Radiological Characterization of the Former UNC Manufacturing Facility, New Haven, Connecticut

UNC Naval Products

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ABBREVIATIONS AND ACRONYMS

µR/hr	microroentgen per hour
AAA/IEM	AAA Environmental Inc./Integrated Environmental Management, Inc.
AEC	Atomic Energy Commission
D&D	decontamination and decommissioning
DHEC	South Carolina Department of Health and Environmental Control
dpm/100cm^2	disintegrations per minute per 100 square centimeters
GEL	General Engineering Laboratory
GM	geiger-mueller detector
MDE	Maryland Department of the Environment
NIST	National Institute of Standards and Technology
ORISE	Oak Ridge Institute for Science and Education
OSHA	Occupational Safety and Health Administration
pCi/gram	picocuries per gram
QAPP	Quality Assurance Project Plan
RSO	Radiation Safety Officer
TCLP	Toxicity Characteristic Leaching Procedure
USEPA	United States Environmental Protection Agency
USNRC	United States Nuclear Regulatory Commission
WAC	Waste Acceptance Criteria

1 INTRODUCTION

This radiological characterization report was prepared to summarize the analytical results of the sampling activities at the former UNC Manufacturing Facility (Former UNC Facility), located at 71 Shelton Avenue in New Haven, Connecticut. The sampling was proposed by UNC Naval Products and approved by the U. S. Nuclear Regulatory Commission (USNRC) in 1999.[1,2]

The Atomic Energy Commission (AEC) issued special nuclear material License No. SNM-368 to Olin Matheson Corporation in 1959, which was transferred to United Nuclear Corporation Company in 1961. This license authorized the use of enriched uranium (greater than 97% uranium 235) and later source materials, including natural uranium, depleted uranium and thorium for research and nuclear fuel fabrication in New Haven, Connecticut.

Manufacturing activities at the Former UNC Facility involved the fabrication of fuel elements which were then shipped to another location for upgrading into naval reactor components. The radioactive material used in these operations was primarily enriched and natural uranium. The Former UNC Facility received enriched uranium and combined it with zirconium to form fuel elements suitable for upgrading into fuel assemblies. All work involving unclad uranium fuel was performed in radiologically controlled areas (Building 3H) at the New Haven site. Trenches, holding tanks and dedicated piping were used to hold waste and debris that contained uranium. The wastes were ultimately pumped to the decon pit for treatment and waste disposal. The facility was decontaminated by removing process equipment and building furnishings. The sumps, drains and pipes serving the radioactive waste system were removed. The final survey activities indicated that the release criteria were satisfied.

Radioactive materials License No. SNM-368 was last amended to release the New Haven facilities for unrestricted use on March 22, 1976.[3] In 1996, the USNRC contacted the current property owner and UNC to request access to perform additional evaluations on the basis that the USNRC's review of the

[1] UNC Naval Products, *Characterization Plan for the Previously Licensed Facility in New Haven, CT*, August 14, 1998.

[2] U.S. Nuclear Regulatory Commission, *Site Characterization and Decommissioning Plan for 71 Shelton Avenue, New Haven, CT*, Docket 070-00371 (retired), April 6, 1999.

[3] US Nuclear Regulatory Commission, *Inspection Report*, Report Number 070-00371/96-001, July 26, 1996.

decontamination and decommissioning (D&D) records showed no clear evidence that soil decontamination would meet the 1996 release requirements.[4] The USNRC subsequently made two site visits to perform these evaluations. Their findings are summarized in Section 2.4 of this report. Based on these findings, the USNRC requested that UNC perform further site characterization.

The team of AAA Environmental, Inc. and Integrated Environmental Management, Inc. (AAA/IEM) was selected by UNC to provide the characterization and decommissioning services. AAA/IEM completed the radiation survey to characterize the radiological constituents present in selected areas of the Former UNC Facility identified by the USNRC.

Areas known to exhibit levels of radioactivity in excess of USNRC release criteria were summarized by the USNRC in 1997.[5] These areas are within and around an old industrial building, now used as a warehouse. The site was no longer owned by UNC, therefore AAA/IEM coordinated access to the site and scheduled all on-site activities with the property owner.

The radiological characterization surveys that are the subject of this report were conducted in February, March and October, 2003. During those visits, radiation measurements were made and discrete samples of various media were collected and analyzed. The characterization work was described in the Quality Assurance Program Plan (QAPP) for the project, and the controls to limit worker exposures to hazardous materials and physical conditions were described in the project's Health and Safety Plan.[6,7] All work was performed by AAA/IEM, with analytical support provided by General Engineering Laboratory (GEL).[8]

The goal of this project was to verify the presence and determine the extent of residual licensed radioactive materials at the Former UNC Facility that exceed the USNRC's criteria for unrestricted use. The sample collection locations were intended to define the concentrations of uranium and provide an estimate of the volume of materials to be removed and disposed of as radioactive waste.

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[4] US Nuclear Regulatory Commission Branch Technical Position, *Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations*, SECY 81-576, Federal Register 46 FR 52601, October 23, 1981.

[5] Oak Ridge Institute for Science and Education (ORISE), *Radiological Scoping Survey of Building 3H and 6H at the Former UNC H-Tract Facility, New Haven, Connecticut*, January 27, 1997.

[6] AAA/IEM, *Quality Assurance Program Plan for Characterizing the Former UNC New Haven Facility*, Report No. 2002020/G-1254, January 28, 2003.

[7] AAA/IEM, *Health and Safety Plan for Characterizing the Former UNC New Haven Facility*, Report No. 2002020/G-1253, January 28, 2003.

[8] General Engineering Laboratory, Inc., 2040 Savage Road, Post Office Box 30712, Charleston, South Carolina 29417, Phone: (843) 556-8171.

A Characterization Plan, approved by the USNRC in 1998, provided detailed information about the locations that were sampled during this task.[9] The sampling effort was to confirm the feasibility of remediation and to help define effective methods for decontamination. This report contains a summary of radiation measurements, survey and sampling methods, a listing of all data acquired, and a comparison of findings to the site-specific release criteria. The findings of this report will be used to develop the decommissioning plan for the site.

[9] UNC Naval Products, *Characterization Plan for Previously Licensed Facility in New Haven, Connecticut*, August 14, 1998.

2 FACILITY INFORMATION

2.1 Site Location

The Former UNC Facility is located at 71 Shelton Avenue in New Haven, Connecticut. It is adjacent to the western portion of Science Park, a commercial-industrial complex in the northwest section of New Haven. The facility is generally bounded by Division Street on the north, Shelton Avenue on the west, and Science Park on the east. The building at the Former UNC Facility is currently used as a warehouse, and it is surrounded by a chain link fence. Access to the site is controlled by the current owner, Mr. Alan Jarman.

2.2 Constituents of Concern

UNC previously possessed and handled enriched uranium (greater than 97% Uranium-235) as well as source material (i.e., natural uranium, depleted uranium and natural thorium) for research and nuclear fuel fabrication. The feed materials were in the form of processed metals and oxides, shipped to the Former UNC Facility after initial purification, meaning the progeny of uranium were removed and were not in general equilibrium with its parent. Therefore, the radionuclides of concern at the site are U-238, U-235, and U-234.

2.3 Release Criteria

The characterization effort was designed for ready comparison to USNRC requirements for clean-up and disposal of residual radioactivity at the Former UNC Facility.[10] The USNRC established the release criteria as concentrations of uranium and thorium in soil "that would limit maximum radiation exposure received by members of the public under various conditions of future land usage". For enriched uranium, the release criteria selected by the USNRC was 30 picocuries per gram above background, averaged over an area of 100 square meters (m^2).[11] The USNRC allows the release criteria to be modified for areas less than 100 m^2 in size; the maximum concentration of 90 pCi/gram is authorized by the USNRC in an area less than 11 m^2. USNRC regulations also specify that external whole body gamma exposure rates anywhere at the site must be less than 10 microroentgen per hour (μR/hr) above the ambient background.

The characterization plan identified concentrations of uranium in soil and sediment that exceeded thirty (30) picocuries per gram. While on-site, AAA/IEM also collected information to confirm that no hazardous constituents were present in the soil and sediment.

[10] US Nuclear Regulatory Commission Branch Technical Position, *Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations*, SECY 81-576, Federal Register 46 FR 52601, October 23, 1981.

[11] This limit was based on the USEPA cleanup standard which limits radiation exposures to the public to less than 1 millirem (mrem) per year to the lung and less than 3 mrem/year to the bone from ingestion and inhalation.

Release criteria for surfaces were established for License SNM-368 by the USNRC using guidelines for source and special nuclear material.[12] The criteria were applicable to any surfaces of the floor, concrete trenches as well as sewer pipes.

2.4 Summary of Previous Characterization Results

The Former UNC Facility was decommissioned by UNC and the radioactive materials license was terminated for the New Haven site by the USNRC in 1976. The USNRC conducted a survey at the Former UNC Facility on May 29, 1996 as part of an overall evaluation of licenses that were previously terminated.[13] The USNRC concluded that all above-ground survey results were below the criteria for release for unrestricted use. However, soil sample data from areas below the concrete flooring of the building suggested potential residual radioactivity (enriched uranium) in the range of 30 to 700 picocuries per gram (pCi/gram). The USNRC's report stated that no immediate public health and safety concern existed, however additional surveys of the decontamination pit, hot waste pipe trenches and sewer sediment samples were deemed necessary in order to determine the need for further remediation.

The Oak Ridge Institute for Science and Education (ORISE) was contracted by the USNRC to complete another radiation survey at the Former UNC Facility. This survey was performed on September 16, 1996.[14] During that effort, radiation measurements were made and solid samples were collected from Building 3H and 6H for analysis.

The ORISE survey included the performance of gamma scans, subfloor soil sampling, residue sampling and sediment sampling from the associated sewer system under Argyle Street. Surface scans for gamma radiation were performed over accessible floor space in all areas of concern. Scans for beta radiation were performed at the openings of accessible floor drains. Radiation scans were performed using sodium iodide (NaI) gamma scintillation detectors and geiger-mueller (GM) detectors coupled with ratemeters and/or scalers with audible indicators.

Three (3) core samples were cut through the concrete floor and samples were taken from two locations in the X-ray Read room and one location in the decon pit area.[15] A total of five (5) soil samples were collected from these locations; two (2) samples were collected from the open pipe

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[12] U.S. Nuclear Regulatory Commission, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material*, July, 1982.

[13] US Nuclear Regulatory Commission, *Inspection Report*, Report Number 070-00371/96-001, Docket 070-00371, July 26, 1996.

[14] Oak Ridge Institute for Science and Education, *Radiological Scoping survey of Buildings 3H and 6H at the Former UNC H-Tract Facility, New Haven, Connecticut*, Final Report, January 27, 1997.

[15] Oak Ridge Institute for Science and Education, *Radiological Scoping survey of Buildings 3H and 6H at the Former UNC H-Tract Facility, New Haven, Connecticut*, Final Report, January 27, 1997.

trench running along the south wall of the building; one sample in the Rectifier room; one from the Chemistry laboratory in Building 6H; and two (2) samples were collected from the sewer system (Manhole #3 and #4) under Argyle street.

The results of the gamma scans identified two locations on the floor of the X-ray Read Room that exceeded the USNRC release criteria. Direct radiation at these locations was approximately three (3) times the ambient background levels; both locations were less than 300 square centimeters (cm^2) in area. The scans in the accessible floor drains did not exhibit beta radiation in excess of the USNRC release criteria.

The soil samples were analyzed by gamma spectroscopy and found the presence of enriched uranium. Radionuclide concentrations in the decon pit was reported to be less than 1 picocuries per gram (<1 pCi/g) of U-235 and <1 pCi/g of U-238; the concentration of total uranium was calculated to be less than 6 pCi/g. Radionuclide concentrations in the X-ray Room were reported to range from <1 to 26 pCi/g of U-235 and <1 to 3 pCi/g of U-238. The range of total uranium was calculated to range from 3 pCi/g to 720 pCi/g in the soil under the floor. The concentrations of total uranium in the south trench were reported to range from 37 to 57 pCi/g. The total uranium in the sewer system was reported to range from 3 to 217 pCi/g. For all soil samples, the concentration of total thorium was reported to range from <1 to 2 pCi/g.

ORISE concluded that the three (3) soil samples collected under the floor of the X-Ray Read room exceeded the USNRC release criteria. The residues collected in the south trench and in the sewer system (Manhole #3) were reported to exceed the release criteria. The total thorium identified in all of the samples collected from the site were below the USNRC release criteria.

3 ORGANIZATION AND RESPONSIBILITIES

3.1 UNC Representatives

This characterization effort was performed under the direction of Robert Bonito of UNC. He was assisted by Robert Gregg, consultant to and former employee of UNC and John Uruskyj, General Electric Company Remedial Project Manager.

3.2 Radioactive Materials License

All work performed at the Former UNC Facility that involved licensable radioactive materials was performed in accordance with the license issued to IEM by the Maryland Department of the Environment (MDE). This license authorizes IEM to possess any radioactive material suitable for transport under DOT regulations within the state of Maryland and elsewhere pursuant to interstate reciprocity.[16] The license was amended by the MDE on December 19, 2002 authorizing performance of the characterization work at the Former UNC Facility.[17] Reciprocity for work within the State of Connecticut was granted by the USNRC on January 3, 2003.

3.3 Radiation Safety Officer

Alan Duff, Registered Radiation Protection Technologist (R.R.P.T.) served as the radiation safety officer (RSO), coordinated the field sampling effort for the on-site work and served as an Authorized User under the MDE License No. 31-281-01. Mr. Duff's resume is provided in Appendix A. Mr. Duff ensured that the requirements of MDE license were met, provided oversight of all radiation-related activities, and ensured compliance with site-specific license conditions and the guidelines approved and specified by the AAA/IEM Project Manager. His specific responsibilities included but were not limited to the following:

- Supervising the collection of field samples;
- Coordinating the schedule of samples being shipped to the analytical laboratory for analysis;
- Preparing routine progress reports, including a summary of field activities and field audit results; and
- Performing radiation measurements to verify that personnel exposures to radioactive materials and ionizing radiation were acceptable.

[16] Maryland Department of the Environment, Radiological Health Program, *Radioactive Materials License issued to Integrated Environmental Management, Inc.*, License Number MD-31-281-01.

[17] Maryland Department of the Environment, *Amendment to Radioactive Materials License*, License Number MD-31-281-01, Amendment 06, December 19, 2002.

3.4 Project Manager

The AAA/IEM project manager for this characterization effort was Billy R. Thomas, C.H.P., C.I.H. Mr. Thomas, who is a Certified Health Physicist and a Certified Industrial Hygienist with over 25 years of experience, ensured all technical requirements were met, and served as UNC point of contact for this project. He is also listed as an Authorized User on MDE License No. 31-281-01. His responsibilities included but were not limited to the following:

- Providing overall direction and management of the sampling activities as defined in the UNC Characterization Plan and the Quality Assurance Project Plan (QAPP);
- Providing management of all aspects of the sampling project;
- Completing the final review of all documents prepared during this sampling effort; and
- Approving reports prior to their submission to UNC.

3.5 Operations Manager

Keith Balbuena was the AAA/IEM Operations Manager for all on site work. Mr. Balbuena has over 10 years of experience in environmental measurements and field work. His responsibilities included managing the field staff and monitoring progress of the sampling effort with respect to the approved schedule. Mr. Balbuena determined the corrective actions necessary to ensure the project met its objectives and that the schedule was maintained.

3.6 Quality Assurance Manager

Carol D. Berger, C.H.P., a Certified Health Physicist, was the AAA/IEM Quality Assurance Manager for the project. Ms. Berger is the Alternate RSO for MDE License No. 31-281-01. Her responsibilities included oversight for all license-related actions performed at the site, as well as the following:

- Reviewing the data and verifying compliance with the QAPP;
- Verifying and validating the analytical data;
- Maintaining the QAPP; and
- Reviewing all reports and deliverables.

3.7 Remediation Manager

William Songer was the AAA/IEM Remediation Manager for this project. Mr. Songer monitored the overall progress of the characterization effort and provided technical support in defining remediation tasks that may be required after the characterization is complete.

3.8 Analytical Laboratory

GEL provided sample analysis and other analytical services to AAA/IEM. This facility was certified by the State of Utah for performing waste characterization in accordance with the Waste Acceptance Criteria for Envirocare of Utah, LLC. GEL performed the analytical work required for both radioactivity and chemistry methods. GEL was also licensed by the State of South Carolina Department of Health and Environmental Control (DHEC) to receive, store and use radioactive materials with Radioactive Material License Number 362, and by the State of Connecticut Department of Public Health - Potable Water, Waste Water, Sewage, and Soil Certification. (GEL ID: PH-0169, exp. March 31, 2005).

4 SURVEY METHODOLOGY

4.1 Instrumentation Description

Instrumentation used during the project was appropriate for the type of radiation expected, of appropriate sensitivity and accuracy to detect the radioactive materials which might be found at the UNC facility and detect the presence of radioactive materials on tools, equipment, clothing, and personnel at levels which may be found at the site. The basis for selection of instruments for use on the project included quality of radiation to be measured, sensitivity required, and purpose of the survey being conducted.

The following instruments were utilized to perform the characterization surveys at the UNC facility:

- Ludlum Model 2224 scaler/ratemeter with Model 43-89 dual alpha/beta probe (total contamination surveys)
- Ludlum Model 2241 scaler/ratemeter with Model 44-10 2" x 2" sodium iodide detector (gamma surveys)
- Bicron MicroRem tissue equivalent gamma survey meter (ambient gamma exposure rate surveys)

4.2 Instrument Calibration

Instruments were calibrated annually and following any significant repairs to the scaler/ratemeter and/or detector. Each ratemeter or scaler/ratemeter was calibrated with a specific detector, designated by the detector serial number.

The radiation survey instruments were calibrated by Ludlum Instruments and Duratek Instrument Services using radiation sources which were traceable to the National Institute of Standards and Technology (NIST).[18,19] Instruments were calibrated according to the guidelines of ANSI N323-1978, "Radiation Instrumentation Test and Calibration".

The following pre-operational checks were performed prior to each use or daily when kept in use, as applicable:

- Battery function

[18] Ludlum Measurements, Inc., 501 Oak Street, Sweetwater, Texas, 79556. Telephone (915) 235-5494.

[19] Duratek Instrument Services, 628 Gallaher Road, Kingston, Tennessee, 37763. Telephone (865) 376-8337.

- Response to a reference source[20]
- Reset Button function
- Audible response function
- Physical damage
- Current calibration sticker
- Response to background radiation

Instruments failing any pre-operational check were taken out of service and repaired prior to use. Each instrument was labeled with a unique identifier (e.g., serial number of detector and rate meter) to enable traceability between instrument and survey records. Appendix B contains the calibration records associated with the instruments used for this project. Appendix C contains the results of the pre-operational checks that were conducted on a daily basis.

4.3 Preparation for Surveys

In areas where alpha radiation was being analyzed, the surface to be surveyed was inspected to ensure that it was free of overlying material such as dust and water. Equipment or materials which restricted the conduct of surveys were relocated as needed. Drawings of each survey area were prepared and used to record the data acquired. Appendix D and E contains the completed survey records for the project in its entirety.

4.4 Determination of Background

A total of three background measurements of ambient gamma exposure rate and surface contamination rate were made at three separate locations within the building where licensed operations had been performed. The measurements were taken at the beginning and at the end of each work shift. If the variance in values exceeded $\pm$ 50%, additional measurements were taken to assure a representative average value. The following equation was used to determine the average background result for each work shift:

$$BKG_{ave}(i) = \frac{\sum_{1}^{n} BKG_i}{n}$$

[20] For each instrument, the response to a specified check source was established. A series of measurements were made with each instrument using the same check source. For instruments with both a scaler and ratemeter mode, both modes were checked. These measurements were documented and the arithmetic mean and standard deviation for each instrument's response was then calculated, along with the two- and three-sigma levels. A new series of measurements were made whenever an instrument was returned from repairs or calibration.

where BKG_{ave} = the average background measurement result for a specific measurement type (e.g., ambient gamma exposure rate or surface contamination rate), BKG_i = the result of measurement number "i", and n = the number of measurements made. Values of BKG_{ave} were used to arrive at the net measurement result from surveys performed on that day.

Background for total uranium in soil was established by UNC at a UNC Facility in Montville, Connecticut in 1993.[21,22] The background was reported to be 3.4 ± 1.2 pCi/gram of total uranium. It is assumed that the total uranium in the background soil in New Haven is similar to that of Montville and is equivalent to 3.4 pCi/gram. This approach for the remedial activities at the Former UNC facility was approved by the USNRC in 1999.[23]

4.5 Measurement of Ambient Gamma Dose Rate

Ambient gamma dose rates were measured using a portable radiation survey instrument that is sensitive to gamma radiation (i.e., a Bicron MicroRem meter). For these measurements, the instrument was turned on and permitted to stabilize (approximately 30 seconds) before proceeding further. In addition, pre-operational checks were completed to ensure functionality.

The surveys were conducted by walking slowly over the area of interest with the detector held at a height of approximately one (1) meter above the ground (waist high) and approximately one (1) meter from each vertical surface. The walking speed was such that a small fraction of the release criteria for the facility was detected with a high degree of confidence.

The highest exposure rate measured in each area was recorded on a pre-prepared survey form, along with any comments and notations necessary for interpretation of results. Special attention was given to obtaining measurements in areas where material may have collected (e.g., drains, floor joints, cracks in the floor). The individual performing the survey signed and dated the completed survey form.

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[21] UNC Naval Products, *Final Site Decontamination Report*, Montville, Connecticut, March 12, 1993.

[22] Background for total uranium in soil was established by ORISE in Montville in 1993. The ORISE report (12/8/1993) indicated that uranium in background averaged 4.0 ± 1.0 pCi/gram.

[23] U.S. Nuclear Regulatory Commission, *Site Characterization and Decommissioning Plan for 71 Shelton Avenue, New Haven, CT*, Letter to Mr. Robert Bonito from Ms. Marie Miller, April 6, 1999.

5 SURVEY/SAMPLING DESIGN

A characterization plan was submitted by UNC in 1998 and approved by the USNRC. The objective of that plan was to investigate the presence of radioactive uranium and progeny in subsurface soil and in the utility trenches at the facility. The plan also investigated previous reports of concentrations of radioactive material in the sewer system under Argyle Street.[24,25] The USNRC-approved plan was implemented during the current characterization effort.

5.1 Sampling Objective

The goal of the characterization plan was to determine if additional decommissioning work was required at the Former UNC Facility. The following information is required to effectively determine the scope of the decommissioning, including:

- The horizontal and vertical extent of the radioactive materials in the soil north of Building 3H;
- The extent of radioactive materials in the sewer running under Argyle street and Shelton Avenue;
- The horizontal and vertical extent of the radioactive materials under the floor of the 3H building; and
- The extent of radioactive contamination in the utility trenches on the north and south sides of the building.

5.2 Sampling Methods

Samples were collected using two techniques, a grab sample or a core sample. A description of each technique is provided in the following subsections.

5.2.1 Grab Sample

Grab samples were collected by using a clean trowel or scoop to collect solids from the surface of the sample location. Samples were transferred from the trowel or scoop into a clean sample container; this process was repeated until a sufficient quantity of solids was collected.

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[24] Oak Ridge Institute for Science and Education, *Radiological Scoping survey of Buildings 3H and 6H at the Former UNC H-Tract Facility, New Haven, Connecticut*, Final Report, January 27, 1997.

[25] UNC Naval Products, *Characterization Plan for Previously Licensed Facility in New Haven, Connecticut*, August 14, 1998.

5.2.2 Core Sample

Core samples were collected using a Geoprobe Model 4220 or Model 54LT. For Model 4220, the probe was attached to a gasoline powered "All Terrain Vehicle" to maneuver the probe to the correct locations. For Model 54LT, the probe was attached to a remote controlled track unit. The sample tube was "pushed" into the soil using hydraulic pressure, delivered by the Geoprobe unit. The device collected a core of soil that was approximately 3 centimeters in diameter and contained inside a plastic liner. The tube was removed and the soil placed into a sample container. The Geoprobe unit was used to remove the core sample at a variety of depths. Each sample was at least 12 inches in depth, beneath the surface of the concrete.

5.3 Sample Locations

Locations for samples were identified in the Characterization Plan. Additional sample locations were identified based on the analytical results from the samples collected in February and April, 2003. Maps of the buildings are provided in Section 10 of this report to describe the locations of each sample. Detailed diagrams are provided in Appendix E which describe the location of each sample and radiation conditions that were observed.

In general, the samples were collected where previous characterization had indicated that total uranium exceeded the USNRC release criteria. Twelve (12) locations were identified to core under the floor in the X-Ray Read room and the warehouse immediately adjacent to the X-Ray Read room; seven (7) core samples in the Decon Pit room, and two (2) in the adjacent warehouse. A calibrated gamma scintillation detector was lowered into the hole created by the geoprobe sample tool to identify elevated radiation readings in the subsurface soil.

Twelve (12) grab samples were collected in the north and south trenches at accessible locations. One sample was collected from the shallow trench immediately outside of the X-Ray Read room. One sample was collected outside of the building at the east end of the south trench, near the property boundary. Two (2) samples were collected from the sewer under Argyle Street and two (2) samples from the sewer under Shelton Avenue.

A trash pile was located on the north side of Building 3H at the time of the ORISE survey in 1997 and the soil under the trash pile could not be characterized. The trash pile was sampled and containerized in February, 2003; the soil under the trash pile was surveyed and sampled after the trash pile was removed.

6 DATA INTERPRETATION

6.1 Detection Limits

The detection limit for surface activity measurements (counts) acquired over a pre-set time period was determined by the following methodology:

$$MDA = \frac{2.71 + 4.65\sqrt{BKG_{ave} \times t}}{t \times E \times \frac{A}{100}}$$

where MDA = the activity level (dpm/100 cm^2), BKG_{ave} = the background count rate for this measurement type (cpm), E = instrument efficiency, t = the measurement duration (min), and A = the area of the detector (cm^2). The MDA for an instrument operating in the rate meter mode was determined by:

$$MDA = \frac{4.65\sqrt{\frac{BKG_{ave}}{2t_c}}}{E \times \frac{A}{100}}$$

where t_c = the meter time constant (min). Alternatively, the detection limits for scanning measurements were approximated, based upon an audibly discernable increase in count rate by the following methodology:

$$MDA = \frac{R_a \times BKG_{ave}}{E \times \frac{A}{100}}$$

where R_a = the audibly discernable increase in instrument response by the individual surveyor.

6.2 Measurement Uncertainty

The rate of radioactive decay is not constant with time and is therefore described by a Poisson probability distribution. Based on such a distribution, the best estimate of the standard deviation (s) on a number of counts (c) is the square root of the counts. Likewise, the standard deviation in a count rate over the count time (t) is:

$$s_r = \frac{\sqrt{c}}{t}$$

For the measurements conducted during the characterization survey, the number of counts due only to background were a significant portion of the total counts. The uncertainty associated with the background was taken into account by:

$$s_r = \sqrt{\frac{c}{t^2} + \frac{BKG_{ave} \times t_{BKG}}{(t_{BKG})^2}}$$

where t_{BKG} = the time period over which the background counts were determined. Each reported measurement value included an assessment of the uncertainty associated with that value. To ensure a 95% confidence level, each value of s_r was multiplied by a factor of 1.96.

6.3 Data Conversion

Total (fixed plus removable) contamination data was converted to units of activity by the following methodology:

$$A_{total} = \frac{cpm - BKG_{ave}}{E} \times \frac{100}{A}$$

where A_{total} = the total surface activity (dpm/100 cm^2), cpm = the counts per minute measured by direct survey, BKG_{ave} = the average background count rate for this measurement methodology (cpm), E = detection efficiency of the instrument used (counts per disintegration), and A = the active surface area of the detector (cm^2).

Ambient gamma exposure rate data were converted to units of exposure rate by the following methodology:

$$R_{net} = R_{gross} - BKG_{ave}$$

where R_{net} = the net measured exposure rate (μR/hr) and R_{gross} = the gross measured exposure rate (μR/hr).

6.4 Laboratory Analysis

The samples collected from the Former UNC Facility were analyzed by GEL for the presence of gamma emitting radioactive isotopes using a U.S. Department of Energy Environmental Measurements Laboratory procedure, HASL-300.[26] The gamma spectroscopy method used a calibrated germanium detector. Gamma peaks associated with uranium and associated progeny were quantified; other gamma lines were identified using existing software libraries employed by GEL. To the extent practical, these gamma lines were quantified also.

The detection limit for laboratory analyses was determined pursuant to laboratory-specific procedures that take into account such factors as chemical recovery, sample size, emission abundances, and other analysis-specific parameters. The following is the general approach that was used:

$$MDA = \frac{2.71 + 4.65\sqrt{B_R \times t}}{t \times E \times S \times Y \times 2.22}$$

where MDA = the soil concentration (pCi/g), B_R = the background count rate for the instrument (cpm), t = the sample count time (minutes), E = the detector efficiency (counts/disintegration), S =

[26] U.S. Department of Energy, Environmental Measurements Laboratory, *Analytical Chemistry, Chapter 4.5.2.3, Gamma*, HASL-300, 28th Edition, Section 4, Volume I, February, 1997.

the sample size (grams), Y = other factors such as percent chemical recovery, number of emissions of radiation being measured per disintegration of the radionuclide, etc., and 2.22 = a factor to convert disintegrations/minute to units of "pCi".

While gamma spectroscopy was not the preferred method for quantifying Uranium-235, the ratio of Uranium-234-to-235 (i.e., 27:1) was established by UNC and ORISE and used during the characterization portion of the project as a "fingerprint" for licensed materials.[27,28] For each sample, total uranium was calculated by adding the concentrations of U-238, U235 and the derived concentration of U-234. The sum was then compared directly to the release criteria.

[27] The dominant gamma line from Uranium 235 (185 kev) is masked by the presence of radium 226 (186 kev). In addition, the activity of Uranium 238 (decay by alpha decay) is derived when using gamma spectroscopy, by assuming secular equilibrium with its progeny, Thorium 234. Alpha spectroscopy is the preferred method to identify enriched uranium, where the activity of Uranium 234, Uranium 235 and Uranium 238 can be clearly separated and quantified.

[28] Oak Ridge Institute for Science and Education, *Radiological Scoping Survey of Building 3H and 6H at the Former UNC Facility, New Haven Connecticut*, Final Report, January 17, 1997

7 SAMPLE RESULTS

Radiation surveys were performed and samples were collected in various areas of the Former UNC Facility on February 5-14, 2003, March 17, 2003 and October 13-17, 2003. Sampling and surveys were conducted under the floor inside Building 3H, inside the utility trenches on each side of Building 3H and 6H, at the trash pile located outside of Building 3H, and in the sewer systems under Argyle Street and Shelton Avenue. Sample locations, analytical methods and results are described in this the following sections; survey maps are provided in Section 10 of this report. Additional information on the sampling/survey effort is provided in the QAPP and the Characterization Plan for this project.[29,30]. The sample Chain of Custody forms and the Certificates of Analysis are contained in Appendices F and G, respectively. The following discussion is a brief review of the analytical results.

7.1 Decon Pit

The decon pit, located on the north side of Building 3H, had been previously remediated and soil was removed in 1976. Soil was excavated from the south side of the decon pit in 1976; all soil was removed adjacent to the building foundation and backfilled with clean soil. ORISE collected a sample from the east side of the decon pit in 1996; the concentration of total uranium was reported to be less than 6 pCi/g. No additional sampling was required for the east side nor the south side of the Decon Pit. Four (4) locations were selected, one in the center of the decon pit, two locations on the west side of the pit and one on the north side of the decon pit. Samples were also collected near the drain line from the Decon Room, located in the large room to the south of the Decon Room.

The Geoprobe unit was used to collect samples around the decon pit; the majority of the samples were collected at less than three (3) feet beneath the concrete floor. Geoprobe 1 was collected in the same location as ORISE in 1996; the ORISE sample was unsuccessful because of the thickness of the concrete. Five (5) of the locations were sampled in February; one additional location was sampled after a review of the analytical results. Each soil sample represented 12 inches in depth and was collected beneath the surface of the concrete floor. A calibrated, sodium iodide gamma scintillation probe (Ludlum Instruments Model 44-10) was inserted into the opening to provide qualitative radiation measurements in the subsurface soil.

The gamma scintillation detector and the GM detector were used to measure traces of uranium on the interface of the two concrete floor layers. It was observed that the concrete was five (5) inches thick over the decon pit and fourteen (14) inches thick over the rest of the floor in the room

[29] AAA/IEM, *Quality Assurance Program Plan for Characterizing the Former UNC New Haven Facility*, Report No. 2002020/G-1254, January 28, 2003.

[30] UNC Naval Products, *Characterization Plan for Previously Licensed Facility in New Haven, Connecticut*, August 14, 1998.

containing the decon pit. No uranium was detected on the concrete above the USNRC release criteria. Whole body gamma exposure rates were less than five (5) μR/hr above background in the Decon Pit room. A summary of the analytical results is provided in Table 9.1, with measurement results captured in Appendix E.

Concentrations of total uranium were detected in excess of the release criteria on the west perimeter of the excavation, at least three (3) feet below the surface of the concrete. The concentrations of total uranium ranged from 168 pCi/g to 267 pCi/g. One (1) sample was collected to verify the boundary of clean soil on the north end of the decon pit. No radioactivity was detected above the USNRC release criteria on the north side of the pit.

The sample results indicated that additional remediation was required on the west perimeter of the decon pit where the total uranium exceeded the USNRC release criteria. It was estimated that the area containing the residual uranium was approximately a 100 square foot (ft^2) in area and at least three feet deep. The presence of uranium will be verified after the concrete floor is removed and the soil is excavated during remedial activities. Field and laboratory measurements will verify that the uranium in soil satisfies the release criteria approved by the USNRC. As applicable, the criteria provided for areas of less than $100m^2$ will be applied. At no time will the residual concentration of uranium in soil exceed 90 pCi/g above background.

7.2 X-Ray Read Room

The X-Ray Read room was located on the south side of Building 3H. Soil was previously removed from this room during the decommissioning effort in 1976. ORISE collected two (2) samples in this room in 1996 and reported that one sample, Borehole #1 contained total uranium in concentrations ranging from 90 to 723 pCi/g at a depth of 18 inches. This sample was collected in the area where soil had been previously excavated. Borehole #2 was collected on the east side of the room where no uranium was detected above the USNRC release criteria.

Soil samples were collected from locations surrounding the previous excavations and immediately outside of the X-Ray Read room. Thirteen (13) samples were collected and analyzed to verify the boundary of clean soil surrounding the excavation. The previously excavated area extended approximately sixteen (16) feet from the south trench to the interior wall and approximately ten (10) feet into the warehouse area. The excavated area was approximately eight (8) feet in width. Sample locations were selected to surround the excavated area on the north, east and west of the excavated area. Geoprobe 5 was located near the sample collected by ORISE and labeled Borehole #2.

A gamma scintillation detector and the GM detector were used to measure traces of uranium on the interface of the two concrete floor layers. The thickness of the concrete varied from twelve inches to thirty inches thick over the excavated area. No uranium above the USNRC release criteria was detected on the concrete. Ambient gamma exposure rates were less than five (5) μR/hr above background in the X-Ray Read room. A summary of the analytical results is provided in Table 9.2 and Appendix E. The sample locations are highlighted on Figure 10.2 and summarized as follows:

- Southeast Side of Excavation - Total uranium was detected above the USNRC release criteria on the southeast side of the excavation in sample Geoprobe 9-2. The location was approximately eight (8) feet from the edge of the previously excavated area. The concentrations of total uranium ranged from 73 to 131 pCi/g in the top two feet of the soil beneath the concrete. It was noted that a three (3) foot deep void was discovered beneath the concrete floor at the location where sample Geoprobe 9-2 was collected; it was located on the southeast side of the previously excavated area. A sample was collected at approximately twelve (12) feet from the edge of the excavated area (Geoprobe 9-3), where the concentration of uranium was below the USNRC release criteria; the sample contained less than three (3) pCi/g at a depth of one (1) foot.

- East Edge of Excavation - A sample, Geoprobe 14, was collected on the east edge of the excavated area and located near the sample collected by ORISE and labeled Borehole #1. Uranium was detected above the USNRC release criteria at a depth of one (1) foot, the sample was reported to contain 1,770 pCi/g. A second sample was collected in the same location at a depth of four (4) feet where the uranium concentration was determined to be less than 3 pCi/g.

- Eight Feet from East Edge of Excavation - A sample identified as Geoprobe 7 was collected approximately eight (8) feet from the east edge of the excavation where uranium was detected in excess of the USNRC release criteria. The sample was reported to contain 95 pCi/g of total uranium in the top one (1) foot of the soil. A second sample was collected at a depth of two (2) feet where the concentration of uranium was found to be less than 3 pCi/g.

- Twelve Feet from East Edge of Excavation - A sample identified as Geoprobe 13 was collected approximately twelve (12) feet from the edge of the excavation where uranium was reported to be less than 3 pCi/g in the top one (1) foot of soil.

- West Edge of Excavation - Uranium was detected above the USNRC criteria on the west edge of the excavation. The sample, Geoprobe 8-2, was reported to contain 1,855 pCi/g in the top one (1) foot of soil and approximately three (3) feet from the edge of the excavation. A second sample was collected at three (3) feet beneath the surface of the concrete and was reported to contain less than 3 pCi/g of total uranium.

- Six Feet from West Edge of Excavation - A second sample, Geoprobe 8-3, was collected approximately six (6) feet from the edge of the excavation where total uranium was reported to be less than 3 pCi/g in the top one (1) foot of soil.

- North End of Excavation (Outside X-Ray Reading Room) - One sample, Geoprobe 16, was collected on the north end of the excavated area, outside of the X-Ray Read

room. It was located in the center of the excavated area and found to contain 49 pCi/g of total uranium in the top one (1) foot of soil. Soil was collected at eight (8) feet beneath the surface of the concrete and found to contain less than 1 pCi of total uranium.

- Three Feet from North End of Excavation - A second sample, Geoprobe 17, was collected approximately three (3) feet north of the excavated area where no uranium was detected above the USNRC release criteria in the top one (1) foot of soil. The sample was reported to contain 6 pCi/g.

There were several locations around the perimeter of the excavated area in the X-Ray Read Room where the Geoprobe unit could not be used because the cutting tool was rejected. Therefore, soil could not be retrieved and analyzed in these locations. Three (3) locations on the north edge of the excavated area, inside the warehouse were unsuccessful; two (2) locations on the south side of the excavation were unsuccessful. These areas should be investigated during remediation when the concrete and subsurface debris is removed to expose the soil. At that time, it will be possible to confirm that the subsurface soil satisfies the USNRC release criteria.

The sample results suggest that additional remediation is required inside and on the perimeter of the excavated area where the total uranium exceeded the USNRC release criteria. It was estimated that the area containing the uranium was approximately 500 ft^2 and at least three (3) feet deep. The presence of uranium will be verified after the concrete floor is removed and the soil is excavated during remedial activities. Field and laboratory measurements will verify that the uranium in soil satisfies the release criteria approved by the USNRC. As applicable, the criteria provided for areas of less than $100m^2$ will be applied. At no time will the concentration of residual uranium in soil exceed 90 pCi/g above background.

7.3 South Trench

The south trench, located along south end of both buildings, extends throughout the entire facility and continues east of Building 3H outside of the building. The concrete trench extends 820 feet along the length of Building 3H and 6H; the trench is approximately six (6) feet deep along the length of the two buildings.[31] The trench contained utility pipes and conduits that had been abandoned; some of the pipes were insulated with friable asbestos. The pipes and conduits limit access to the walls and floor of the trench. Samples were collected in accessible areas; there appeared to be loose debris on the floor of the trench; in some cases the debris was more than six (6) inches thick. ORISE collected two (2) samples from the trench, a sample from the east end in the Rectifier room in Building 3H and the Chemistry lab on the west end of Building 6H. Both samples contained total uranium in excess of the USNRC criteria. The residue from the trench in the Rectifier room was reported to contain 37 pCi/g of total uranium while the sample from the trench

[31] The South trench is approximately three (3) feet wide.

in the Chemistry lab contained 57 pCi/g. Twelve (12) samples were collected by AAA/IEM along the south trench from available openings in the floor. The results of the analytical data are provided in Table 9.3. Figure 10.3, 10.4 and Appendix E provide the locations of the samples.

Total uranium was detected in ten (10) samples in concentrations above the USNRC release criteria. The concentrations ranged from 41 pCi/g to as high as 1,916 pCi/g of total uranium. The highest concentration, 1,916 pCi/g, was discovered in the X-Ray Read room portion of the trench. One sample, South Trench 11, was collected on the east end of the south trench where the trench leaves the property. The sample was collected outside of Building 3H near the edge of the property boundary. The concentration of total uranium in this sample was found to be approximately 378 pCi/gram.

A sample was collected inside of a shallow trench located in Building 3H in the warehouse north of the rectifier room. Uranium was detected inside of the trench at a concentration of 706 pCi/g.

Further sampling is required in the south trench in order to fully characterize the extent of uranium. The pipes and conduits must be removed along the entire length of the south trench before the characterization can be completed. Friable asbestos must be removed and packaged correctly in order to minimize employee exposures to airborne asbestos fibers. After the trench is made accessible, the debris can be sampled and the debris that contains concentrations of uranium in excess of the release criteria will be removed. The release criteria for uranium on surfaces will be applied to verify that the uranium is removed adequately. Significant cracks in the floor of the trench, if any are observed, should be investigated to determine the potential that uranium may have leaked into the soil, beneath the concrete floor.

7.4 North Trench

The north trench extended along the north edge of Building 6H. It was a utility trench and contained utility pipes similar to those pipes contained in the South Trench. ORISE did not previously collect any samples in this trench. Three (3) samples were collected in the north trench, approximately 100 feet apart. The results of the analytical data are provided in Table 9.4. Figure 10.3, 10.4 and Appendix E provide the locations of the samples.

No concentrations of total uranium exceeded the USNRC release criteria. The highest detectable concentration (total uranium of 22 pCi/gram) was located approximately 100 feet west of the roll-up door in Building 6H. No further work is proposed for the North Trench.

7.5 Sewer System

The sewer system that served the Former UNC Facility was located under Argyle Street, on the south side of the two buildings. ORISE collected two (2) samples from two manholes in Argyle Street where the concentration of total uranium was reported to be 217 pCi/g in Manhole #3 and 3 pCi/g in Manhole #4. It was noted that Manhole #3 was downstream of Manhole #4; the sewer system is connected to the city sewer system via a connection on Shelton Avenue.

Four (4) samples were collected in the sewer system; two under Argyle Street and two under Shelton Avenue. One sample, Sewer-1, was collected in the same manhole that ORISE designated Manhole #3. The second sample was collected downstream at the manhole under the sidewalk on Shelton Avenue. Two (2) samples were collected under Shelton Avenue from manholes that were downstream of Argyle Street. The results of the analytical data are provided in Table 9.5. Figure 10.5 and Appendix E provide the locations of the samples.

The two samples under Argyle Street exceeded the release criteria established by the USNRC. The concentration measured in Sewer-1 was reported to be 1,036 pCi/g of total uranium while the concentration of total uranium in the sample Sewer-2 was reported to be 815 pCi/g. There were loose solids in the Argyle Street sewer, easily removed with a trowel. A sample collected under Shelton Avenue (Sewer-3), was located immediately downstream of the Argyle Street sewer and found to contain 50 pCi/gram of total uranium. It was observed that the surface of the sewer pipe under Shelton Avenue was free of debris; the sample was scraped from the surface of the pipe with considerable effort. Another sample collected under Shelton Avenue (Sewer-4) was located approximately 1,000 feet downstream of the Argyle Street branch and was reported to contain 27 pCi/g of total uranium. This concentration was below the USNRC release criteria.

The data suggested that remediation is required in the sewer under Argyle Street, extending along the sewer pipe to the connection with the pipe under Shelton Avenue. The sewer contained residual uranium that exceeded the USNRC release criteria in the length that ran from Building 6H to the Shelton Avenue connection (i.e., approximately 820 feet). It is also possible that uranium may be present in the soil around the sewer pipe on Argyle Street. This potential should be evaluated during the remediation phase of the project.

7.6 Trash Pile

A trash pile was located outside of Building 3H, east of the decon pit room. It was created after The Former UNC Facility was decommissioned in 1976. The USNRC collected a sample from the edge of the trash pile in 1996 and reported the concentration of U-238 to be 0.3 pCi/gram and U-235 to be 3.31 pCi/gram; the concentration of total U was reported to be 3.6 pCi/gram.[32] The USNRC revised their conclusion in 1997 after the concentration of U-234 was determined; the concentration of total U was reported to be 97.5 pCi/gram.[33] The sampling plan required that the trash pile be sampled and shipped off site so that the surface soil under it could be characterized correctly.

Representative samples were removed from the trash pile and analyzed to verify that the debris was eligible for disposal at a local construction landfill. It was determined that the trash pile contained

[32] U.S. Nuclear Regulatory Commission, *NRC Inspection Report, New Haven, Connecticut*, Inspection No. 070-00371/96-001, July, 26, 1996.

[33] U.S. Nuclear Regulatory Commission, *NRC Inspection Report, New Haven, Connecticut*, Inspection No. 070-00371/97-001, February 12, 1997.

non-friable asbestos and required disposal in compliance with Connecticut state regulations for asbestos waste. No radioactive materials were detected in the debris above background. The trash pile was removed for proper disposal on April 21, 2003.

After the debris was removed, it was discovered that a concrete pad was located under the trash pile. The surface was cored to expose the surface soil beneath the concrete. A summary of the analytical results is provided in Table 9.6. Figure 10.6 and Appendix E provide the locations of the samples.

A grid was established over the concrete pad; the grid was ten (10) meters long on each side. A calibrated, sodium iodide detector was used to scan the surface of the grid and no readings above background were detected. Eight (8) soil samples were collected by coring through the concrete pad. The soil samples were submitted for analysis to verify that no concentrations of total uranium exceeded the USNRC release criteria. The analytical results ranged from less than 1 pCi/g to 14 pCi/g of total uranium in the surface soil. No further remediation is recommended for the area under the trash pile.

7.7 Hazardous Characteristics

Composite samples were created for the three (3) waste streams that were likely to be created during a future decommissioning effort. The waste streams included the soil samples collected by the Geoprobe unit, representing the decon pit and X-ray Read room, the south trench, and the sediment in the sewer. A representative samples was collected from the trash pile and analyzed in a similar manner. The composite samples were analyzed by the following analytical methods, including:

- TCLP Semivolatiles by SW-846 Method 1311/8270C;
- TCLP Volatiles by SW-846 Method 1311/8260B;
- TCLP Metals by SW-846 Method 6010B/7470A (including Copper and Zinc);
- TCLP Pesticides by SW-846 Method 1311/8081A;
- TCLP Herbicides by SW-846 Method 1311/8151A;
- Reactivity;
- pH;
- Paint test; and
- total organics (TOX).

The analytical procedures were defined by the Federal Environmental Protection Agency (USEPA) and described in 40 CFR Part 261.24, Toxicity Characteristic.[34] The toxicity characteristic leaching procedure (TCLP) was used for each of the composite samples to determine whether hazardous characteristics were present in the waste streams. These same procedures and regulatory limits are also required in the Waste Acceptance Criteria (WAC) established by Envirocare.[35] It was anticipated that contaminated soil excavated from the Former UNC Facility will eventually be disposed of at Envirocare, thus compliance with their acceptance criteria must be demonstrated. A summary of the analytical results for this portion of the characterization effort is provided in Table 9.7. Figures 10.1 through 10.6 and Appendix E provide the locations of the samples.

A drum containing an unknown solid was discovered in the trash pile. A sample of its contents was collected and submitted for chemical analysis. The contents of the drum exhibited no hazardous characteristics; the laboratory reported that the white solid appeared to be a surfactant and likely to be similar to soap. The drum was disposed of with the debris in the trash pile.

The composite sample collected from the trash pile was determined to contain non-friable asbestos. Analysis of the debris in the trash pile was completed using polarized light microscopy in accordance with the State of Connecticut Department of Public Health regulations. The debris in the trash pile was disposed in accordance with the State requirements. The presence of asbestos in the waste streams is not specified in the USEPA criteria. The Envirocare WAC does not prohibit the presence of asbestos for disposal but does require compliance with OSHA and USEPA regulations, 29 CFR 1910.1001 and 40 CFR 61.

The composite sample from the south trench contained a concentration of lead that exceeded the concentrations allowed in the USEPA criteria. The composite sample contained 148 milligrams per liter (mg/l) of lead while the limits established by the USEPA is less than 5 mg/l. The same sample contained 94 mg/l of zinc; there are no limits established by the USEPA or the Envirocare WAC for the presence of zinc. The waste streams that are created during decommissioning may require additional analysis and possibly chemical treatment prior to disposal at Envirocare.

The composite sample from the sewer under Argyle Street contained a concentration of lead that exceeded the criteria established by the USEPA. The sample contained 6 mg/l of lead.

Two (2) composite samples were created from the subsurface soil in the X-Ray Read room; one composite sample from the cores collected at location Geoprobe 9-3 and a second sample from Geoprobe 17. Both composite samples were submitted for TCLP analysis. Only the leachable

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[34] U.S. Environmental Protection Agency, *Identification and Listing of Hazardous Waste*, Title 40, Code of Federal Regulations, Part 261.

[35] Envirocare of Utah, Inc., *Waste Acceptance Criteria*, Revision 3, May 16, 2001.

metals were detected in the composite samples. All leachable metals were reported to satisfy the USEPA criteria for TCLP metals.

No hazardous organic compounds were detected above the USEPA criteria in the composite samples for all sample locations. No additional treatment for hazardous organic chemicals is required prior to disposal.

8 SUMMARY AND CONCLUSIONS

1. The release criteria for uranium in soil was established by the USNRC in the 1982 Branch Technical Position Paper; the acceptable concentration of total uranium for the unrestricted release of the Former UNC Facility is less than 30 picocuries per gram above background.

2. There are several areas that exhibited elevated concentrations of uranium, however deeper and adjacent samples generally indicated that the concentrations of uranium were attenuated quickly to below 30 pCi/gram above background.

3. Two (2) samples were collected in the sewer system under Argyle Street. Both samples exceeded 30 pCi/gram of uranium above background. The sewer line extended approximately 820 feet from the east edge of Building 6H to Shelton Avenue. Two (2) samples were collected from the manholes on Shelton Avenue. One (1) of the samples, closest to the Argyle Street connection, exceeded 30 picocuries per gram.

4. Twelve (12) samples were collected in the south trench; ten (10) of the samples exceeded 30 pCi/gram of uranium above background. Remediation is required in the south trench as well as the shallow trench in the warehouse, where the total uranium exceeded 30 pCi/gram above background. The south trench extended approximately 780 feet along the two buildings, 3H and 6H. Remedial work is also required on the east end of the trench outside of Building 3H near the edge of the property.

5. Thirteen (13) samples were collected in and adjacent to the X-Ray Read room around the perimeter of the area that was previously excavated; six (6) of the samples exceeded 30 pCi/gram of uranium above background. The sample results suggested that additional remediation is required on the east, north and west sides of the excavation where the total uranium exceeded the USNRC release criteria. It was estimated that the area containing the uranium is approximately 500 ft^2 surrounding the excavated area and approximately three (3) feet deep.

6. There were five (5) locations around the perimeter of the excavated area in and adjacent to the X-Ray Read Room where the Geoprobe unit could not sample. The cutting tool was rejected and the soil could not be retrieved and analyzed. These areas should be investigated during remediation where the concrete and subsurface debris is removed to expose the soil. At that time, it will be possible to confirm that the subsurface soil satisfies the USNRC release criteria.

7. Six (6) subsurface samples were collected in the Decon Pit room; two (2) of the samples exceeded 30 pCi/gram of uranium above background. The sample results suggested that additional remediation will be required on the west perimeter of the decon pit where the total uranium exceeded the USNRC release criteria. It was estimated that the area containing the uranium is approximately a 100 square foot (ft^2) area and at least three (3) feet deep.

8. Core samples were collected from the concrete floor near the decon pit and in the X-Ray Read room where two layers of concrete were detected. Radiation measurements were made at the interface of the two layers using both a gamma scintillation detector and a geiger mueller beta detector. No elevated radioactivity was detected.

9. Whole body gamma exposure rates were measured in the Decon Pit room, the X-Ray Read room and the rooms where the south trench was located. No gamma radiation levels exceeded 5 μR/hr above background for whole body exposures.

10. Three (3) samples were collected in the North trench. No areas in the North trench contained radionuclides in excess of the established release criteria. No concentrations of total uranium exceeded the USNRC release criteria. No further work is proposed for the North Trench.

11. Six (6) samples were collected and analyzed for the presence of hazardous chemicals. Hazardous organic constituents were not detected in the composite samples; some metals, specifically lead, copper and zinc were detected in five (5) of the samples. Two (2) of the samples, the South Trench and the sewer under Argyle street exceeded the concentration specified for TCLP lead by the USEPA criteria. The composite sample from the South trench was reported to contain 148 mg/l of lead; the sewer sample under Argyle Street was reported to contain 6 mg/l.

12. The waste streams that will be created during decommissioning may require additional chemical analysis to confirm the actual concentration of TCLP lead. The waste streams may require chemical treatment prior to disposal at Envirocare.

13. The trash pile was characterized and no radioactive materials were detected in the debris. The trash pile was shipped offsite for proper disposal. A walkover gamma survey was conducted on the concrete pad and eight (8) samples were collected underneath the pile. None of the samples contained total uranium in excess of the USNRC release criteria. No further work is recommended for the area under the trash pile.

14. The decommissioning plan for the Former UNC Facility will be revised to address the areas where total uranium was detected in concentrations in excess of the USNRC release criteria.

9 TABLES

Table 9.1 - Radionuclide Concentrations near the Decon Pit

Sample Number	Sample Date	Collection Location	Depth (feet)	Radionuclide Concentration (pCi/g)				Total Uranium Exceeds 30 pCi/g
				U-235	U-234	U-238	Total U	
Geoprobe-1	2/11/03	Adjacent to removed line Adjacent to ORISE sample location	0-1	0.3	8.1	ND	8.4	
Geoprobe-2	2/11/03	Adjacent to removed line	0-1	ND	ND	1.3	<3	
Geoprobe-3	2/11/03	Center of the Decon pit	13-14	ND	ND	ND	<3	
Geoprobe-4	2/11/03	West side, Adjacent to decon pit	0-1	6.0	162.0	ND	168.0	Yes
Geoprobe-4	2/11/03	West side, Adjacent to decon pit	2-3	9.5	256.5	1.2	267.2	Yes
Geoprobe-15	2/14/03	Adjacent to decon pit	0-1	0.1	2.7	1.4	4.2	
Geoprobe-15	2/14/03	Adjacent to decon pit	1-2	ND	ND	1.8	<3	
Geoprobe-18	10/13/03	Three feet north of decon pit	0-1	ND	ND	1.5	<3	

Note: Concentration of Uranium 234 assumed to be 27x the concentration of Uranium 235.

Table 9.2 - Radionuclide Concentrations near the X-ray Read Room

Sample Number	Sample Date	Collection Location	Depth (feet)	Radionuclide Concentration (pCi/g)				Total Uranium Exceeds 30 pCi/g
				U-235	U-234	U-238	Total U	
Geoprobe-5	2/12/03	Southeast corner of X-ray Read Room ORISE Spl Borehole #2	0-1	ND	ND	ND	<3	
Geoprobe-6	2/11/03	X-ray Read Room	13-14	ND	ND	ND	<3	
Geoprobe 7	2/12/03	X-ray Read Room	0-1	3.3	89.1	2.3	94.7	Yes
Geoprobe 7	2/12/03	X-ray Read Room	1-2	ND	ND	1.7	<3	
Geoprobe8-2	2/13/03	X-ray Read Room	0-1	66.1	1784.7	3.9	1854.7	Yes
Geoprobe8-2	2/13/03	X-ray Read Room	2-3	ND	ND	ND	<3	
Geoprobe8-3	2/14/03	X-ray Read Room	0-1	ND	ND	0.9	<3	
Geoprobe9-2	2/12/03	X-ray Read Room	0-1 A void (3 feet thick) was discovered under the concrete	2.6	70.2	ND	72.8	Yes
Geoprobe9-2	2/12/03	X-ray Read Room	1-2	4.6	124.2	1.8	130.6	Yes
Geoprobe 9-3	10/13/03	X-ray Read Room	0-1	ND	ND	1.4	<3	
Geoprobe 9-3	10/13/03	X-ray Read Room	3-4	ND	ND	ND	<3	
Geoprobe-10	2/12/03	X-ray Read Room	0-1	0.3	8.1	1.0	9.4	
Geoprobe1 2-2	2/14/03	Adjacent to X-ray Read Room	0-1	0.1	2.7	0.6	3.4	
Geoprobe-13	2/13/03	X-ray Read Room	0-1	ND	ND	1.4	<3	
Geoprobe-14	2/13/03	X-ray Read Room ORISE Spl Borehole #1	0-1	63.2	1,706.4	ND	1,769.6	Yes
Geoprobe-14	2/13/03	X-ray Read Room	3-4	ND	ND	0.9	<3	
Geoprobe-16	10/13/03	Center of Excavated Area	0-1	1.7	45.9	1.3	48.9	Yes
Geoprobe-16	10/13/03	Center of Excavated Area	7-8	ND	ND	1.0	<3.0	
Geoprobe-17	10/13/03	Three feet north of excavated area	0-1	0.2	5.4	ND	5.6	

Note: Concentration of Uranium 234 assumed to be 27x the concentration of Uranium 235.

Table 9.3 - Radionuclide Concentrations in the South Trench

Sample Number	Sample Date	Collection Location	Depth (feet)	Radionuclide Concentration (pCi/g)				Total Uranium Exceeds 30 pCi/g
				U-235	U-234	U-238	Total U	
South Trench 1	2/05/03	Furthest west trench access	Surface	1.4	37.8	1.4	40.6	Yes
South Trench 2	2/05/03	X-ray Read Room	Surface	0.3	8.1	ND	8.4	
South Trench 3	2/06/03	X-ray Read Room	Surface	10.4	280.8	1.0	292.2	Yes
South Trench 4	2/06/03	Rectifier room, east trench access	Surface	1.5	40.5	ND	42.0	Yes
South Trench 5	10/14/03	West of Chem Lab	Surface	2.5	67.5	1.6	71.6	Yes
South Trench 6	10/14/03	West of X-ray Read room	Surface	68.4	1,846.8	1.1	1,916.3	Yes
South Trench 7	10/14/03	Under plastic tanks, X-ray Read room	Surface	0.8	21.6	0.8	23.2	
South Trench 8	10/14/03	West of X-ray Read Room, Column 26	Surface	1.4	37.8	0.8	40.0	Yes
South Trench 9	10/14/03	West end of X-ray Read Room	Surface	3.8	102.6	ND	106.4	Yes
South Trench 10	10/14/03	East end of X-ray Read Room	Surface	62.3	1,682.1	ND	1,744.4	Yes
South Trench 11	10/14/03	East end of Bldg 3H Outdoors	Surface	13.5	364.5	ND	378.0	Yes
Small Trench	10/15/03	Large room north of Rectifier room	Surface	25.2	680.4	ND	705.6	Yes

Note: The sample collected at South Trench 11 was collected on the east side of Building 3H, outside of the building.

Note: Concentration of Uranium 234 assumed to be 27x the concentration of Uranium 235.

Table 9.4 - Radionuclide Concentrations in the North Trench

Sample Number	Sample Date	Collection Location	Depth (feet)	Radionuclide Concentration (pCi/g)				Total Uranium Exceeds 30 pCi/g
				U-235	U-234	U-238	Total U	
North Trench 1	10/14/03	50 feet west from rollup door	Surface	0.2	5.4	ND	5.6	
North Trench 2	10/14/03	86 feet west from rollup door	Surface	0.8	21.6	ND	22.4	
North Trench 3	10/14/03	Building 6H, Column 16	Surface	ND	ND	ND	<3	

Note: Concentration of Uranium 234 assumed to be 27x the concentration of Uranium 235.

Table 9.5 - Radionuclide Concentrations in the Sewer System

Sample Number	Sample Date	Collection Location	Depth (feet)	Radionuclide Concentration (pCi/g)				Total Uranium Exceeds 30 pCi/g
				U-235	U-234	U-238	Total U	
Sewer-1[NOTE]	2/10/03	Property manhole	Surface	36.9	996.3	3.2	1,036.4	Yes
Sewer-2	2/10/03	Street manhole	Surface	29.0	783.0	2.9	814.9	Yes
Sewer-3	10/13/03	SW of Argyle Street	Surface	1.7	45.9	2.8	50.4	Yes
Sewer-4	10/13/03	Next manhole downstream of Sewer-3	Surface	0.8	21.6	4.8	27.2	

NOTE: Samples Sewer-1 was designated as the #3 Manhole during the survey performed by the USNRC/ORISE in 1996.

Note: Concentration of Uranium 234 assumed to be 27x the concentration of Uranium 235.

Table 9.6 - Radionuclide Concentrations in the Trash Pile

Sample Number	Sample Date	Collection Location	Collection Depth (feet)	Radionuclide Concentration (pCi/g)				Total Uranium Exceeds 30 pCi/g
				U-235	U-234	U-238	Total U	
Trash Pile	2/3/03	Trash Pile	Surface Debris	<0.2	<0.2	<1.3	<1	
WP-Soil-1	4/22/03	Trash Pile	0-1	0.2	5.4	<1.4	5.6	
WP-Soil-2	4/22/03	Trash Pile	0-1	<0.1	<0.1	<0.9	<1.0	
WP-Soil-3	4/22/03	Trash Pile	0-1	<0.1	<0.1	1.4	1.4	
WP-Soil-4	4/22/03	Trash Pile	0-1	0.3	8.1	<1.0	8.4	
WP-Soil-5	4/22/03	Trash Pile	0-1	<0.2	<0.2	3.2	3.2	
WP-Soil-6	4/22/03	Trash Pile	0-1	0.5	13.5	<1.2	14.0	
WP-Soil-7	4/22/03	Trash Pile	0-1	0.2	5.4	1.2	6.6	
WP-Soil-8	4/22/03	Trash Pile	0-1	<0.2	<0.2	1.1	1.1	

Note: Concentration of Uranium 234 assumed to be 27x the concentration of Uranium 235.

Table 9.7 - Hazardous Characteristics in Waste Streams

Sample Number	Sample Date	Collection Location	Volatile Organics (mg/l)	Semi Volatile Organics (mg/l)	TCLP Metals					
					Ba (mg/l)	Cd (mg/l)	Cu (mg/l)	Pb (mg/l)	Hg (mg/l)	Zn (mg/l)
Trash Pile Drum	2/6/03	Trash Pile	<0.01	<0.001	0.2	<0.01	0.1	<0.03	<0.01	0.3
Trash Pile Debris	2/3/03	Composite of grab samples	<0.01	<0.001	0.5	0.02	0.4	0.1	<0.01	4.5
South Trench	2/5/03	Composite of grab samples	<0.01	<0.001	2.3	0.1	1.0	**148**	<0.01	94.1
Sewer	2/10/03	Composite of grab samples	<0.01	<0.001	2.5	0.01	23.5	**6.0**	<0.01	6.5
Soil	2/14/03	Composite of Geoprobe samples	<0.01	<0.001	0.3	0.01	5.5	0.2	<0.01	12.0
WP Soil Haz	4/22/03	Composite of soil under trash pile	<0.01	<0.001	0.3	<0.01	1.9	2.3	<0.01	1.3
9-3 Metals	10/13/03	Composite of Geoprobe 9-3	Not analyzed	Not analyzed	0.5	0.2	137	0.3	<0.01	273
17 Metals	10/13/03	Composite of Geoprobe 17	Not analyzed	Not analyzed	0.7	<0.01	0.2	<0.03	<0.01	7.6
Maximum Concentration of Contaminants for the Toxicity Characteristic 40CFR 261.24 Table 1			0.5	0.5	100	1	Not listed	5	0.2	Not listed

10 FIGURES

10.1 Sample Locations for the Decon Pit

IEM
Integrated Environmental Management, Inc.

Project No: 2002070		Page 1 of 1	
Subject: Location of Decon Room Geoprobe Samples			
Performed by: R.A. Duff		Date: 2/9/04	
Checked by: N/A		Date: N/A	

UNITED NUCLEAR CORPORATION
FUELS DIVISION

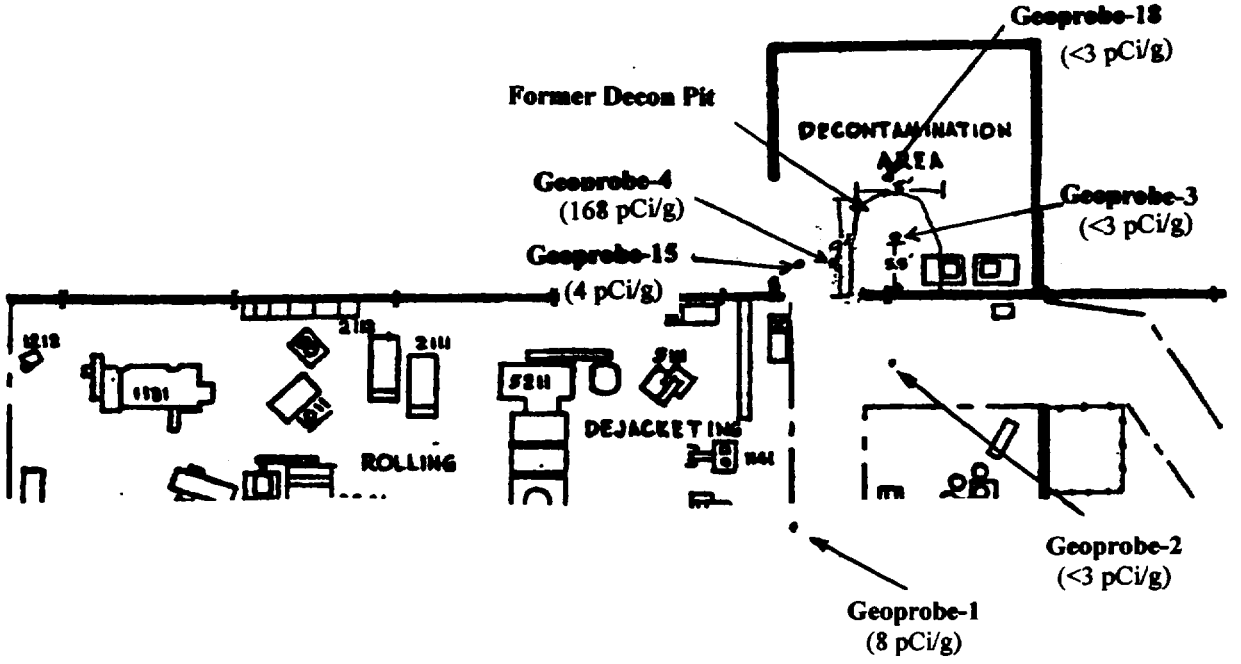
NEW HAVEN FACILITY 3H.

SCALE 1" = 20'

0 10 20 30 40 50 60 70 FEET

N

TOTAL AREA 17,600 SQ. FT.

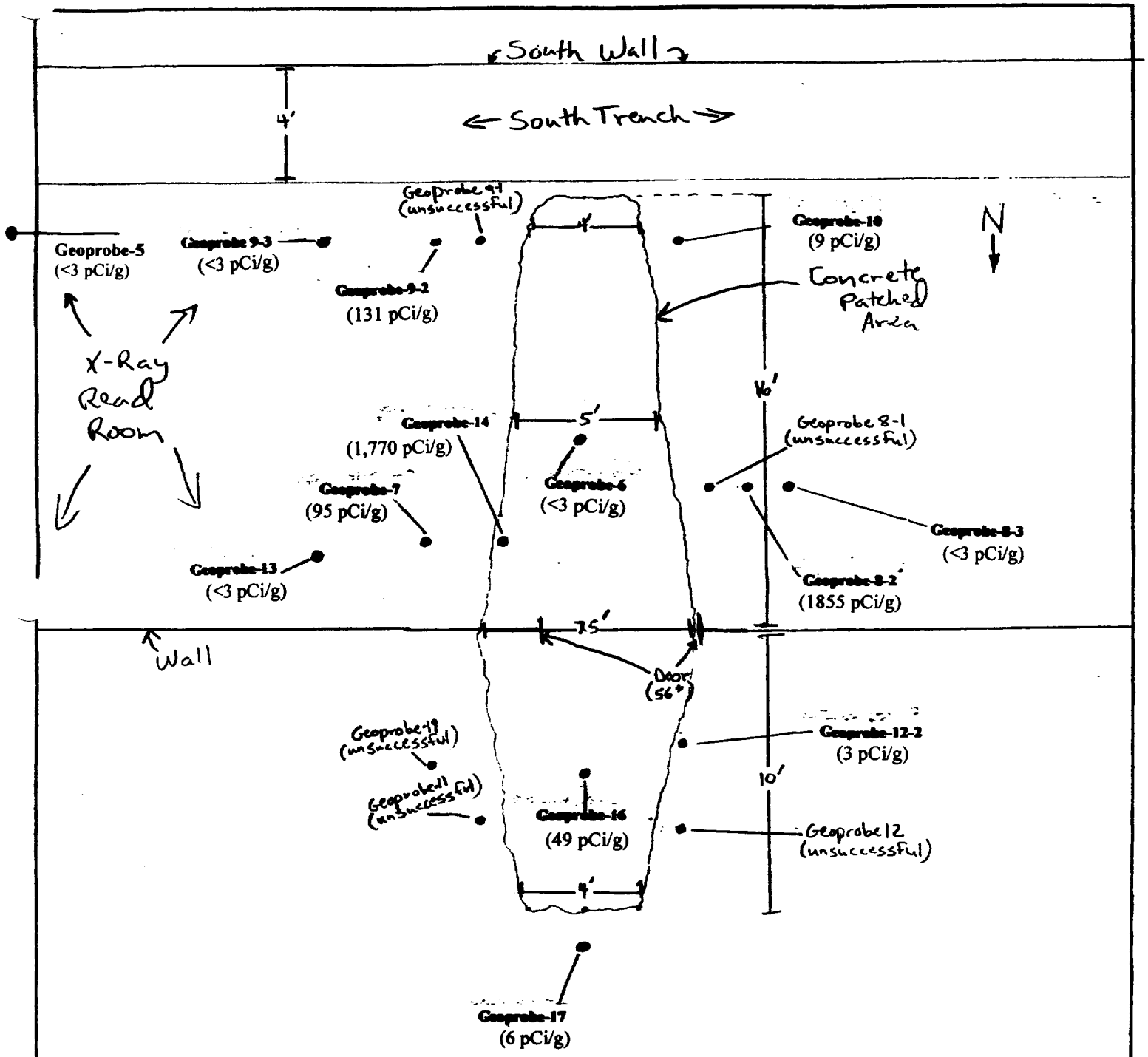


Note: The concentration of total Uranium is provided in ( ) for the sample location.

10.2 Sample Locations for the Xray Read Room

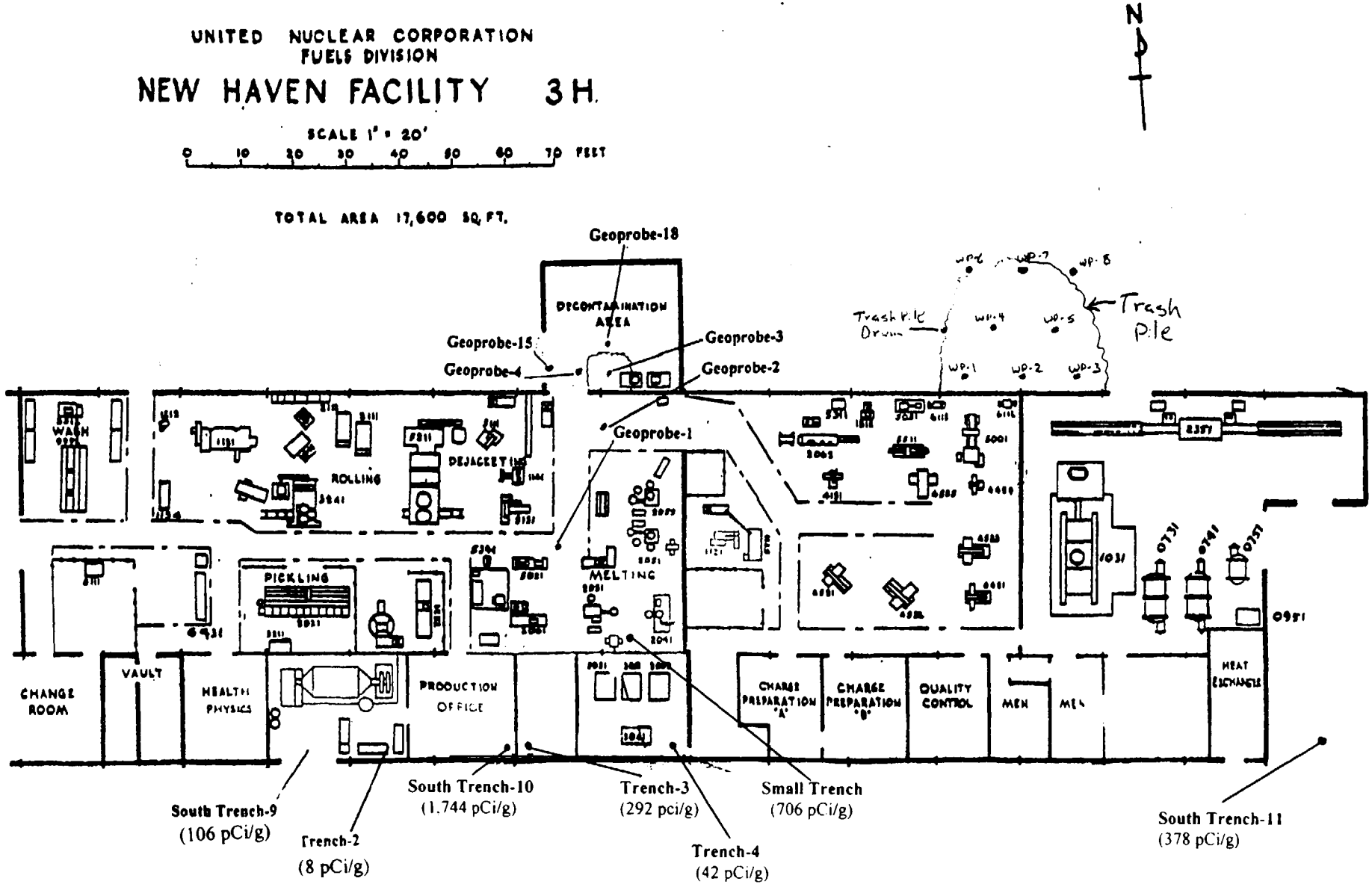
IEM
Integrated Environmental Management, Inc.

Project No:	2002020	Page	1 of 1
Subject:	Location of X-Ray Read Room Geoprobe Samples		
Performed by:	R.A. Duff	Date:	12/30/03
Checked by:	N/A	Date:	N/A



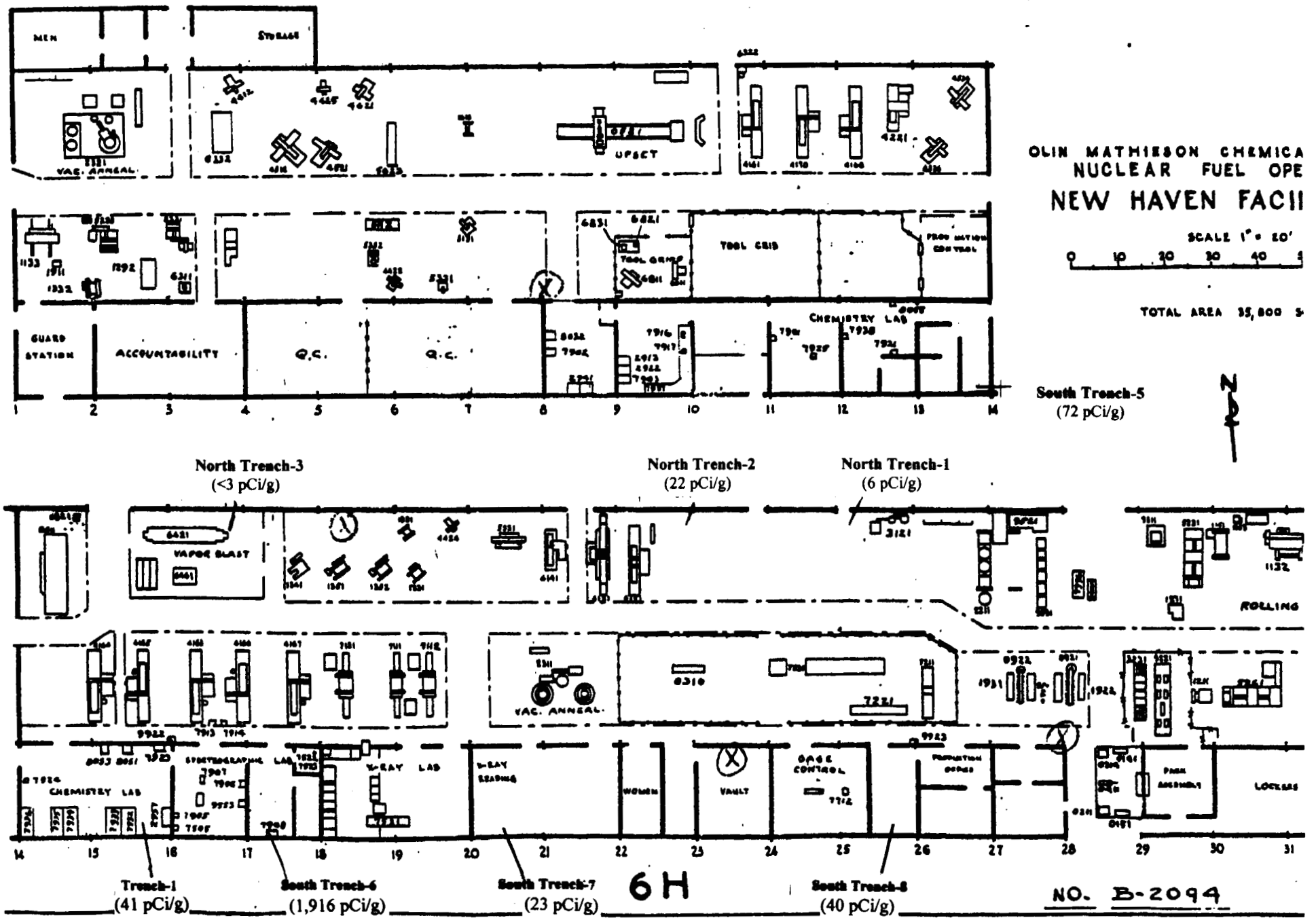
Note: The concentration of total Uranium is provided in ( ) for the sample location.

10.3 Sample Locations for Building 3H Trenches



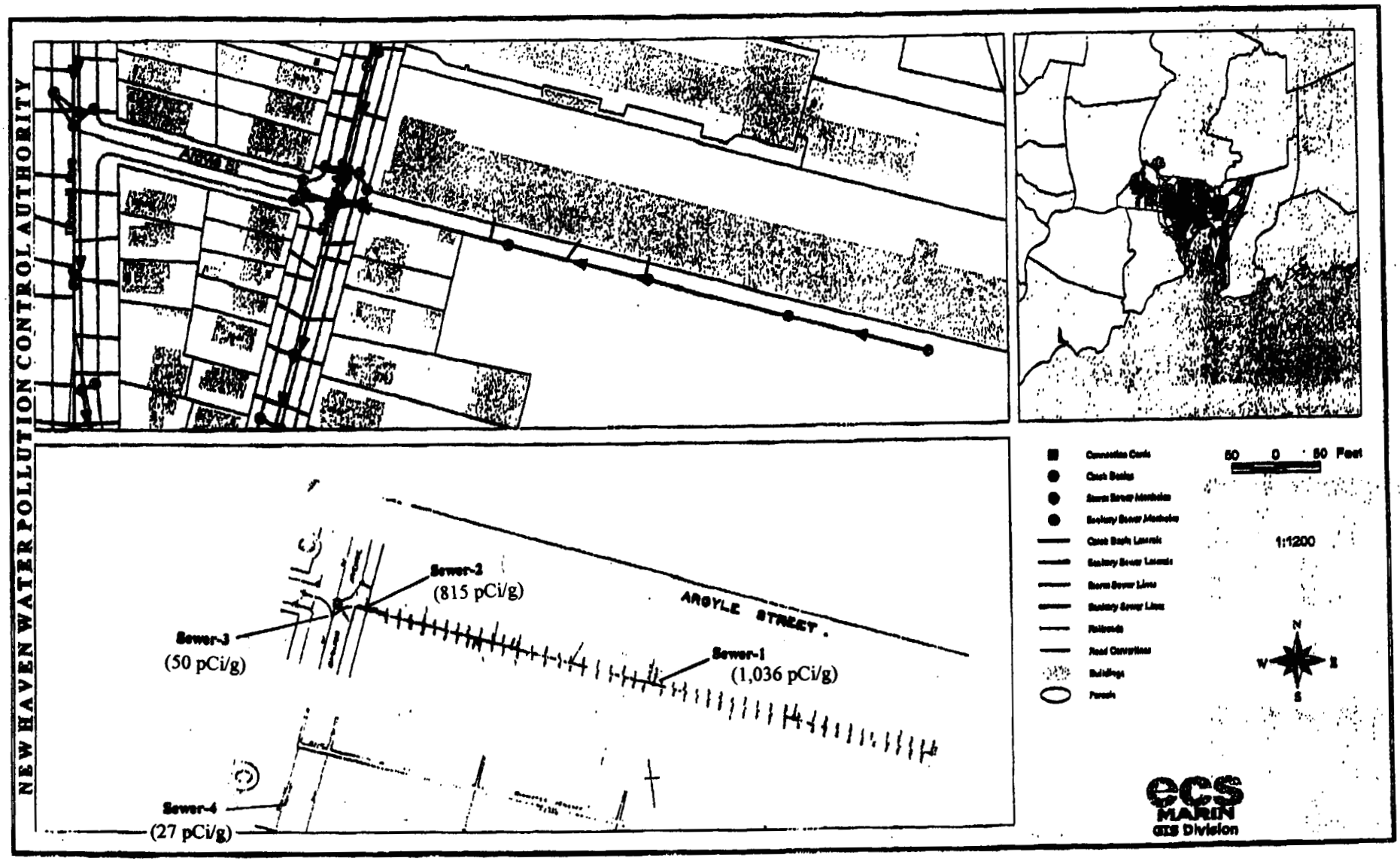
Note: The concentration of total Uranium is provided in ( ) for the sample location.

10.4 Sample Locations for Building 6H Trenches



Note: The concentration of total Uranium is provided in ( ) for the sample location.

10.5 Sample Locations for the Sewer

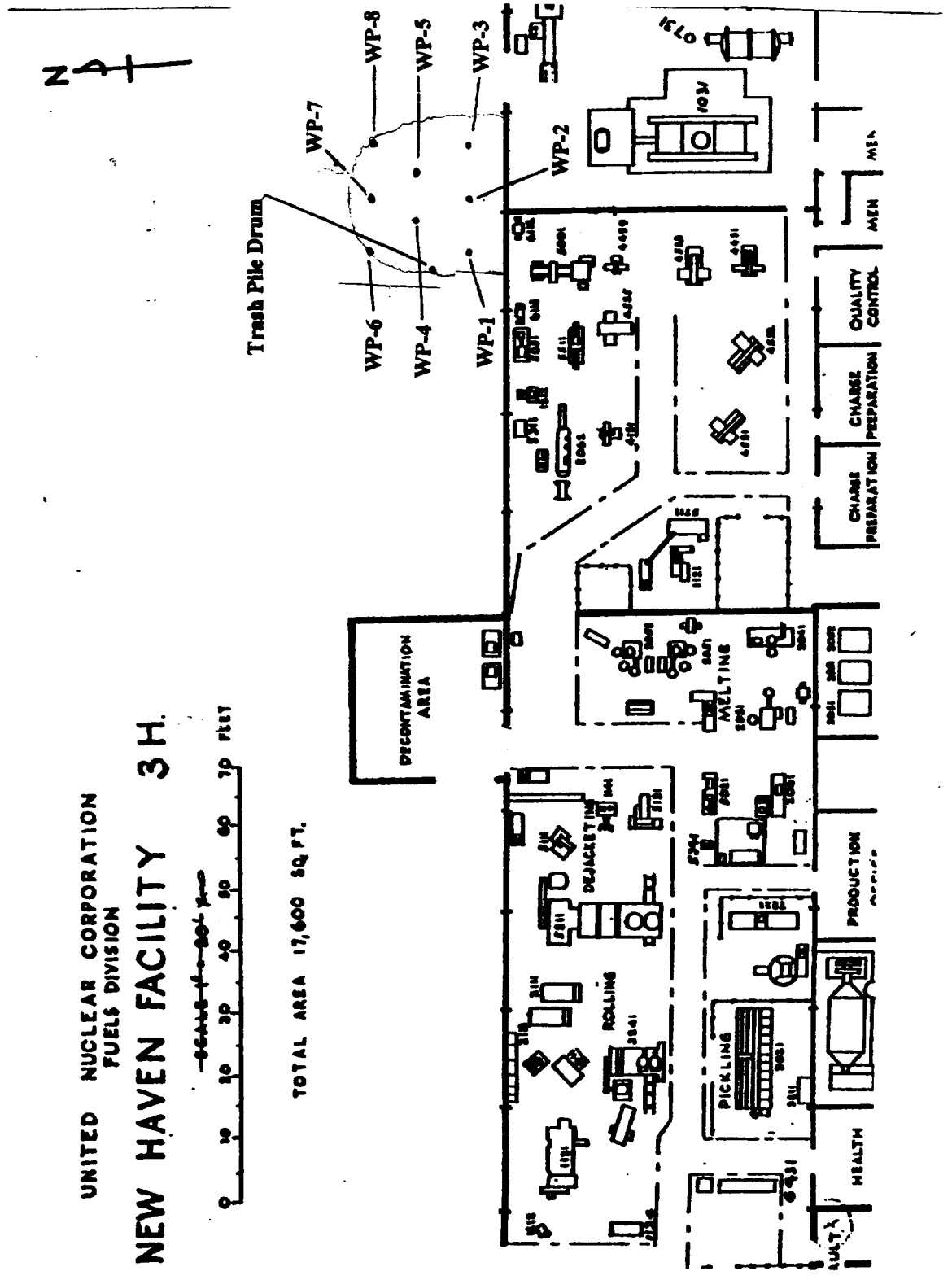


Note: The concentration of total Uranium is provided in ( ) for the sample location.

10.6 Sample Locations for the Trash Pile

IEM
Integrated Environmental Management, Inc.

Project No: 2002020		Page 1 of 1
Subject: Location of Waste Pile Samples		
Performed by: R.A. Duff / BMW	Date: 2/9/04	
Checked by: N/A	Date: N/A	



This report was prepared under the direction of
UNC Naval Products

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