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ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

January 21, 1997

Rec'd 1-28

Ms. Elaine Brummett
U.S. Nuclear Regulatory Commission
Division of Waste Management - NMSS
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Rockville, MD 20852

SUBJECT: FINAL TRIP REPORT—DECOMMISSIONING INSPECTION OF THE HOMESTAKE MINING COMPANY OF CALIFORNIA, GRANTS, NEW MEXICO (RFTA NO. 96-16)

Dear Ms. Brummett:

Enclosed is the final trip report for the site decommissioning inspection of the Homestake Mining Company of California facility in Grants, New Mexico. This report discusses the results of the inspection that the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education performed together with representatives from the U.S. Nuclear Regulatory Commission during the period September 30 through October 2, 1996. Comments that were provided on the revised draft report have been incorporated.

If you have any questions, please direct them to me at (423) 576-5073 or Eric Abelquist at (423) 576-3740.

Sincerely,

Timothy J. Vitkus
Survey Projects Manager
Environmental Survey and
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NL05

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TRIP REPORT
DECOMMISSIONING INSPECTION OF THE HOMESTAKE MINING COMPANY OF CALIFORNIA GRANTS, NEW MEXICO

Provided below is the trip report for the decommissioning inspection of the Homestake Mining Company of California in Grants, New Mexico. The decommissioning inspection closely followed the site-specific plan (ORISE 1996), and as such, the trip report will serve to provide information for many of the items in the inspection plan. The major elements reviewed during the decommissioning inspection included the six areas listed below.

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

DECOMMISSIONING INSPECTION PARTICIPANTS

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1.0 GENERAL

1.1 Review the past operational radiological surveys that were used to demonstrate radiological control of the uranium mill. Are there any records of spills or other releases of yellowcake other than the February 1977 occurrence? If so, do the records adequately document the cleanup of these releases of material?

- Records and interviews of Homestake personnel indicated that the only uncontrolled release of materials was the previously documented February 1977 breach of the mill tailing pile evaporation pond dike. A February 28, 1978 report documented the cleanup of the portions of the site contaminated as a result of this spill. Two samples collected after the cleanup of this area showed Ra-226 levels in excess of the current site cleanup standards. Final cleanup of these residual locations was performed

during the site decommissioning and was documented in the decommissioning report. Site areas that were affected by this spill correspond to decommissioning grids H4, H5, [illegible], J3, J4, J5, K3, and K4.

In addition to records of any spills, the general survey procedures for radiological control of the mill and release of equipment from the site during decommissioning activities were also reviewed. A review of the licensee calibration procedures for survey of equipment prior to release from the site identified a concern with the alpha instrument calibration procedure. The licensee had been using an efficiency factor of 0.28 for converting count rates to dpm/100 cm^2 for equipment to be released off-site. This efficiency was based on the use of a 2 π source emission rate previously approved and documented in a June 8, 1992 correspondence from the NRC regional staff. The interpretation was based on NRC Regulatory Guide 8.30 for removable activity on skin and clothing where the 1,000 α dpm/100 cm^2 was considered comparable to the 2,200 α dpm/100 cm^2 removable activity level recommended by the International Atomic Energy Agency. However, Regulatory Guide 8.30 references the total contamination level guidelines found in Regulatory Guide 1.86 for surveys of equipment and material removed from the site. A review of the 4 π calibration source activity determined that the licensee's actual alpha efficiency factor should be 0.14. The use of the 0.28 efficiency factor would therefore underestimate residual surface activity by a factor of two. Based on this, ESSAP recommends that consideration be given to performing a review and reevaluation—using the 0.14 efficiency factor—of the total activity survey data used to release equipment from the site. Further guidance on establishing efficiencies for instrumentation used to measure alpha or beta activity per unit area may be found in ISO 7503-1 (ISO 1988); and Draft NUREG/CR-5849. In ISO 7503-1, a correction factor ε_s—the efficiency of the contamination source—is incorporated into the equation for converting count rates to activity per unit area. This correction factor accounts for the total (4 π) source emission.

1.2 Review the results of characterization surveys for justification of the classification of uranium mill areas—specifically, the delineation of the Inner and Outer Zones.

- The licensee delineated the Inner and Outer Zones primarily through site history and process knowledge. The decision for the boundary was further supported by the licensee through a more intensive, statistically-based survey and sampling effort of those grid blocks that comprised the border.

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 (excavation control) surveys?

- Characterization survey and sampling results were initially evaluated. Then through an iterative process, windblown area surface soils were scraped with heavy equipment, resurveyed by performing gamma surface scans, additional soils removed

where the gamma action level was exceeded, the area resurveyed, and when remediation was completed, the final verification was performed. The licensee was specifically questioned about the paths the scrapers took across the site in order to determine whether the potential existed for contamination being left in spillover rows. The licensee stated that the scrapers followed overlapping paths in order to pickup any spillover rows that may have occurred.

1.4 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?

- Haul roads were installed to transport contaminated soils removed from the windblown areas to the tailings pile. Based on aerial photographs, the initial remediation of the windblown areas did not proceed in a systematic fashion (i.e., beginning from the outermost windblown perimeter and working in) but rather moved from area to area throughout the site to remediate previously known contaminated zones. Then as remediation and post-remediation surveys progressed, the remainder of the windblown areas were addressed. The result was that contaminated soils were transported over previously remediated areas. However, the licensee addressed the potential for re-contaminating transportation routes by scraping and removing the soils from the transportation routes prior to initiating the final verification surveys.

2.0 Identification of Contaminants and Guidelines

2.1 Review the past analytical results to confirm the nature of the contaminants throughout the Outer Zone. Has uranium ore contamination been adequately characterized and distinguished from the tailings contamination?

- There were limited analytical results that included data for uranium and Th-230 for windblown areas of the site. Th-230 analysis was performed following the 1977 spill and combined with the alkaline-leach process knowledge, the licensee concluded that there were no occurrences that would enhance the Th-230 concentration relative to the Ra-226 concentration. The data from the spill did not show significant Th-230 relative to Ra-226. Other than this data, the licensee had not demonstrated that Th-230 contamination was not a potential contaminant of concern (see Section 2.2). For uranium, the licensee indicated that ore stockpiles were maintained within the Inner Zone and that any residual uranium contamination in the windblown areas would be confined to natural ore spillage zones along transportation routes. Confirmation that elevated levels of Ra-226 in spillage zones and transportation routes was the result of natural ore and not tailings was accomplished through soil sampling and independent analysis where the licensee committed to having an independent laboratory analyze approximately 15% of the verification samples. For these samples, the independent laboratories provided analytical data for U-238 and/or total uranium. The licensee provided further documentation that addressed this issue

by performing air stack effluent monitoring during milling operations to ensure that there were no releases of yellowcake from the air stacks. These records were not reviewed at the time of the inspection to validate this contention.

For the characterization of State Road 605 Right-of-Way North of County Road 63, significant levels of subsurface Ra-226 activity levels were detected by the licensee. However, the licensee stated that the elevated levels are the result of natural ore spillage and provided U-238 data for 15 of the characterization samples to support this statement. ESSAP's comparison of the TMA U-238 concentration to the Ra-226 concentrations reported by both TMA and the licensee indicated that nine of these samples appeared to be ore—that is, approximately equivalent levels of Ra-226 and U-238. The Ra-226 levels in the remaining samples (samples 2172, 2182, 2192, 2202, 3122, and 3162) exceeded the U-238 values by a factor ranging from approximately 3 to 5 and is potentially indicative of residual contamination. A similar disequilibrium was also identified in a number of the licensee's background soil samples and was attributed to unique geological conditions within the area of the site, but may have been the result of background samples being collected from potentially affected areas (see Section 3.2).

2.2 Evaluate how the licensee has addressed the potential for residual Th-230 contamination. Determine whether additional analysis of samples is necessary to perform this evaluation.

- The licensee stated that based on the alkaline-leach process, Th-230 concentrations would not be enhanced relative to Ra-226 and that removal of Ra-226 contamination would also eliminate any potential Th-230 contamination. Therefore, the licensee did not analyze verification samples for Th-230. The only soil sample data available that specifically addressed Th-230 was the data developed for the characterization and subsequent remediation of the 1977 spill (see Section 2.1). ESSAP and the licensee collected eight composite soil samples from various windblown areas and two from the North Toe of the Tailings Pile for confirmatory analysis and reviewed the resultant analytical data to assess the site conditions for Th-230 (an additional ninth composite sample from the windblown areas was later provided by the licensee). The analytical results, which are summarized in Table 1, showed that the Th-230 levels were comparable to the Ra-226 levels within the statistical deviations of the analytical procedure, and therefore support the licensee's conclusion.

2.3 The soil guideline for Ra-226 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 top 15 cm.

- A subsurface gamma correlation factor was determined to be unnecessary for final surveys. Most Outer Zone contaminated areas were determined by the licensee to be shallow, and the licensee therefore relied upon the surface contamination guideline and the corresponding correlation factor. Although contamination below the initial 15 cm was found in areas where water had pooled and possibly resulted in the

percolation of contamination to levels greater than 15 centimeters below the surface, such areas were identified after the initial overburden had been removed, exposing subsurface soils. In an iterative process these soil areas were then gamma scanned and the results compared to the surface criteria. Subsurface contamination was principally a concern at the site within roadside ditches where past utility and construction activities may have transferred surface contamination from transportation spillage or windblown materials to deeper levels. For these situations, the licensee primarily relied on direct gamma scans of exposed subsurface soils and soil sampling and analysis to guide remedial activities rather than a subsurface Ra-226/gamma correlation factor.

3.0 Final Status Survey Procedures and Instrumentation

3.1 Review situations where an area's classification was changed based on accumulated survey data from scoping and characterization surveys. Were these reclassifications clearly documented?

- The windblown Outer Zone was expanded in an iterative process as the remediation activities progressed. The final buffer zone boundaries—demarcating the affected Homestake properties and offsite properties from unaffected properties—was established at the time of the final verification survey. The licensee then collected soil samples at 500 foot intervals within the buffer zone to demonstrate that the outer expanse of the windblown areas had been reached. However, the supporting data had not been formally documented. The licensee was requested to formally submit this data for review and did so as Attachment 13 to their comment response documentation; ESSAP subsequently evaluated the data. See Section 6.1 for results.

3.2 Determine whether the licensee has performed sufficient background soil sample analyses to adequately assess the true Ra-226 background level and its variability to ensure that there are no potential problems relative to health and safety. Evaluate appropriateness of locations selected for background sampling.

- A review of the background sampling locations determined that a number of these samples had been collected from site areas that may have been affected by windblown tailings. The possibility of added Ra-226 activity from site operations at several of the sampling locations was supported after a review of the original background data showed a disequilibrium between the U-238 to Ra-226 ratio, with the Ra-226 activity exceeding the U-238 activity by up to a factor of five. This disequilibrium has previously been addressed by the licensee in an August 16, 1988 correspondence as being the result of geologic conditions unique to the site. The licensee was requested to provide an updated map showing all background soil sampling locations relative to the site. The NRC may then reevaluate the background data, after excluding those data points obtained from affected areas, and determine if a significant difference in background exists. If so, then the NRC will evaluate any health and safety concerns that could result should a significant difference in background be identified.

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 calculated Ra-226 concentration.

- During the initial development of the correlation factor, the licensee selected areas with known Ra-226 contamination levels ranging from 6 to 15 pCi/g. Surface scans of these areas were then performed using the final status survey procedures and recording the average gamma radiation levels. The 30 data points generated, including outliers, were then plotted and a conservative gamma count rate selected that would minimize the occurrence of not identifying residual contamination. The licensee reevaluated the correlation factor (action level) as the final surveys progressed. A review and comparison of final status gamma survey results that exceeded the action level and the corresponding soil sample analytical data did not identify any soil sample results in excess of the 10.5 pCi/g guideline (guideline based on a background factor of 5.5 pCi/g). The licensee has not performed a formal statistical evaluation of the correlation factor to determine the magnitude of uncertainty. ESSAP suggests that the NRC request that the licensee perform this exercise in order to add further confidence to the appropriateness and reliability of the correlation factor.

3.4 Determine the use of investigation levels for gamma measurements using the gamma walkover method and global positioning system (GPS) survey methods. Determine if the change in the distance of the detector to the ground surface between the two methods affected the gamma correlation factors.

- The licensee used the walkover method with the detectors within 15 centimeters of the ground surface for surveys of the Inner Zone and of the highway excavations. Because of significant interference to gamma radiation levels as a result of proximity to both the large and small tailings piles for the Inner Zone and geometry factors for the highway excavations, a separate correlation factor was established and used for surveys of these areas. The licensee changed the final status survey procedure to incorporate the GPS when surveys of the Outer Zone were initiated and developed a separate correlation factor which accounted for the change in height of the detector to ground surface.

3.5 Did the licensee perform appropriate follow-up actions based on gamma measurements that exceeded the Ra-226/gamma correlation action levels?

- The licensee either performed soil sampling to quantify Ra-226 or re-excavated areas where the final status survey identified gamma activity levels in excess of the action level. All remaining locations where the gamma activity action level was exceeded at the completion of remediation were then documented by plotting on appropriate maps. Two of these areas were randomly selected from the site maps and cross-

checked to the final survey data. In both cases, soil samples had been collected and the Ra-226 concentrations were less than the guideline.

3.6 Evaluate the methodologies used for soil sampling and compositing. By reviewing grid coordinates for selected grid blocks where potential residual contamination was detected during surface scans, determine if sample locations were appropriately selected that would provide an accurate representation of the average residual activity within selected 100 m^2 areas.

- Soil sampling within questionable grid blocks—grid blocks where elevated direct gamma radiation was detected in excess of the action level—followed the systematic five-point soil sampling pattern specified in the verification plan. The licensee did not account for large-area hot spots that either encompassed multiple contiguous grids or if a hot spot was outside of any of the systematic sampling locations (refer to Section 5.2 for additional discussion of this issue).

4.0 Analytical Procedures for Soil Samples

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

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

- The on-site laboratory sample preparation procedures followed standard industry-accepted practices. Each composite sample was placed in an aluminum pan and dried in an oven at 400° F for a minimum of 4 hours. The sample was then crushed/pulverized to a uniform consistency and sieved to remove any rocks. The sample was then homogenized, and if split for off-site analysis, passed through a riffler splitter. Samples were then sealed in a preweighed 1-quart paint can, weighed, and stored for 15 days to allow for ingrowth of the radon progeny. All pertinent data was recorded on appropriate laboratory forms and containers.

  The licensee's contractor laboratories, TMA and Energy Labs, analyzed samples by wet chemistry techniques. Uranium was analyzed flourometrically in accordance with Environmental Protection Agency (EPA) Method 908.1 and Ra-226 was analyzed by alpha spectrometry in accordance with EPA Method 903.0. Both of these analytical methods are specific for the analysis of water and a number of potential interferences may result when adapted to a soil matrix. Sample preparation followed Method SW3050. The licensee shipped samples to the laboratories under appropriate chain-of-custody.

Overall, the licensee's sample handling, preparation, and analytical procedures are acceptable. The contract laboratories analytical methods may not be appropriate for soil analysis, although the comparison of licensee's and contract laboratories' results were generally in agreement. Acceptions to this had been previously documented in the NRC's comment letter (see Section 4.1.3).

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

- The licensee's laboratory used a NaI detector coupled to a multichannel analyzer to analyze soil samples. The system background was determined by counting an empty sample container overnight. Then a NIST traceable mixed gamma standard—containing Ra-226, Th-232, and K-40—was counted and three regions of interest (ROIs) established. The ROI for Ra-226 was the 0.609 MeV photopeak from the radon daughter Bi-214. Samples were then counted for a minimum of 1,000 seconds after the 15 day minimum ingrowth period, after which radon daughter concentrations would be at greater than 90% equilibrium with the Ra-226 concentration, which should be sufficient to provide reasonable counting statistics. Three simultaneous equations, based on the three ROIs, were solved to quantify Ra-226. The use of simultaneous equations to resolve multiple peaks on a NaI detector is an acceptable practice.

  ESSAP's review of the licensee's mixed gamma standard used to calibrate the NaI counting system determined that the standard-to-sample volumes were equivalent, but the standard weight of 443.5 g was significantly less than the typical sample weight of approximately 1200 to 1500 g. Standard and sample density should approximate one another in order to account for the attenuation of lower-energy photons in the denser sample matrix. This difference may have been a contributing factor to the differences in analytical results discussed in Section 6.5.

4.1.3 Review the laboratory QA/QC procedures, including duplicates, blanks, and matrix spikes. Determine the frequency of analysis for each of the QC checks.

- The sites primary QA/QC program involved the independent analysis of a minimum of 15 % of the verification soil samples. The licensee relied on these comparative analyses for cross-checks of the in-house laboratory's results. Overall, the majority of the data generated by the independent laboratory appeared to be comparable within the limits of the method chosen to present the data (analytical errors were absent from the report) and therefore confirmed the licensee's reported Ra-226 concentrations. Discrepancies that were identified were brought to the attention of the licensee in the NRC's comment letter.

4.1.4 Determine whether the lab participates in some sort of cross-check or performance evaluation program, such as that offered by the Environmental Measurements Laboratory (EML) and EPA.

- The laboratory did not participate in either a cross-check or performance evaluation program. ESSAP recommends that the licensee participate in these programs during the course of any future remedial activities in order to further validate the final status survey sample data quality. The NRC will determine if the licensee's contract laboratory participates in such a program which would be an appropriate alternative, provided the licensee's and the contractor laboratory's data continue to be comparable.

4.2 Review the interlaboratory 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?

- There were a number of discrepancies identified in both data generated by the on-site laboratory and data from the interlaboratory comparison. Each discrepancy identified was previously documented in the NRC's comment letter submitted to the licensee. The licensee has provided responses to each comment that related to the data comparison. The NRC will address the appropriateness of the licensee's responses.

5.0 Final Status Survey Results

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

- The licensee provided only final survey data in their report. Any contaminated areas identified during the final status survey were re-cleaned and re-scanned. The new data was then entered into the computer system, automatically replacing the old data. The system did not annotate this replacement data.

5.2 Select completed survey data and review data for compliance with procedures and final survey plan. In particular, determine how area-weighted averages over 100 m^2 were performed and documented.

- The review of completed data packets, which contained both on-site maps and were summarized in Appendices B through I of the final status survey report, indicated that the licensee met the requirements of the plan relative to the gamma readout frequency per 100 m^2 area and sampling the 100 m^2 area within each grid block with the highest average gamma radiation level. Average Ra-226 concentrations for each 100 m^2 area were determined by a standard mathematical averaging of the gamma

activity readouts from the GPS system. For selected 100 m^2 areas, five-point composite soil samples were collected and analyzed for Ra-226. The licensee then used the sample data to validate the correlation factor and to document the average activity level for the specific area.

However, the concern was raised with the licensee that the soil sampling methodology used—collecting samples from the systematic locations—was approved only for those 100 m^2 areas where gamma radiation levels were less than the action level. This method may not adequately characterize the average Ra-226 concentration at those locations where the gamma radiation action level was exceeded and additional cleanup was not performed. The surface scanning and systematic soil sampling methodology used assumes homogenous contaminant distribution, which may not always be the case. To fully address this issue, ESSAP recommended that aliquots from locations of elevated direct radiation be incorporated into the composite sample or the licensee perform additional investigations to determine the areal extent of hot spots, collect individual samples from the hot spots, and determine the weighted grid block or area (if multiple grid blocks are affected) average for grids where the gamma action level was exceeded. This issue was investigated by the inspection team when the gamma action level was exceeded over what appeared to be areas greater than 100 m^2 in a number of locations—particularly within the buffer zone. The NRC selected a number of these areas and ESSAP performed gamma surface scans and collected soil samples. Locations selected for soil sampling ensured any areas of elevated direct radiation within the scanned areas were represented in the composite samples. The outcome of this investigation determined that each investigated area satisfied the Ra-226 guideline (see Section 6.5 for analytical results). However, there were a number of areas within the Buffer Zone that exceeded the action level and were not sampled or remediated. Therefore, the NRC may consider requesting the licensee to justify a different gamma action level or perform additional soil sampling in the Buffer Zone.

5.3 Review survey results to ensure compliance with guidelines and conditions and determine that averaging was adequately performed—such as for soil concentrations.

- Any locations of above guideline Ra-226 levels or where questionable data was identified were brought to the attention of the licensee in the NRC's comment letter. These comments were discussed with the licensee in detail during the inspection and the licensee is currently finalizing responses to comments. For determination of the adequacy of soil concentration averaging, refer to Section 3.6 and 5.2 of this trip report.

5.4 Review the documentation for scan surveys. How were technicians instructed to identify and investigate any elevated readings while scanning—were locations of elevated measurements properly documented? Does documentation indicate how the hot spots were treated—e.g., either remediated or averaged over 100 m^2?

- Documentation of the scan surveys for the Outer Zones was accomplished automatically with the computer system that was integrated with the NaI detector and GPS system. All areas of elevated activity were documented with the coordinate range. For surveys of the roadways, the survey technician manually averaged the gamma levels. If an area exceeded the action level, the area was immediately reexcavated and/or sampled. The final walkover data for the roadways was then documented and incorporated into the report. During the inspection, spot checks were performed following the raw data to the report and finally to the maps documenting anomalies.

5.5 Review survey results from the raffinate line removal—does the data indicate compliance with guidelines? Were the number and quality of data sufficient to demonstrate compliance with guidelines?

- The raffinate line removal was determined to not be an issue during the inspection. The line was above-ground extending from the mill site to the pile and was dismantled and disposed of.

5.6 For the windblown areas (Outer Zones) contiguous with the innermost portion of the Outer Zone, were there any locations of positive levels of contamination that justified the use of a greater sampling frequency similar to that used for the innermost portion?

- The licensee elected to perform a more rigorous, statistically based study of this area that employed a smaller grid spacing and greater sampling frequency. The data was then evaluated at the 95% confidence level as recommended in NUREG/CR-5849. ESSAP reanalyzed the data and validated the results.

6.0 Miscellanfous

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

- The licensee committed to providing the data for the buffer zone sampling regimen. This data had not been incorporated into the final report at the time of inspection. The licensee subsequently provided the data as Attachment 13 to their comment response documentation. ESSAP was tasked with performing a statistical evaluation of the buffer zone data to determine that any residual contamination within the buffer zone satisfies the guideline at the 95% confidence level. The data from the 28 soil samples collected in the buffer zone was tested in accordance with the format suggested in NUREG/CR-5849. The calculated μ_α equaled 5.5 pCi/g Ra-226 showing the buffer zone satisfied the 10.5 pCi/g guideline at the 95% confidence level.

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

- The NRC headquarters representative will address this item.

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.

- The licensee provided personnel with detailed procedures for performing each task related to field surveys and sample preparation and analysis. Due to time constraints, a thorough review of training records and documentation was not performed. The NRC will complete this task during the next inspection.

6.4 Perform gamma readings with a μR meter at random and suspect locations, in windblown areas and on cell covers.

- ESSAP performed gamma surface scans over seven 900 m^2 areas—selected on the basis of the licensee's data indicating potential anomalies—within the Outer Zone (Figures 1 through 9) and seven areas within the buffer zone and μR/h measurements were performed at 40 locations within the Outer Zone. These measurements are provided in Table 1. No measurements were made on the pile covers.

  Gamma scans identified a number of locations of elevated direct radiation within surveyed areas from which ESSAP collected composite samples from the 100 m^2 area associated with each anomaly (a total of eight samples were collected from the seven surveyed areas). These samples were processed by the licensee and split samples prepared for confirmatory gamma spectrometry analysis by the licensee and ESSAP. The licensee was requested to collect a sample from an eighth area identified within the buffer zone. An additional sample was collected by the licensee and provided to ESSAP for analysis on November 7, 1996.

6.5 Select archived soil samples so that independent laboratory analysis for Ra-226 and Th-230 may be performed.

- Rather than selecting samples from the licensee's archives for confirmatory analysis, ESSAP together with licensee's representatives collected samples from eight locations (a ninth sample was provided after the completion of on-site activities) selected by ESSAP on the basis of ESSAP's gamma scan results and two additional locations from the North Toe of the Tailing Pile. The licensee processed and split the samples into two aliquots for comparative analysis by ESSAP and the licensee. ESSAP's gamma spectrometry analytical process used germanium detectors coupled to a multichannel analyzer. The licensee used a NaI system (as stated in Section 4.1.2). ESSAP's analytical results are provided in Table 1. Concentrations of Ra-226 were all below the 10.5 pCi/g cleanup guideline, Th-230 concentrations were statistically comparable to the Ra-226 and indicated probable secular equilibrium between the two radionuclides, and U-238 appeared to be within the expected background level range for the area. A comparison of ESSAP's, the licensee's, and the licensee's contract laboratory analytical results for Ra-226 are provided in Table 2. The comparison of results showed that the Ra-226 concentration determined by both the licensee's laboratory and the licensee's contract laboratory were consistently less than the value determined by ESSAP—averaging 25 % lower and 20 % lower for the licensee's laboratory and the contract laboratory, respectively. The cause of

the difference in the reported concentrations was most likely the result of the analytical instrumentation precision (germanium detector versus NaI detector), the difference in the licensee's standard and sample density, the contract laboratories analytical method (see section 4.1.1), and principally the quantification methods. ESSAP uses the 0.352 MeV photon from Pb-214 to calculate Ra-226 concentrations and the licensee quantifies Ra-226 from the 0.609 MeV photopeak from Bi-214. ESSAP has determined that the use of the 0.609 MeV photopeak tends to underestimate the Ra-226 levels as a result of the summing of coincident photons. This determination was based on the results of ESSAP's analysis of an International Atomic Energy Agency (IAEA) reference material and review of the spectra. The data clearly showed that the Bi-214 0.609 MeV photopeak underestimated the known Ra-226 value of 134 ± 0.2 pCi/g by 12%. Based on this, ESSAP recommends to the NRC that the licensee's data be reevaluated and that representative samples be provided to ESSAP for analysis from locations where the reported Ra-226 value was greater than or equal to approximately 75% of the 10.5 pCi/g guideline value.

SUMMARY

During the period September 30 through October 2, 1996, the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) participated together with representatives from the U.S. Nuclear Regulatory Commission's Headquarters and Region IV offices in an on-site inspection of the Homestake Mining Company of California's decommissioning project in Grants, New Mexico. Inspection activities included a review of the licensee's remediation process, final status survey procedures and results, analytical procedures; and the performance of independent gamma surface scans, exposure measurements, and soil sampling and analysis.

It is ESSAP's opinion that overall the licensee's final status survey procedures and supporting documentation adequately represented the radiological conditions of the site. However, there are a number of issues that were identified that may be considered for further evaluation or require follow-up activities.

- The licensee's use of a 2 π source activity for determining the efficiencies—and not correcting for the total source activity either during calibration or when converting count rates to activity per unit area—for instrumentation used for surveys of equipment or materials that may be released from the site may underestimate total surface activity by approximately one-half. ESSAP recommends instrumentation used for conducting surveys of equipment or materials that will be released off-site for unrestricted use be calibrated in a manner that will account for total surface activity. That is, determining the efficiency factor based on the 4 π calibration source activity. This will ensure that the data generated is adequate and comparable to the appropriate NRC guidelines.

- Further evaluation of the licensee's background data should be performed to ensure that all samples were collected from areas that were not impacted by windblown tailings and demonstrate that the observed disequilibrium between Ra-226 and U-238 in some samples is indeed the result of natural geologic occurrences.

- The licensee should determine whether their contract laboratory participates in an EPA or EML performance evaluation or cross-check program.

- ESSAP's comparative analysis of soil samples determined that the licensee may be under estimating the Ra-226 concentration in soils. Because the licensee's reported Ra-226 levels were consistently less than ESSAP's reported levels for the same sample, ESSAP recommends that the NRC consider requesting that the licensee investigate data and provide ESSAP with representative archived samples for confirmatory analysis from areas where the Ra-226 concentration exceeds approximately 75% of the 10.5 pCi/g guideline.

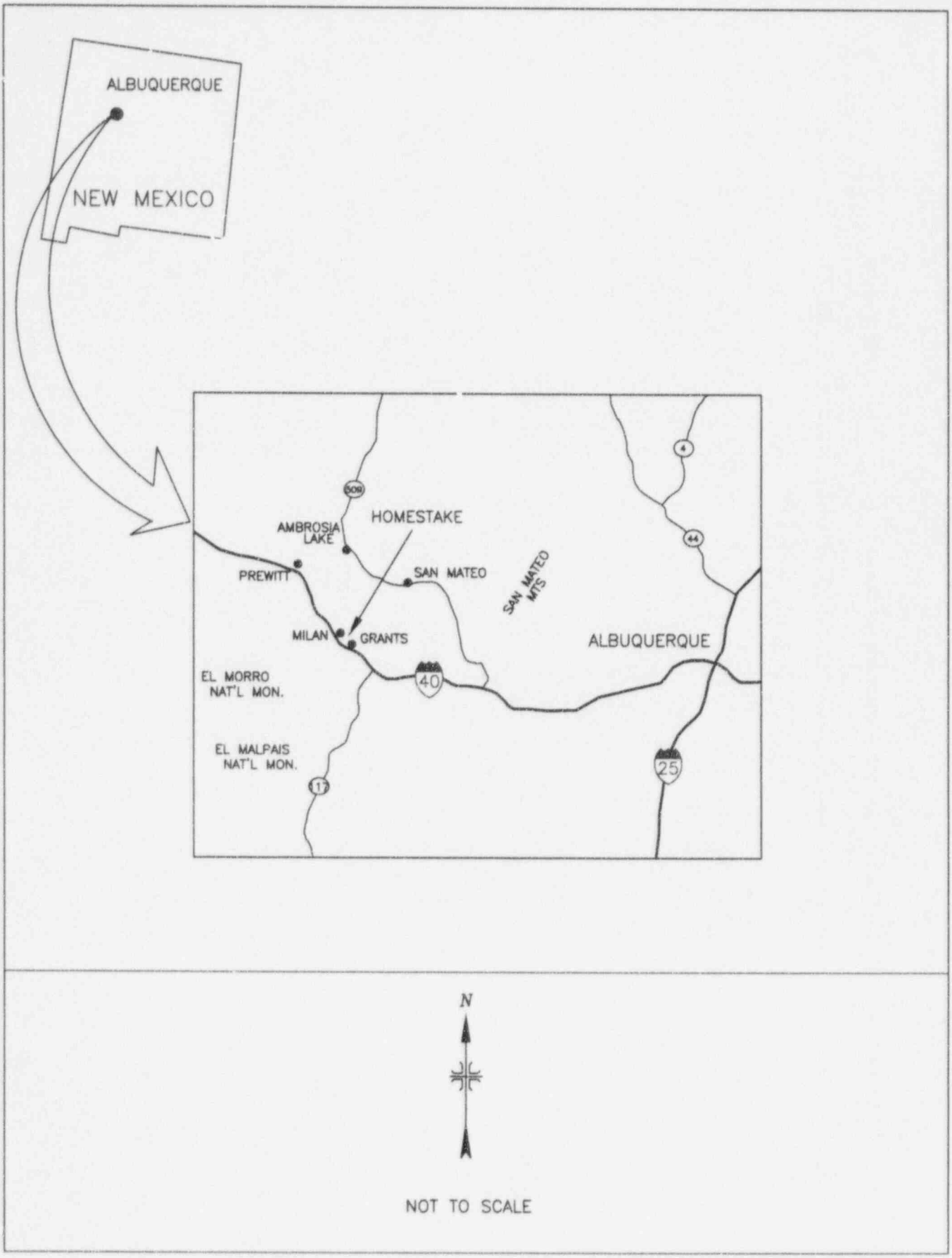

FIGURE 1: Location of Homestake Uranium Mill Site

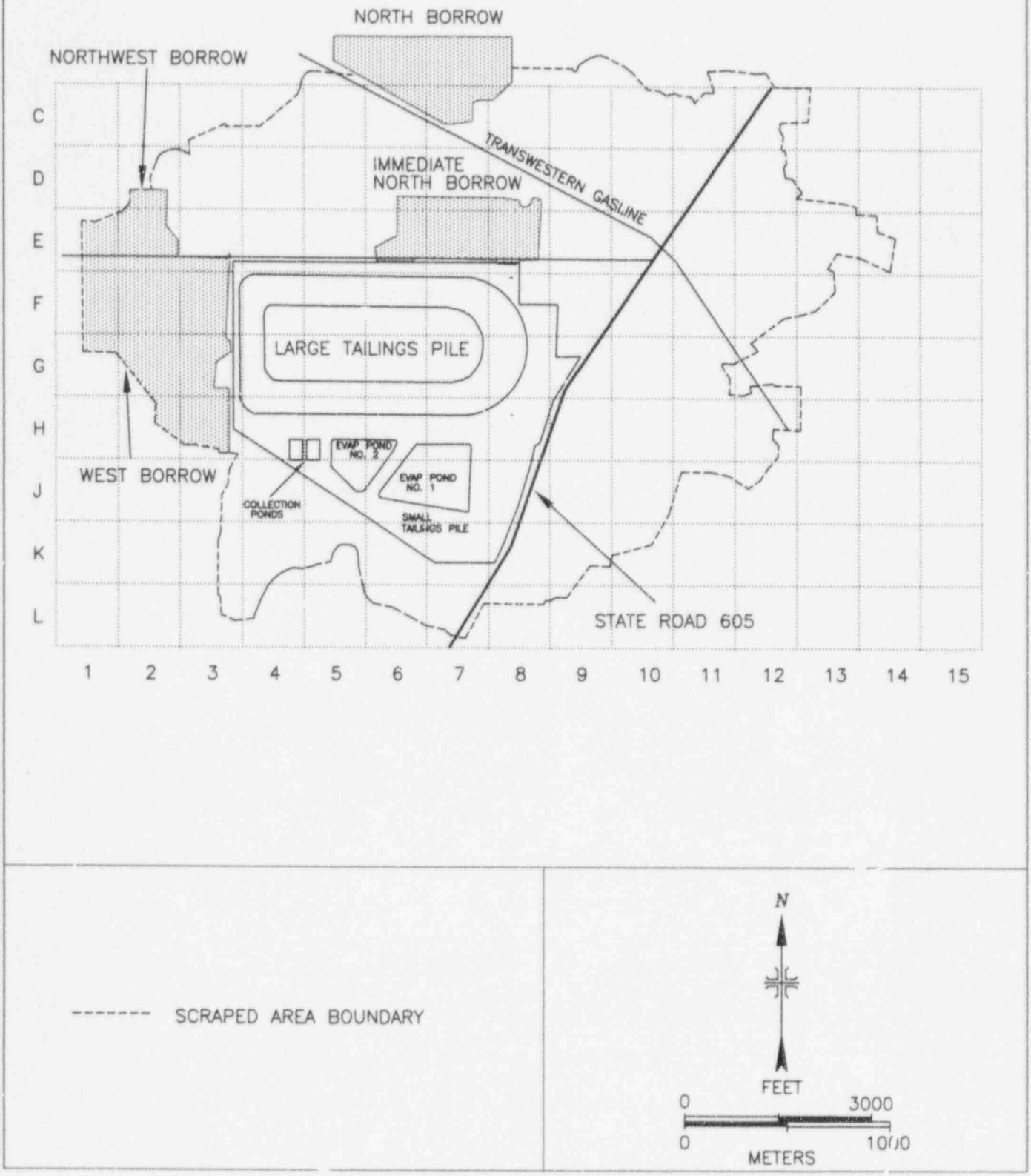

FIGURE 2: Plot Plan of Homestake Uranium Mill Site

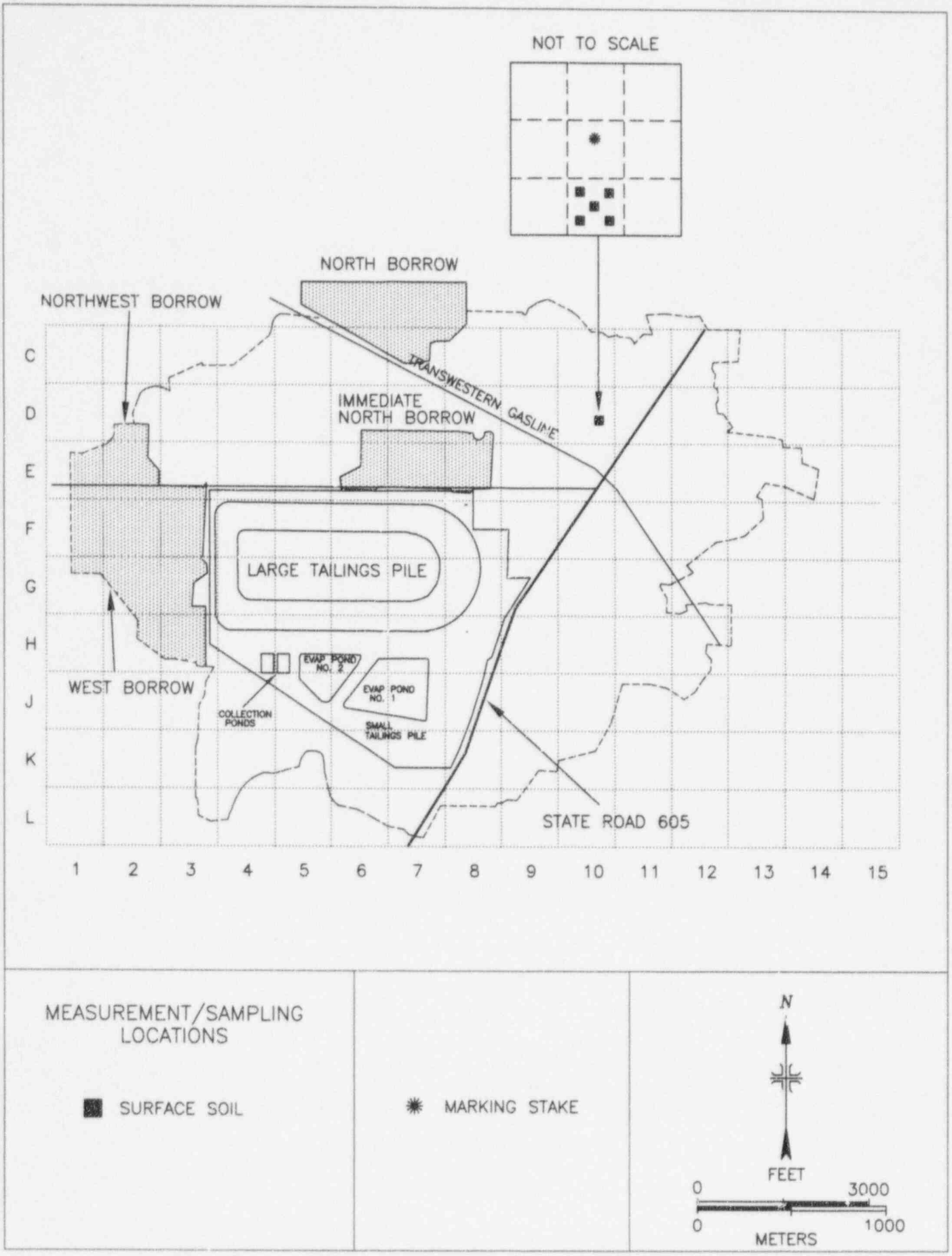

FIGURE 3: Area D104086 – Measurement and Sampling Locations

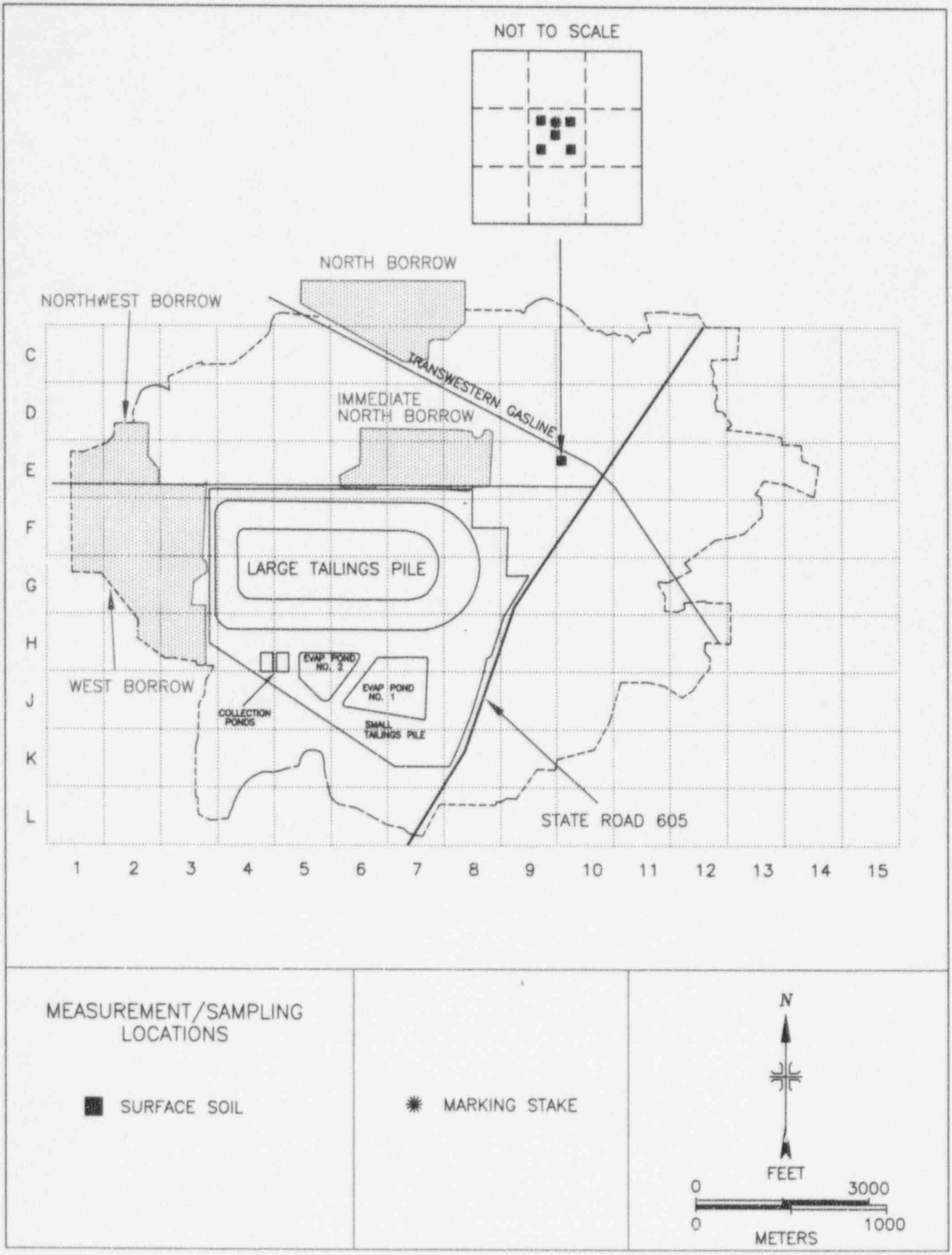

FIGURE 4: Area E92059 – Measurement and Sampling Locations

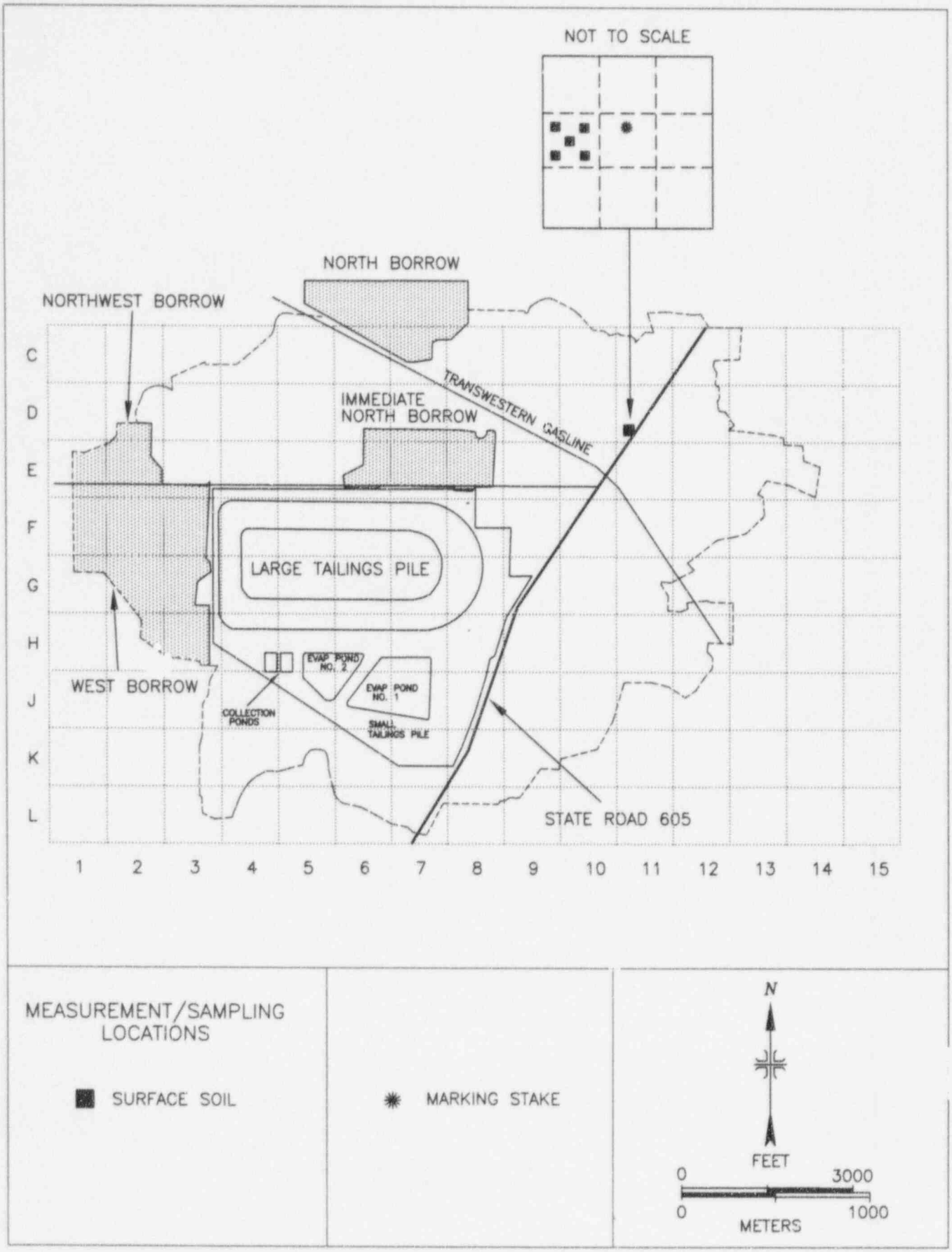

FIGURE 5: Area D113213 – Measurement and Sampling Locations

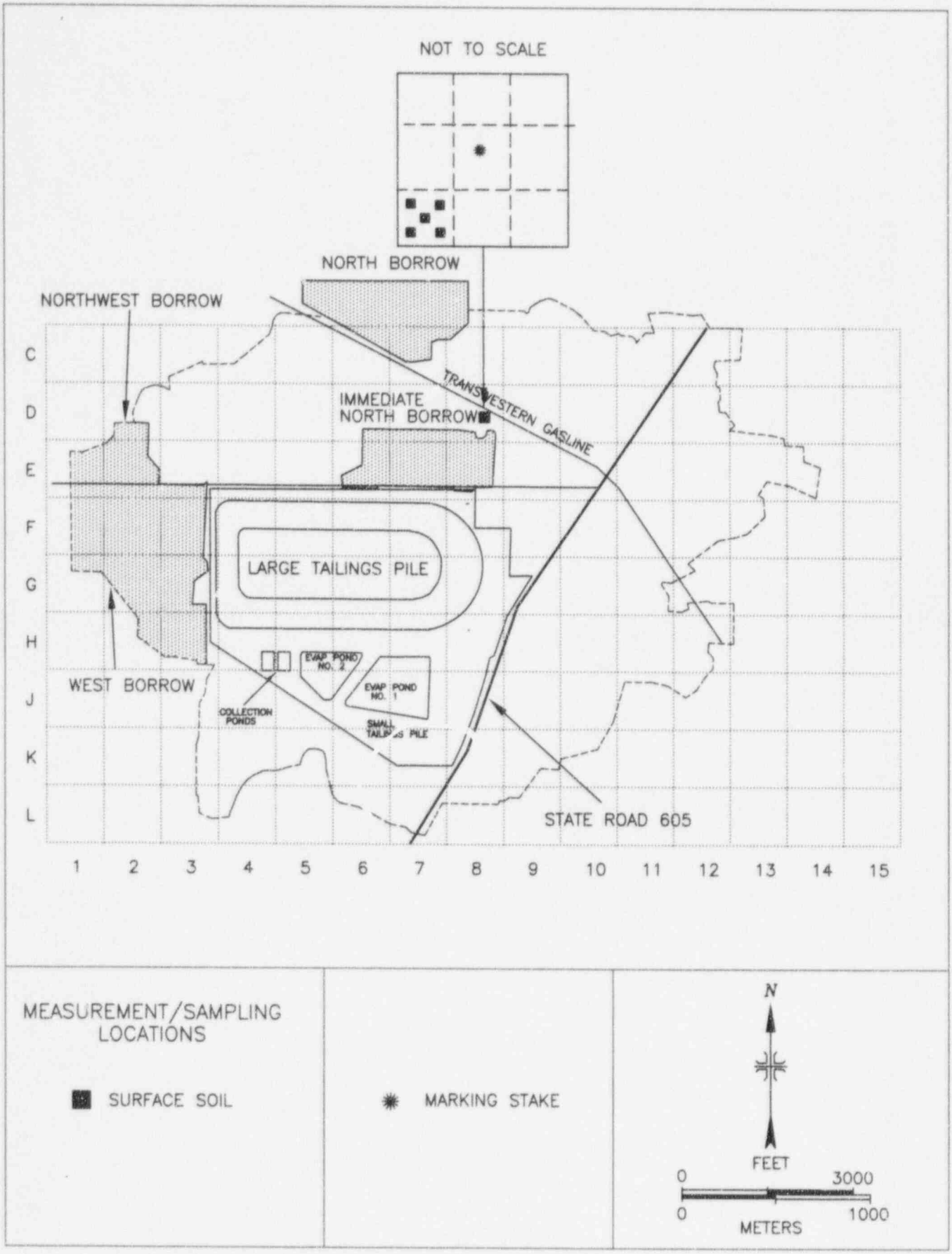

FIGURE 6: Area D84033 – Measurement and Sampling Locations

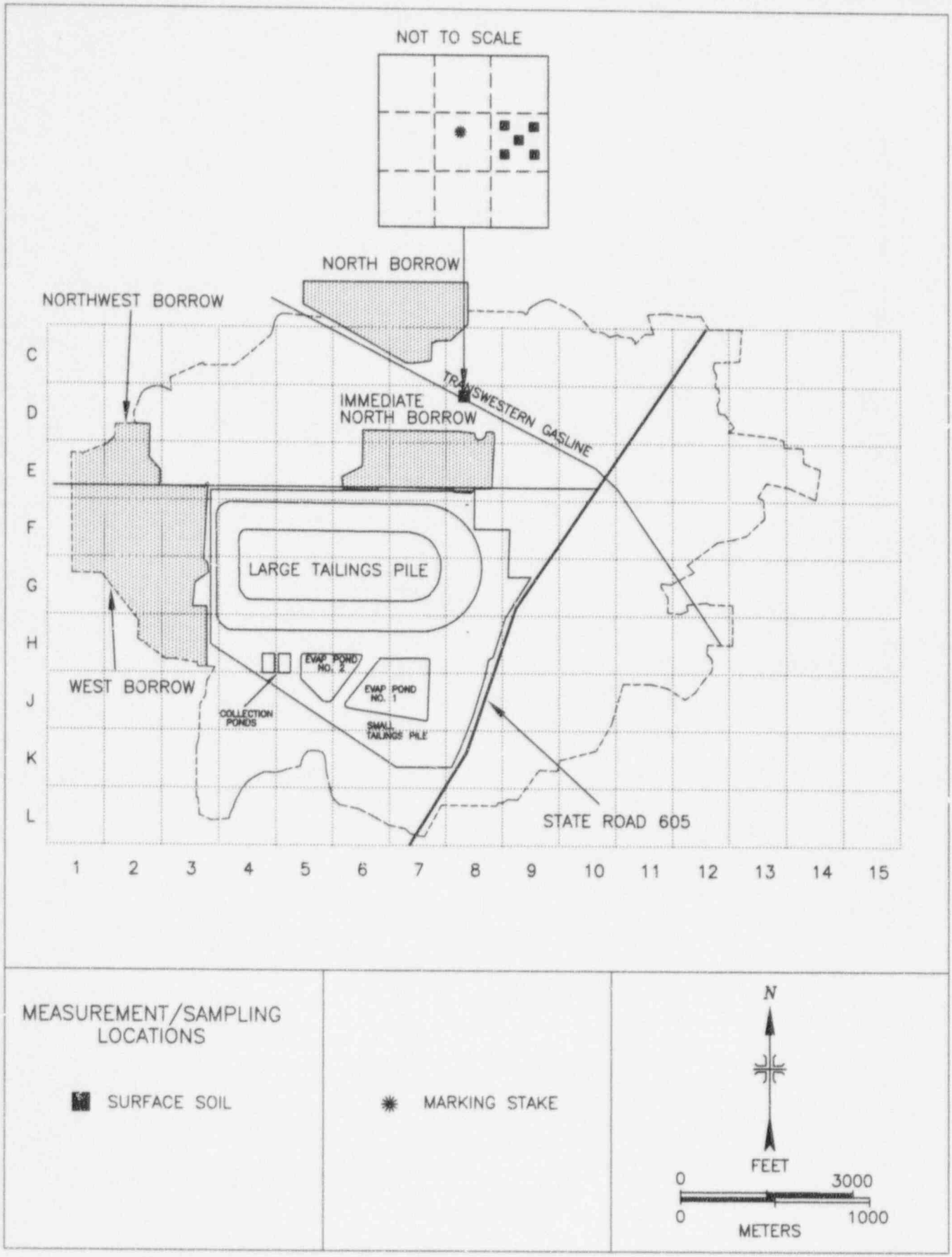

FIGURE 7: Area D81097 – Measurement and Sampling Locations

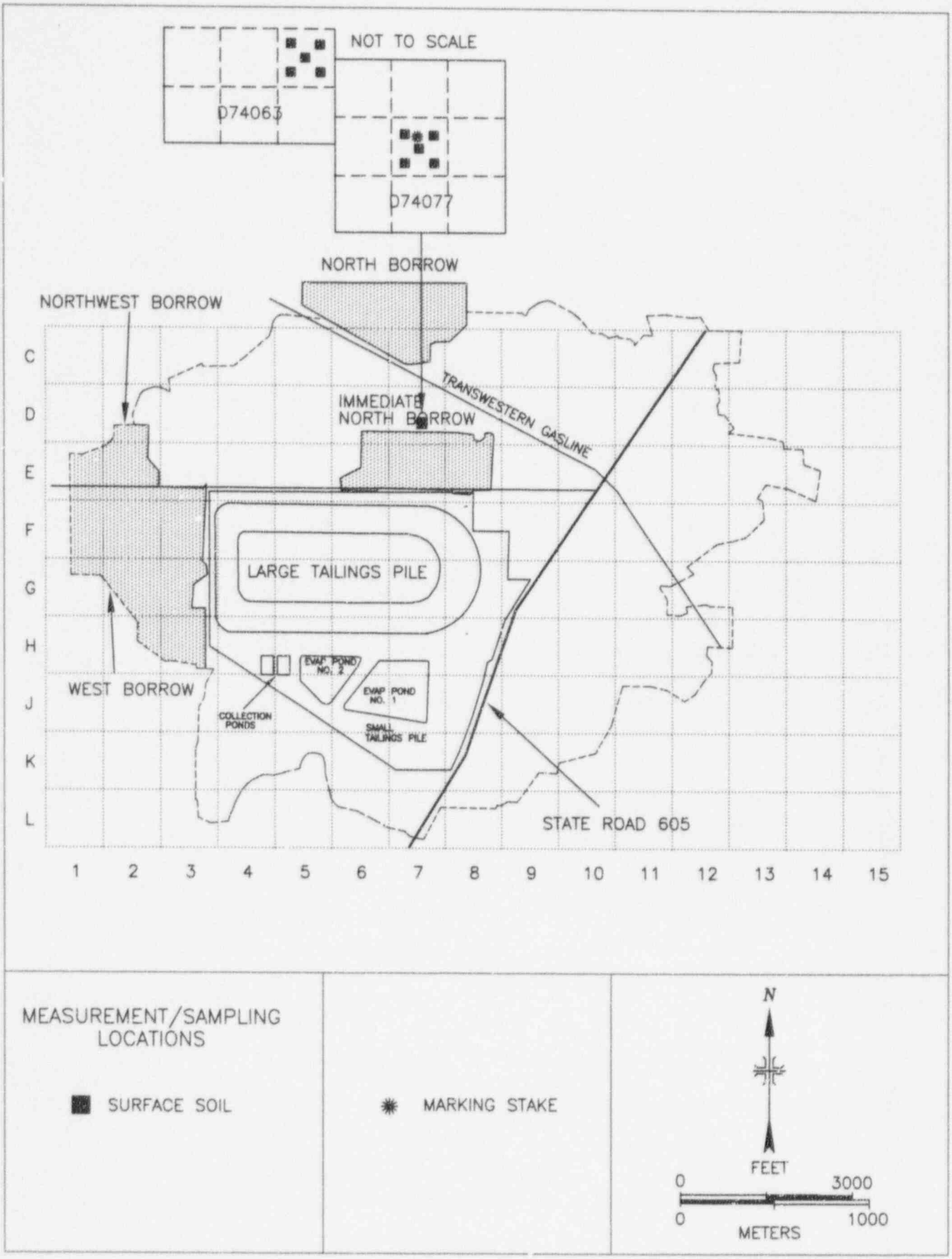

FIGURE 8: Area D74063 and D74077 – Measurement and Sampling Locations

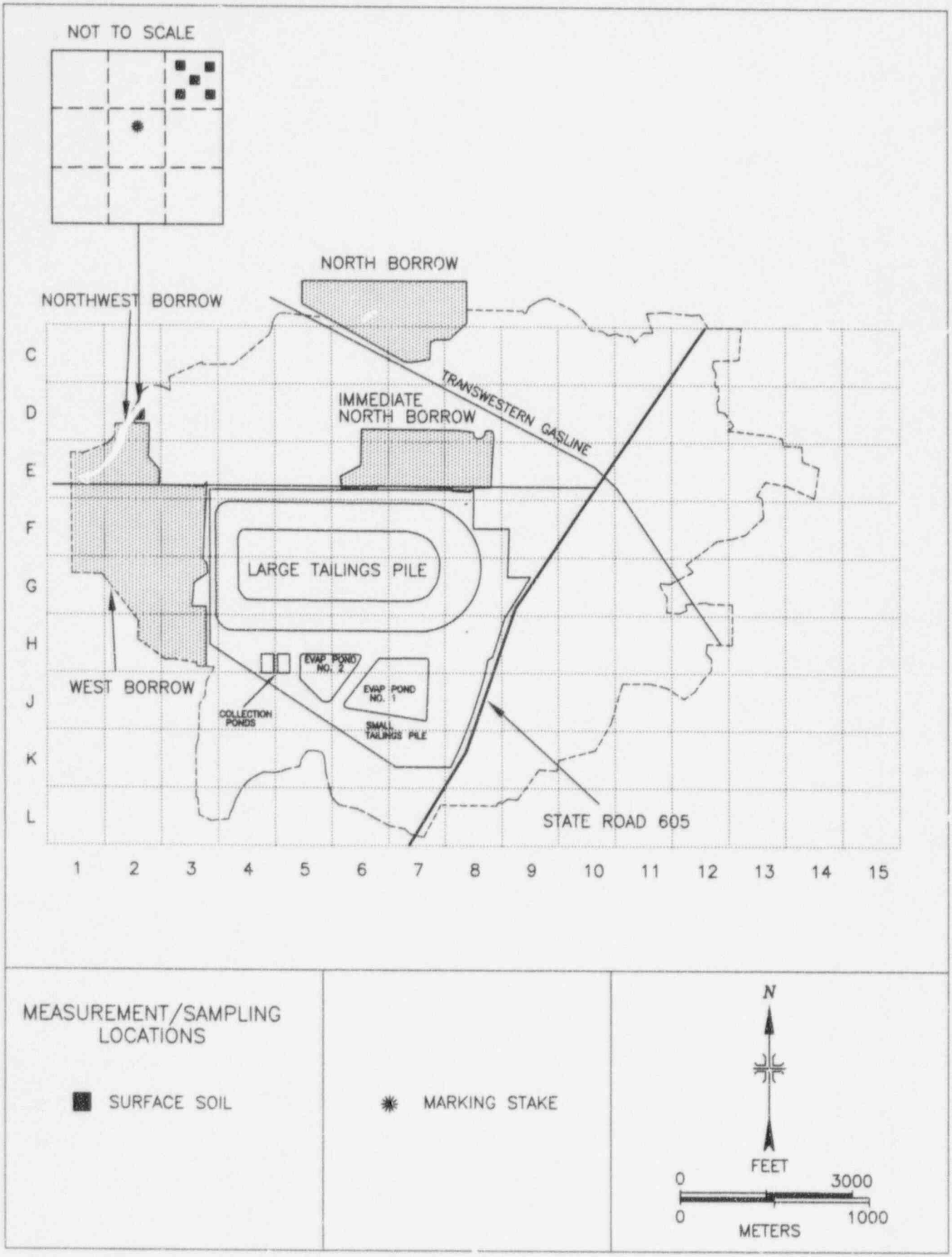

FIGURE 9: Area D24072 – Measurement and Sampling Locations

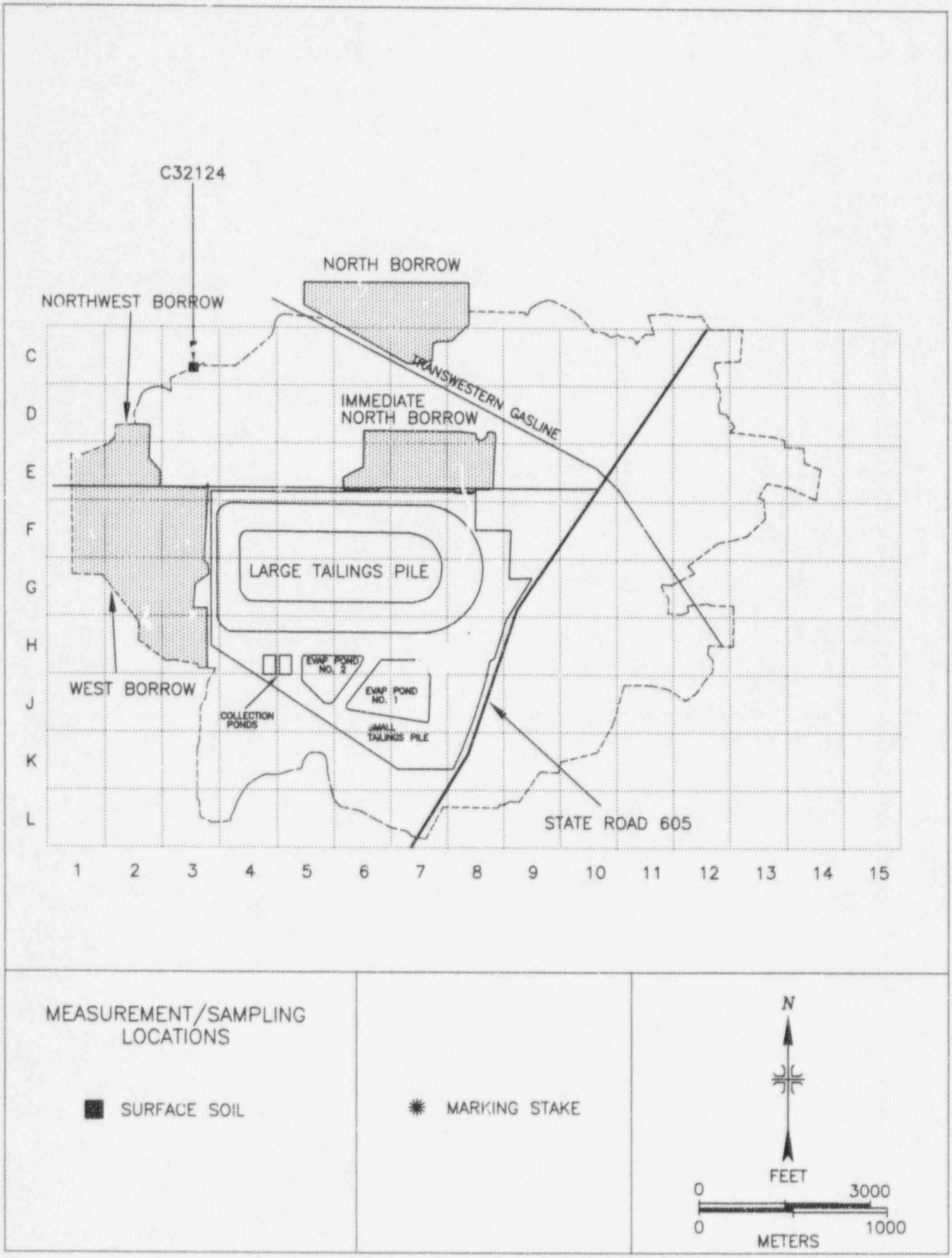

FIGURE 10: Area C32124 – Sampling Locations

TABLE 1

EXPOSURE RATES AND RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES HOMESTAKE MINING COMPANY OF CALIFORNIA GRANTS, NEW MEXICO

Location	Exposure Rate Range at 1 m (μR/h)	Radionuclide Concentration (pCi/g)[a]		
		Ra-226	Th-230	U-238
D104086[b]	18 to 25	2.8 ± 0.1[c]	6.1 ± 3.4	1.7 ± 0.5
E92059[b]	14 to 16	1.7 ± 0.1	<5.8	2.7 ± 0.7
D113213[b]	13 to 19	3.0 ± 0.1	5.8 ± 3.5	1.9 ± 0.4
D84033[b]	16 to 20	1.6 ± 0.1	<4.8	1.7 ± 0.6
D81097[b]	11 to 20	2.1 ± 0.1	<4.9	1.3 ± 0.5
D74077[b]	11 to 20	5.1 ± 0.1	<5.3	5.0 ± 0.5
D74063[b]	11 to 30	8.6 ± 0.2	6.5 ± 4.9	3.5 ± 0.8
D24072[b]	12 to 25	6.8 ± 0.1	10.1 ± 4.8	2.2 ± 0.6
C32124[b]	---[d]	5.9 ± 0.1	<6.9	2.1 ± 0.5
AS1.1, E10.2	---	1.1 ± 0.1	<4.2	1.8 ± 0.5
AS1.1150, E14.2	---	0.9 ± 0.1	<3.6	1.0 ± 0.4

[a]Samples analyzed by gamma spectrometry. Ra-226 quantified from the 0.352 MeV Pb-214 photopeak, Th-230 quantified from the 0.067 MeV photopeak, U-238 quantified from the 0.063 MeV Th-234 photopeak.
[b]Refer to Figures 3 through 10.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.
[d] Measurement not performed.

TABLE 2

COMPARISON OF Ra-226 CONCENTRATIONS IN SOIL SAMPLES HOMESTAKE MINING COMPANY OF CALIFORNIA GRANTS, NEW MEXICO

Sample No.	Ra-226 Concentration (pCi/g)		
	ORISE[a]	Homestake[b]	Energy Lab[c]
1	2.8 ± 0.1[d]	2.20	2.40
2	1.7 ± 0.1	0.97	1.50
3	3.0 ± 0.1	2.67	3.00
4	1.6 ± 0.1	1.23	1.40
5	2.1 ± 0.1	1.64	1.80
6	5.1 ± 0.1	3.87	4.10
7	8.6 ± 0.2	7.18	6.40
8	6.8 ± 0.1	6.23	5.90
9	1.1 ± 0.1	0.83	0.60
10	0.9 ± 0.1	0.33	0.50
11	5.9 ± 0.1	5.19	4.7 ± 0.3

[a]Samples analyzed by gamma spectrometry. Ra-226 quantified from the 0.352 MeV Pb-214 photopeak.
[b]Samples analyzed by gamma spectrometry. Ra-226 quantified from the 0.609 MeV Bi-214 photopeak.
[c]Samples analyzed by wet chemistry.
[d]Uncertainties represent the 95% confidence level, based only on counting statistics.

REFERENCES

International Organization for Standardization (IS0). Evaluation of surface contamination—Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters. ISO 7503-1, First Edition, 1988-08-01.

Oak Ridge Institute for Science and Education (ORISE). Final Site-Specific Decommissioning Inspection Plan for Homestake Mining Company of Californis, Grants, New Mexico (RFTA No. 96-16). Oak Ridge, TN; September 23, 1996.