil sampling locations with analytical results. The adequacy of the number of soil samples collected could not be determined.

- A map showing the affected and unaffected area boundaries was not available.

- See Item 6.3 regarding training.

5.3 Review survey results to ensure compliance with guidelines and conditions and determine that averaging was adequately performed—including soil concentration and as applicable, exposure rates. What percentage of the grids have quantitative Ra-226 data? Review this data and compare with the correlation factor. Also, determine how area-weighted averages over 100 m^2 were performed and documented. Determine the basis used for the number of grids from which samples were collected.

- Only preliminary final status data were available for review at the time of the inspection. The data reviewed was that for a recently remediated and surveyed windblown area. Again, these data consisted of a color-coded map documenting the gamma count rates during the walkover surveys. It was not apparent that these maps provided average gamma count rates on a 100 m^2 basis. Rather, they were used to visually identify—through the color-coding—locations with gamma count rates in excess of the licensee's established action level.

- The licensee was in the process of compiling analytical data from soil sampling. A definitive procedure for determining which areas would be sampled and/or the frequency of sampling could not be established. Additionally, it was not apparent that the licensee had established any type of fixed point reference grid system, rather the site relied upon a GPS system to reference survey and sampling locations. Therefore, a percentage of grids sampled could not be determined.

- The licensee's Standard Operating Procedure 2.09 Correlation Between Gamma-Ray Measurements and Ra-226 in Soil, specifies collecting soil from nine locations within a 100 m^2 area and compositing. However, it was not evident following discussions with the licensee as to whether this approach was used for final status survey sampling to determine the 100 m^2 Ra-226 concentration average. Refer also to Item 3.7 above.

5.4 Review the documentation for scan surveys. Were locations of elevated measurements properly documented and investigated?

- Refer to Item 3.6 above. The site documentation relied upon to identify areas requiring additional investigation or remediation was the 1998 vehicle drive-over map. This map showed that the potential windblown areas around Ponds 7 and 8, all located southwest of the site, had not been investigated.

6.0 MISCELLANEOUS

6.1 Identify any decommissioning program-specific observations concerning the overall performance of the licensee's decommissioning and final survey program.

- The licensee is currently completing remediation of windblown areas and some of the ponds under procedures not yet approved by the NRC. The NRC representative recommended that a revised soil decommissioning plan be submitted for NRC approval. The plan should include the following: detailed procedures including those for determining numbers/percentages of remediated 100 m^2 areas to be verified via soil sampling versus gamma-only measurements, a defensible Ra-226 background value, a defensible and validated Ra-226-gamma correlation, proposed methods for verifying the radiological status of the unaffected areas, and an adequate QA/QC program.

6.2 Verify that any commitments made by the licensee were incorporated into the plan and implemented into the procedures.

- Discussions related to this item are currently ongoing and have not been finalized. As a result of these confirmatory activities, the following commitments were made by the licensee:

  1) Provide an electronic map indicating grids sampled by ORISE (received by ORISE on 12/15/99);
  2) Provide NRC representative a list of the archived soil samples that were submitted to ORISE for confirmatory analysis and include the corresponding Ra-226 and/or Th-230 results (received by ORISE 12/13/99);
  3) Provide NRC representative a revised, smaller map of background locations with current site piles/ponds outlined as well as Homestake cleanup area and archeology site (Received by NRC 12/14/99).

6.3 Review the qualifications and training for survey technicians and other project personnel. Qualifications should include, in part, specific training on performing the survey tasks described in the final status survey procedures, data reduction procedures, and training on QA/QC procedures related to the final status survey.

- This item will be evaluated during the next routine NRC inspection.

6.4 Select areas for confirmatory surveys. Areas selected should be both random and judgmental based on data reviews. Perform gamma surface scans using NaI scintillation detectors coupled to ratemeters with audible indicators. Scans should be performed over 50 to 100% of selected areas to evaluate the average gamma activity level and evaluate the areas for the presence of hot spots that could indicate that the average activity in the grid exceeds the Ra-226 limits. Collect five samples from each selected area and prepare a field composite for analysis. Obtain independent exposure rate measurements at one meter above the surface using a microrem meter at random and suspect locations. Include previously backfilled locations in those areas selected for confirmatory surveys. These areas should be investigated by soil sampling through shallow boreholes.

- Confirmatory gamma surveys were performed over four windblown tailings areas. Surveyed areas are shown on Figures 4 through 7. Surveys of these areas consisted of gamma surface scans using NaI scintillation detectors coupled to ratemeters with audible indicators. The distance between the detector and the ground surface was maintained at a minimum—nominally about 10 centimeters. Within each area surveyed, parallel one meter-wide detector scan paths were traversed for the entire length of the area. Scan paths were walked at intervals of every 10 to 20 meters across each surveyed area. Areas of elevated direct radiation in excess of the ambient background by a factor of greater than two times were marked and 100 % of the surrounding area was scanned. There were numerous such areas identified while performing the gamma scans. Sixteen representative anomalous areas identified were then selected for soil sampling. Samples were collected from the center of each selected anomaly and from four points equidistance between the center and what would be the corners of a 10 m × 10 m area, and field composited. Within Ponds 4, 5, and 8, general area gamma measurements were made while traversing each pond from end-to-end. General elevated gamma activity up to 10 times ambient background was noted throughout each of the ponds. Composite soil samples as described above were collected from three locations each in Ponds 4 and 5. For Pond 8 which had been remediated and backfilled, a composite sample was collected from one location at the surface (0 to 15 cm) and then a composite subsurface (15 to 30 cm) sample collected. Figures 5 through 7 show soil sampling locations. Exposure rate measurements were determined not to be required with the NRC representative's concurrence.

- Gamma scans over the top of the main tailings pile were also performed and were comparable to background (2.8K to 6.0K cpm as compared to an ambient background of 7.0K cpm). The reduced gamma levels were the result of the shielding provided by the pile cover.

- Soil samples were returned to ESSAP's laboratory in Oak Ridge, Tennessee for analysis. Samples were dried, mixed, crushed and/or homogenized as necessary, and a portion sealed in a 0.5-liter marinelli beaker. Net material weights were determined and the samples stored for 20 days prior to counting using intrinsic germanium detectors to a pulse height analyzer system. Background and compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the system. All photopeaks associated with the radionuclides of concern were reviewed for consistency. Energy peaks used for determining the activities of radionuclides of concern were:

Ra-226	0.352 MeV from Pb-214*
Th-230	0.067 MeV
U-238	0.063 MeV from Th-234*

*Secular equilibrium assumed.

- Confirmatory soil sample results are provided in Table 1. Radionuclide concentrations in samples collected from the windblown/buffer zone areas ranged from 5.5 to 18.0 pCi/g for Ra-226, 6.7 to 404 pCi/g for Th-230, and less than 2.9 to 4.4 pCi/g for U-238. Results for the ponds ranged from 7.6 to 90 pCi/g for Ra-226, 714 to 5340 pCi/g for Th-230, and less than 7.5 to 16.4 pCi/g for U-238.

- Eight of the samples were analyzed within 24 hours of processing and then again 20 days later. For these samples, the 20 day Ra-226 activity levels were between 1.22 and 1.58 times the Ra-226 activity of the initial count, with the average increase in activity being 1.38 times the initial.

6.5 Select archived soil samples for independent, confirmatory laboratory analysis for Ra-226 and Th-230. Ensure representative samples from beneath backfilled areas are included.

- The licensee provided three Pond 7 archived samples for confirmatory analysis. In addition, three final status survey samples recently collected from one of the windblown areas and analyzed by the licensee were also selected for confirmatory analysis. The results of these analyses are presented in Table 2. The licensee has provided their Ra-226 results for these samples, which are also provided in Table 2. A comparison of the data shows that for five out of the six samples the ORISE-determined activity is the higher value, with the ORISE results ranging from 0.75 to 1.98 times the licensee's reported value.

SUMMARY

During the period November 8 through 10, 1999, personnel from the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education assisted the U.S. Nuclear Regulatory Commission (NRC) with the confirmatory activities for the windblown soils decommissioning project at the Quivira Mining Company's Ambrosia Lake facility. These activities included a review of the decommissioning program and independent measurements and sampling.

The results of these confirmatory activities identified several areas within the licensee's program that should be reevaluated. These include procedures for collecting soil samples, Ra-226 quantification methods, data management systems, and the Ra-226/gamma correlation. Additionally, the confirmatory survey identified numerous areas of residual Ra-226 and/or Th-230 concentrations that indicate site remediation and final status surveys may not be adequate for demonstrating that the radiological criteria have been satisfied.

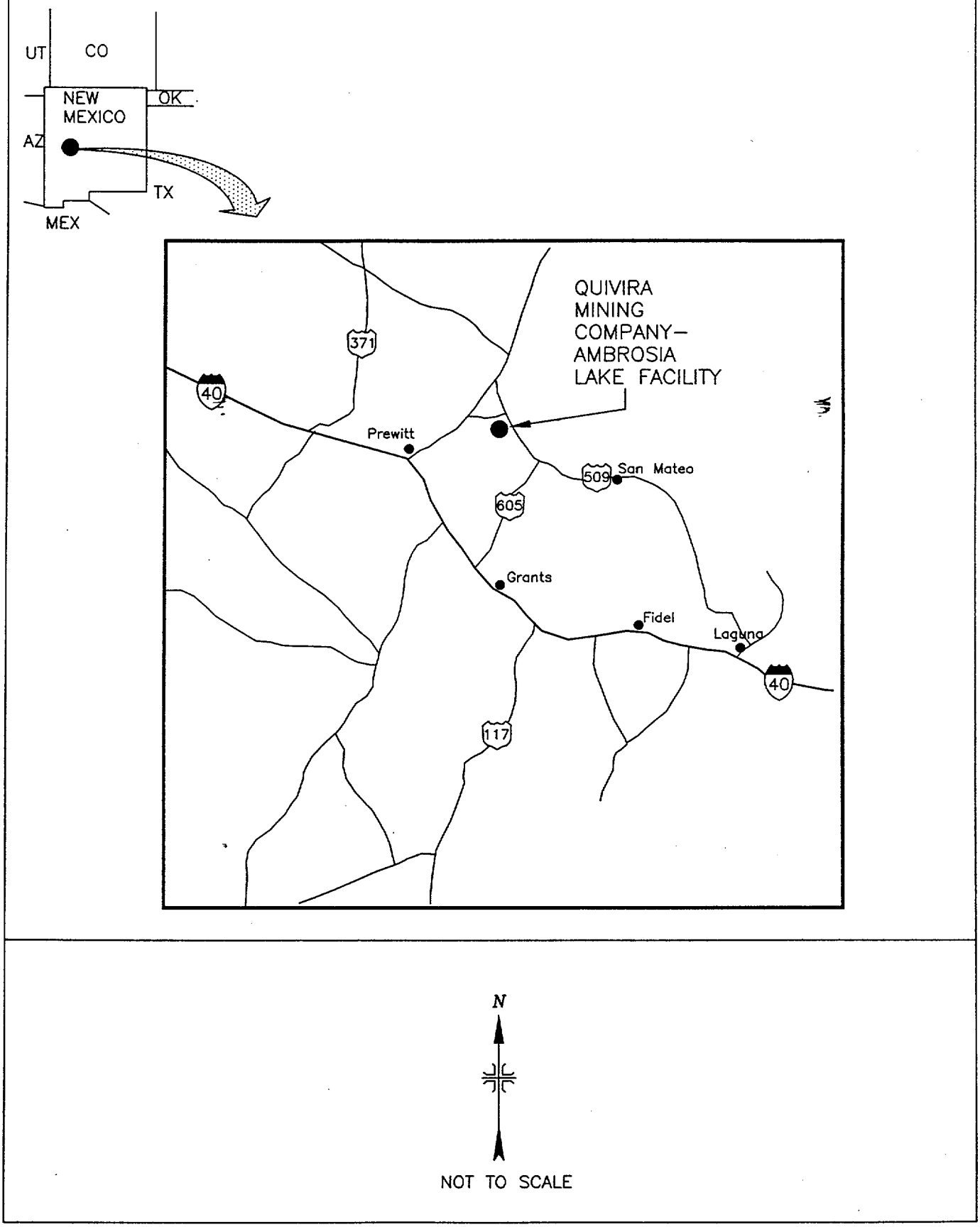

FIGURE 1: Location of the Quivira Mining Company – Ambrosia Lake, New Mexico

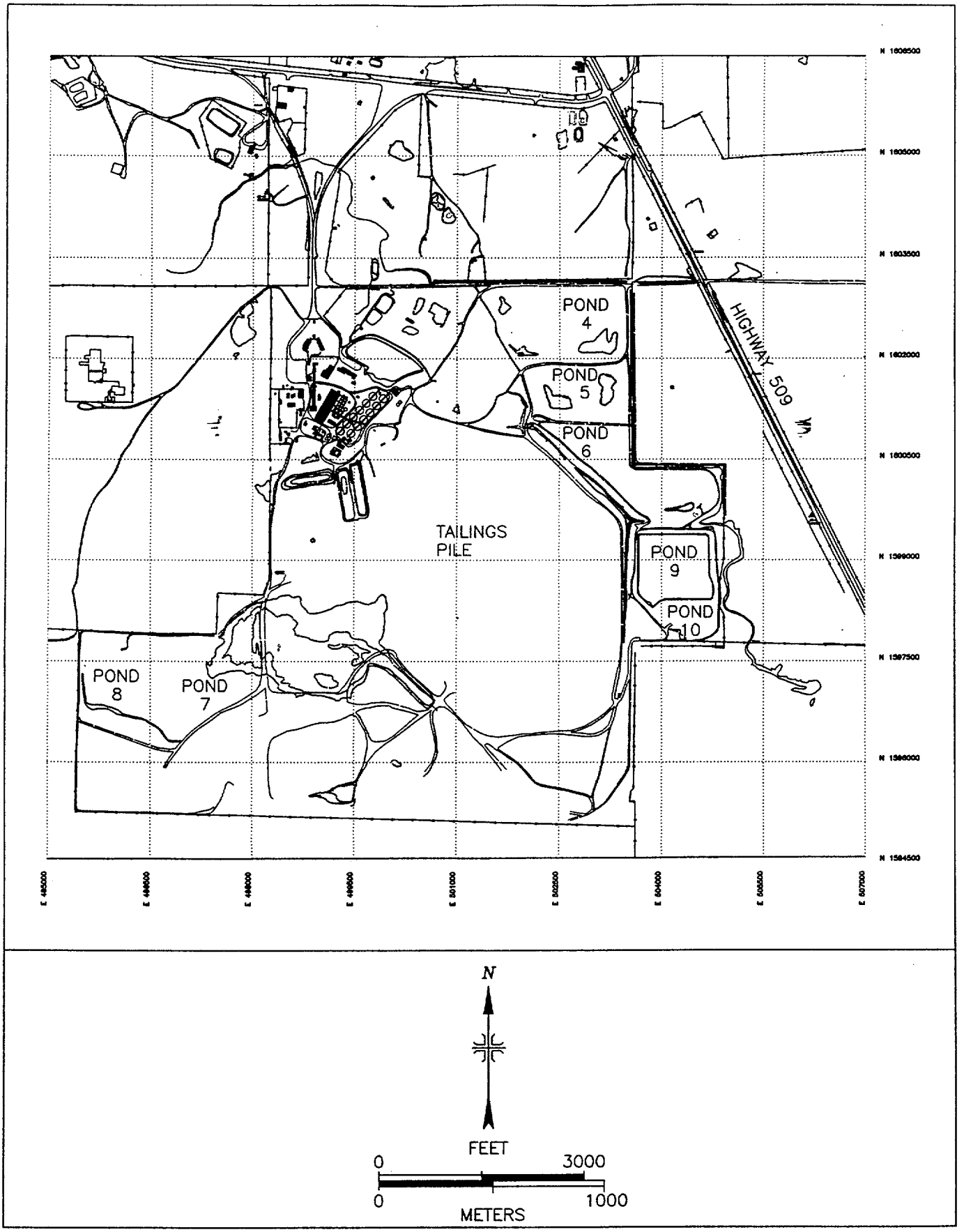

FIGURE 2: Plot Plan of the Quivira Mining Company – Ambrosia Lake Facility

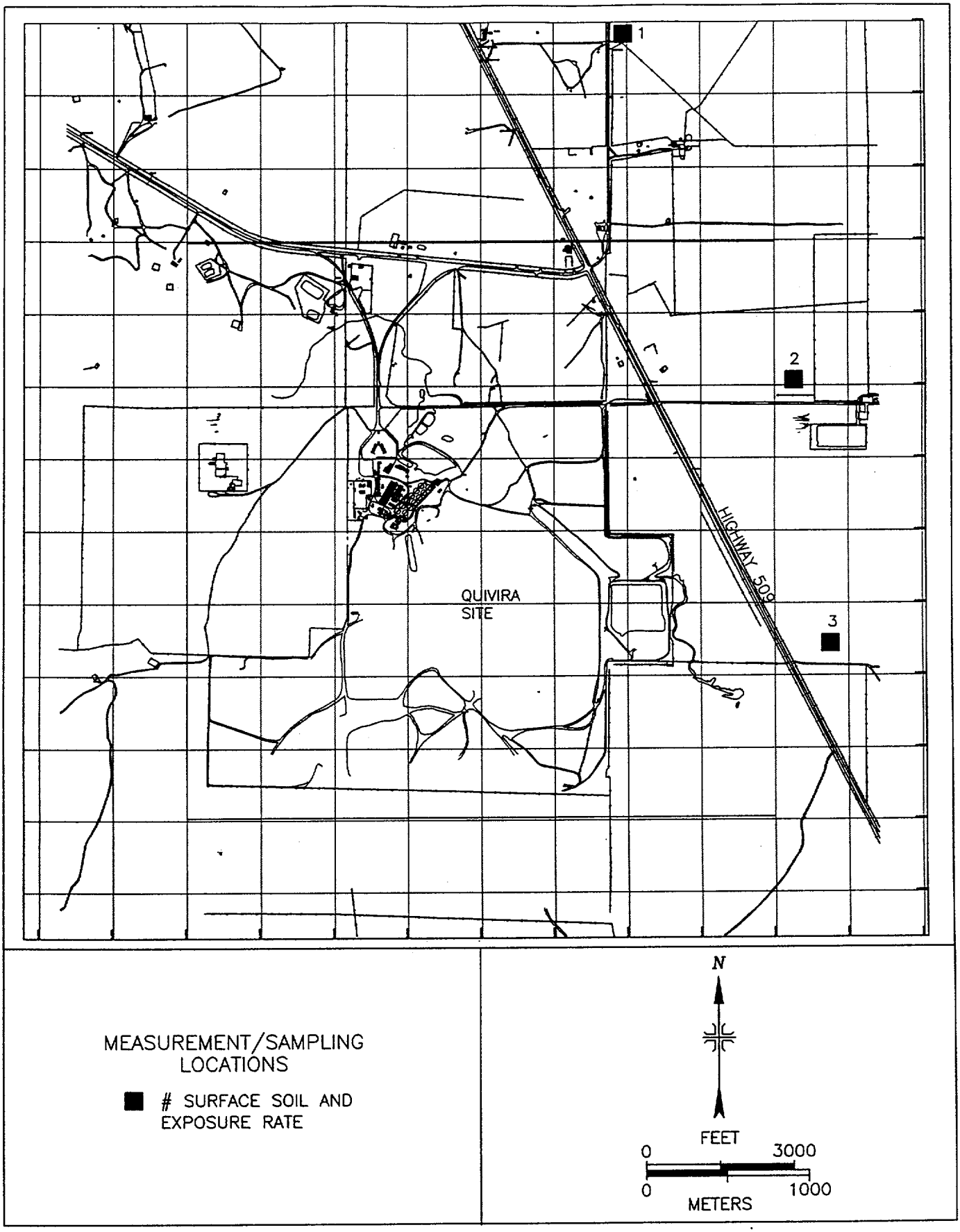

FIGURE 3: Quivira Mining Company – Background Exposure Rate Measurement and Sampling Locations

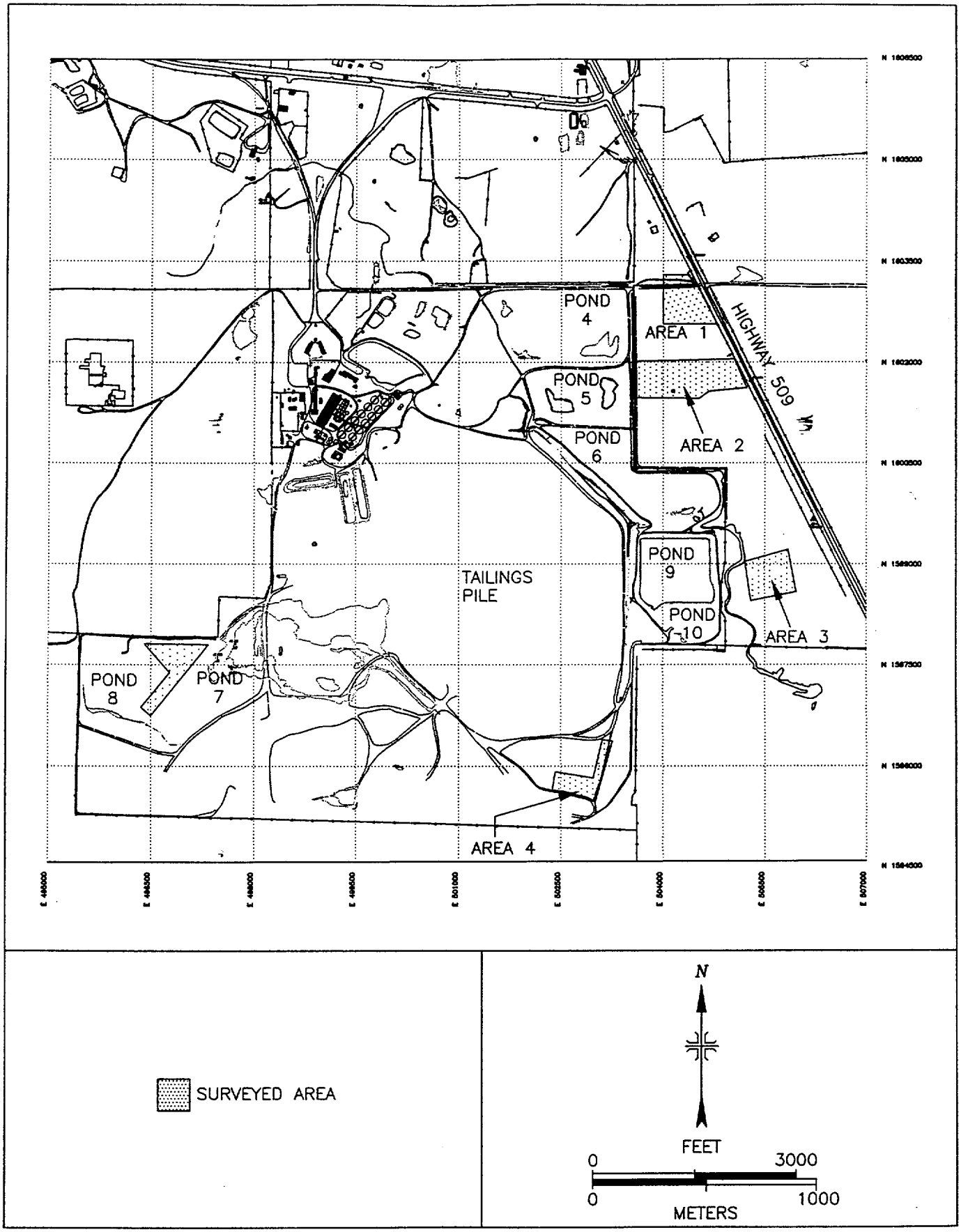

FIGURE 4: Quivira Mining Company – Surveyed Areas

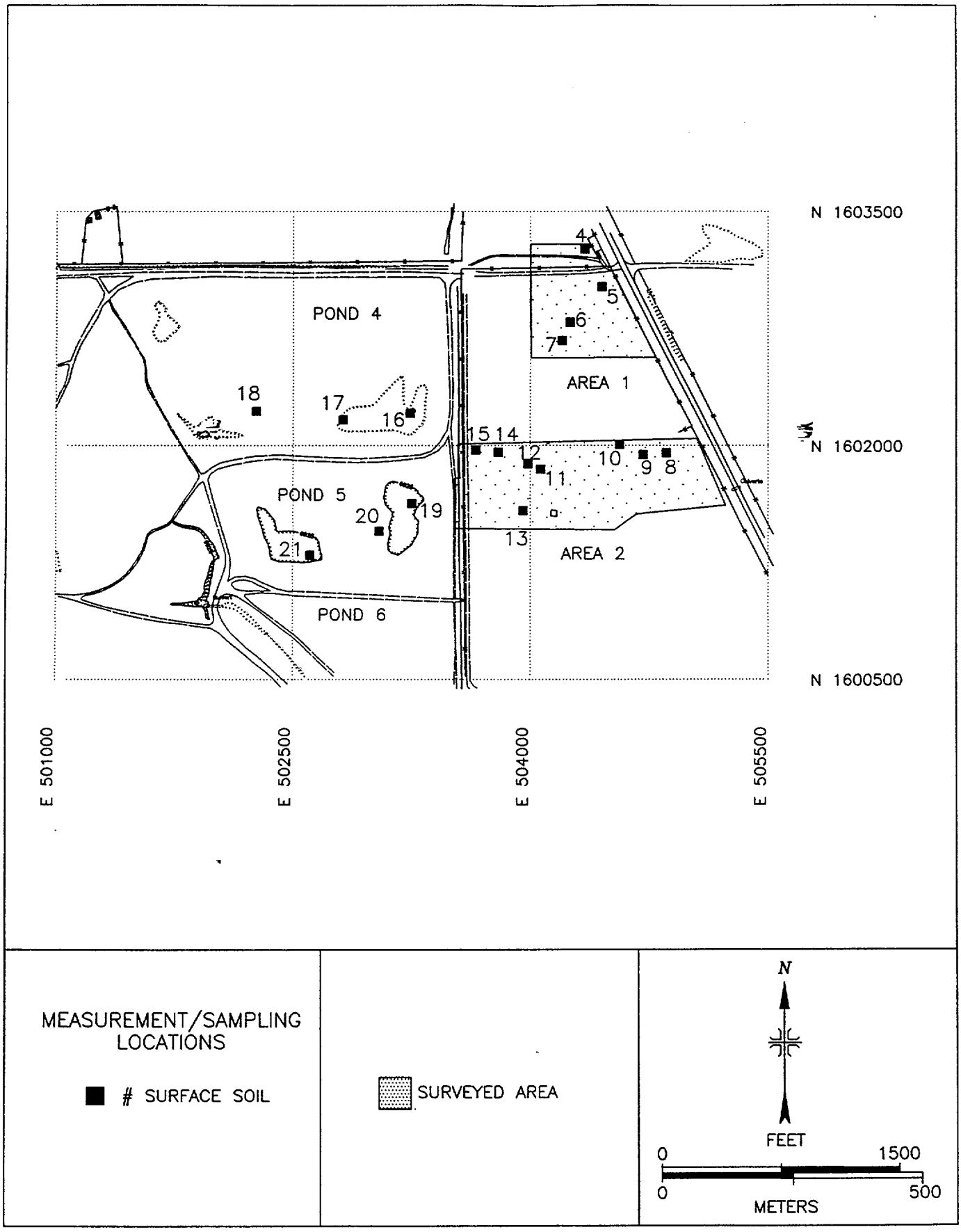

FIGURE 5: Quivira Mining Company – Measurement and Sampling Locations

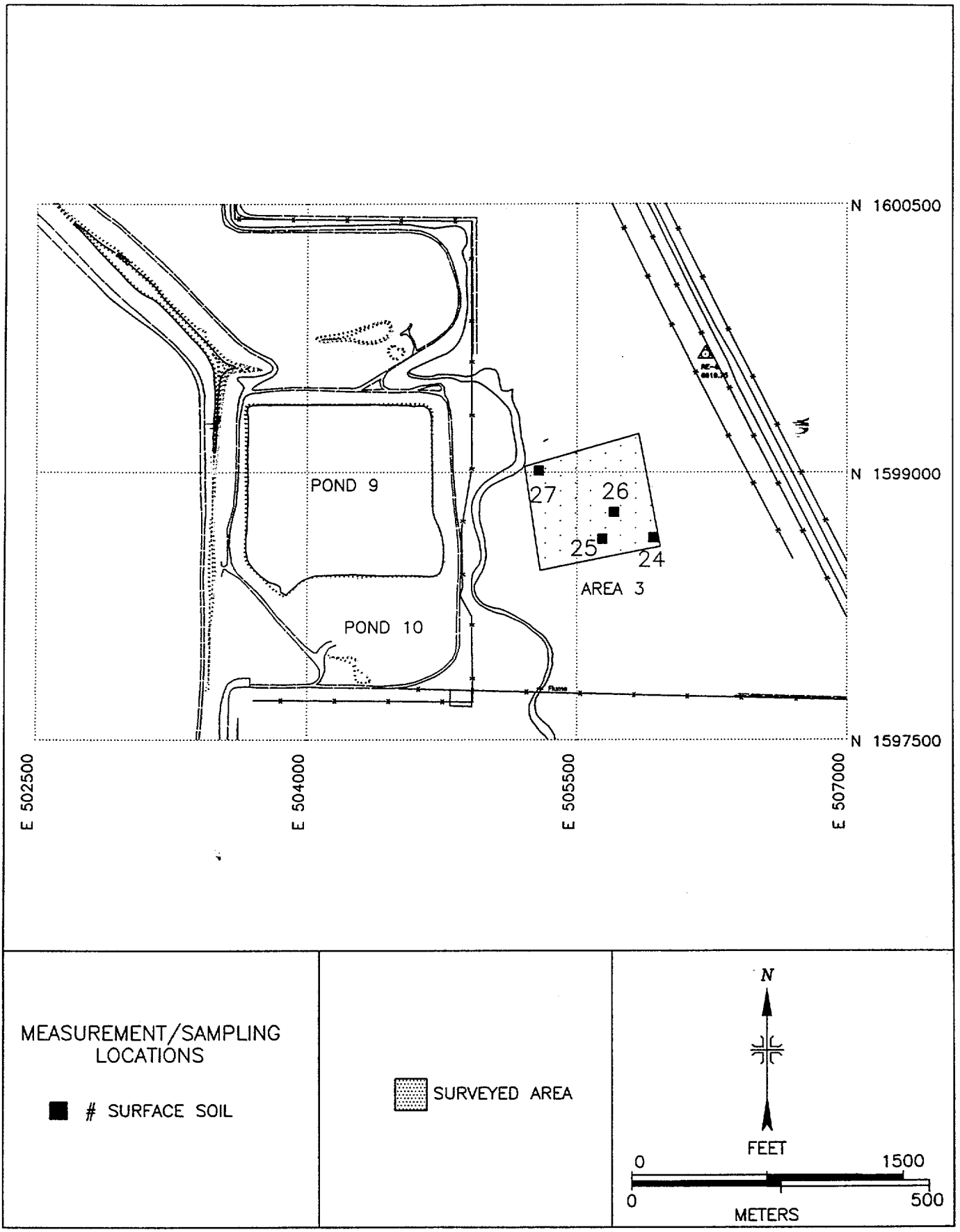

FIGURE 6: Quivira Mining Company – Measurement and Sampling Locations

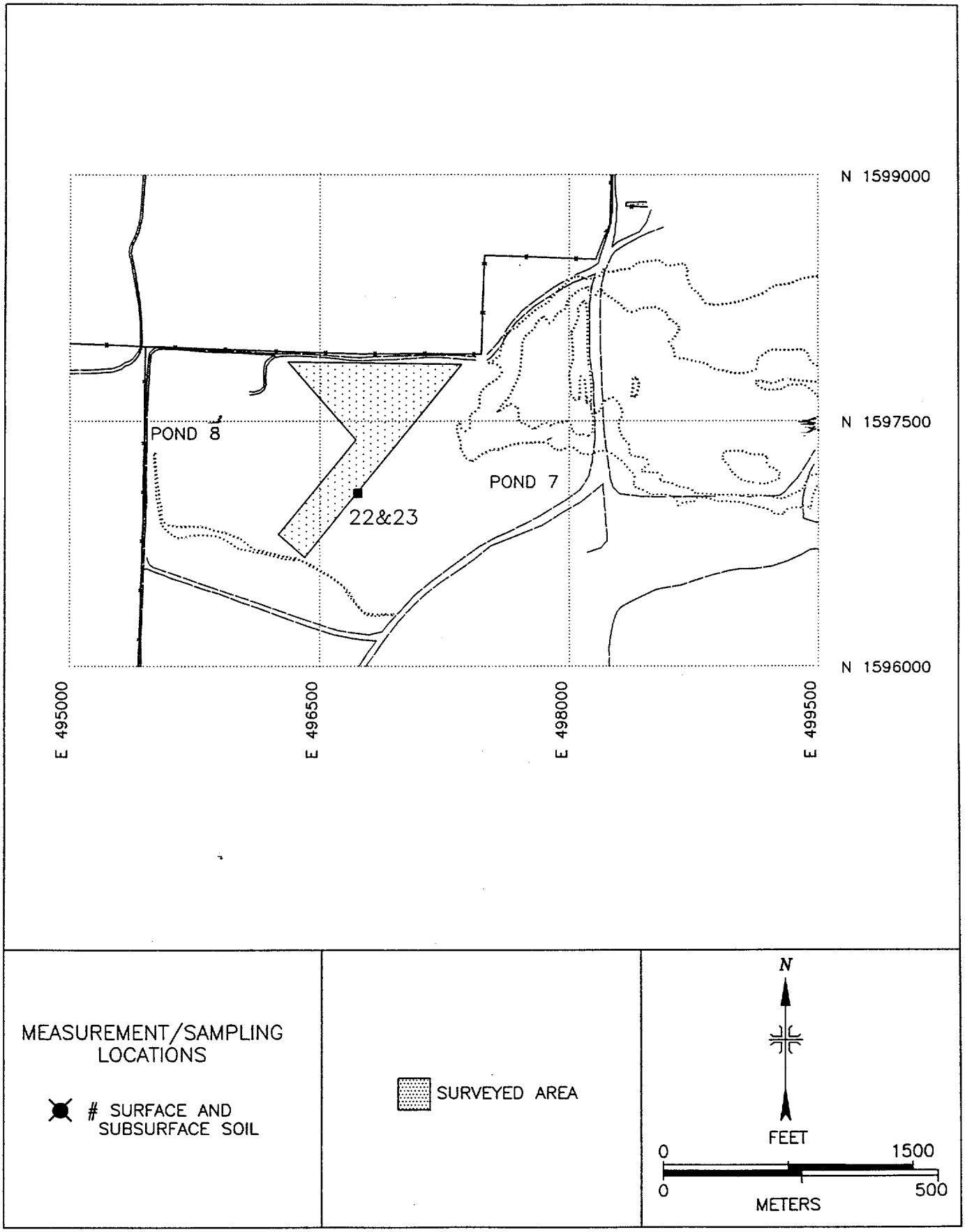

FIGURE 7: Quivira Mining Company – Measurement and Sampling Locations

TABLE 1

RADIONUCLIDE CONCENTRATIONS IN CONFIRMATORY SAMPLES
QUIVIRA MINING COMPANY
GRANTS, NEW MEXICO

Sample ID	Location[a]	Radionuclide Concentrations (pCi/g)		
		U-238	Th-230	Ra-226
760S001	Background	2.0 ± 0.6[b]	6.2 ± 3.2	4.4 ± 0.4
760S002	Background	2.5 ± 1.2	10.0 ± 8.5	7.1 ± 1.5
760S003	Background	1.7 ± 1.0	5.8 ± 3.8	4.5 ± 0.4
760S004	Area 1	2.8 ± 1.0	82 ± 11	7.9 ± 0.7
760S005	Area 1	1.6 ± 1.1	57 ± 11	6.9 ± 0.6
760S006	Area 1	< 1.9	85 ± 13	7.4 ± 1.6
760S007	Area 1	1.6 ± 1.0	84 ± 11	7.0 ± 1.5
760S008	Area 2	2.2 ± 1.3	55 ± 14	10.6 ± 0.9
760S009	Area 2	2.2 ± 1.1	45 ± 13	7.2 ± 0.6
760S010	Area 2	4.4 ± 1.2	155 ± 12	18.0 ± 1.5
760S011	Area 2	< 2.6	182 ± 17	14.8 ± 3.2
760S012	Area 2	1.1 ± 0.8	96 ± 11	5.7 ± 0.5
760S013	Area 2	1.8 ± 1.2	45 ± 12	12.8 ± 2.7
760S014	Area 2	< 2.9	404 ± 25	17.1 ± 3.7
760S015	Area 2	2.7 ± 1.1	175 ± 11	5.1 ± 0.4
760S016	Pond 4	< 7.5	5340 ± 230	90 ± 19
760S017	Pond 4	< 3.4	3570 ± 150	60.5 ± 5.0
760S018	Pond 4	16.0 ± 3.2	1294 ± 59	24.6 ± 2.1
760S019	Pond 5	7.9 ± 2.2	1099 ± 48	14.5 ± 1.2
760S020	Pond 5	16.4 ± 2.1	714 ± 37	7.6 ± 1.6
760S021	Pond 5	6.9 ± 2.4	1524 ± 67	20.0 ± 1.7

TABLE 1 (Continued)

RADIONUCLIDE CONCENTRATIONS IN CONFIRMATORY SAMPLES
QUIVIRA MINING COMPANY
GRANTS, NEW MEXICO

Sample ID	Location[a]	Radionuclide Concentration (pCi/g)		
		U-238	Th-230	Ra-226
760S022	Pond 8 0-15cm	< 3.1	2197 ± 97	43.6 ± 3.6
760S023	Pond 8 15-30cm	< 2.9	1237 ± 61	20.7 ± 1.8
760S024	Area 3	2.7 ± 1.3	30 ± 13	13.2 ± 1.1
760S025	Area 3	1.7 ± 1.4	14 ± 12	13.7 ± 1.2
760S026	Area 3	2.1 ± 1.1	30 ± 11	15.4 ± 1.3
760S027	Area 3	1.8 ± 1.2	6.7 ± 4.1	5.5 ± 1.2

[a] See Figures 3 through 7
[b] Uncertainties are total propagated uncertainties at the 95% confidence level.

TABLE 2

RADIONUCLIDE CONCENTRATIONS IN ARCHIVED SAMPLES QUIVIRA MINING COMPANY GRANTS, NEW MEXICO

ESSAP Sample ID	Quivira Sample ID	Radionuclide Concentration (pCi/g)			
		U-238	Th-230	Ra-226	Licensee-determined Ra-226
760S028	32-CC-B[a]	6.6 ± 1.5[c]	406 ± 20	7.9 ± 0.7	5.5
760S029	32-CC-K[a]	1.6 ± 0.9	23.1 ± 8.8	4.4 ± 0.4	4.2
760S030	SG-32-7[a]	1.7 ± 0.6	12.8 ± 5.7	1.8 ± 0.2	2.4
760S031	H4-B5[b]	< 4.7	1391 ± 69	29.2 ± 6.3	14.7
760S032	G3-B3[b]	14.6 ± 1.8	1571 ± 67	15.3 ± 1.3	9.5
760S033	F5-83[b]	17.2 ± 2.4	1010 ± 45	10.9 ± 2.3	10.7

[a]Samples collected from Section 32 of the Windblown Tailings area.
[b]Samples collected from Pond 7.
[c]Uncertainties are total propagated uncertainties, at the 95% confidence level.