DOE/OR/01-2203/R1
DRAFT FOR PUBLIC REVIEW

ATTACHMENT A

Environmental Baseline Survey Report for the Title Transfer of the K-1400 Building at the East Tennessee Technology Park, Oak Ridge, Tennessee

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Environmental Baseline Survey Report for the Title Transfer of the K-1400 Building at the East Tennessee Technology Park, Oak Ridge, Tennessee

Date Issued—February 2005

Prepared by
Science Applications International Corporation
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BECHTEL JACOBS COMPANY LLC
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East Tennessee Technology Park
Y-12 National Security Complex Oak Ridge National Laboratory
Paducah Gaseous Diffusion Plant Portsmouth Gaseous Diffusion Plant
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The results of this report are based on record reviews, site reconnaissance, interviews, and the radiological report reviewed and approved by BJC. SAIC has not made, nor has it been asked to make, any independent investigation concerning the accuracy, reliability, or completeness of such information.

All sources of information on which SAIC has relied in making its conclusions are identified in Chap. 7 of this report. Any information, regardless of its source, not listed in Chap. 7 has not been evaluated or relied upon by SAIC in the context of this report.

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ACRONYMS

BEAR	Baseline Environmental Analysis Report
bgs	below ground surface
BJC	Bechtel Jacobs Company LLC
C&CCC	Carbide and Carbon Chemicals Corporation
CDR	Covenant Deferral Request
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
COE	U. S. Army Corps of Engineers
COPC	chemical of potential concern
CROET	Community Reuse Organization of East Tennessee
DCGL	derived concentration guideline level
$DCGL_{EMC}$	derived concentration guideline level $_{\text{elevated measurement comparison}}$
1,2-DCE	1,2-dichloroethene
DOE	U. S. Department of Energy
dpm	disintegrations per minute
EBS	Environmental Baseline Survey
ED	exposure duration
EPA	U. S. Environmental Protection Agency
ESU	exterior survey unit
ETTP	East Tennessee Technology Park
FFA	Federal Facility Agreement
FSU	furnishings survey unit
H_a	alternative hypothesis
H_o	null hypothesis
HI	hazard index
HQ	hazard quotient
ISU	interior survey unit
kg	kilogram
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual*
MCL	maximum contaminant level
NaI	sodium iodide
NORM	naturally occurring radioactive material
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCB	polychlorinated biphenyl
PHS	Preliminary Hazard Screening
PRG	preliminary remediation goal
QA/QC	quality assurance/quality control
RADCON	Radiological Control Organization
RCRA	Resource Conservation and Recovery Act of 1976
RCW	Recirculating Cooling Water
ROD	Record of Decision
RQ	reportable quantity
SHHRA	screening-level human health risk assessment
SWMU	solid waste management unit
TCE	trichloroethene
TRU	transuranic

TVA	Tennessee Valley Authority
^{99}Tc	technetium-99
UF_6	uranium hexafluoride

EXECUTIVE SUMMARY

This Environmental Baseline Survey (EBS) documents the baseline environmental conditions of the U. S. Department of Energy's (DOE's) K-1400 building at the East Tennessee Technology Park (ETTP). DOE is proposing to transfer the title of this building to the Community Reuse Organization of East Tennessee or one of its subsidiaries. This report provides supporting information for the transfer of this government-owned facility at ETTP for reuse and redevelopment by a private company. This EBS is based upon the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

The K-1400 building is a 13,000-ft^2, "L"-shaped, two-story masonry structure that was built in 1953 as an office building and continues in that use. A metal-sided shed located on the north wall of the building that houses the building's fire alarms and firewater header system is included. There is an asphalt parking area on the west side of the building and a grassy area that extends around the north, west, and south sides of the building. The grassy area on the west side is steep and drops down to Avenue "D" and a parking area adjacent to Avenue "D." (This parking area is not a part of the study area.) Concrete steps provide access from the K-1400 building to Avenue "D."

The area proposed for title transfer includes the K-1400 building, the metal shed on the north wall, and the underlying property, also known as the underlying fee.

Preparation of this report included the review of government records, title documents, aerial photos, visual inspections of the property and adjacent properties, and interviews with current and former employees[1] to identify any areas on the property where hazardous substances and petroleum products were stored for one year or more, known to have been released, or disposed. Radiological surveys were conducted to assess the building's radiological condition. Following is a summary of the findings of the evaluation that was performed:

- No evidence was found that any hazardous substances were stored in Bldg. K-1400 for one year or more in quantities equal to or greater than 1000 kilograms (kg) or their respective CERCLA reportable quantities (RQs).

- No evidence was found that acutely hazardous wastes were stored in Bldg. K-1400 for one year or more in quantities greater than or equal to 1.0 kg.

- There was no evidence found of a release or disposal of hazardous substances or petroleum products in excess of the substance's RQ occurring in Bldg. K-1400. However, the contaminated groundwater plume that extends underneath the building is considered a release.

- There is no asbestos present in the building. All insulation and ceiling tiles are of non-asbestos, man-made mineral fibers. Based on the age of the building, the presence of lead-based paint is considered possible. The fluorescent light fixtures have the potential of containing low concentrations of polychlorinated biphenyl ballasts, and auxiliary fire alarm boxes in the buildings may contain 2- to 10-mL ampules of mercury.

- All observed floor drains were plugged in the early 1990s.

[1]Personal communications with L. W. Perkins and E. Williams (either previously or currently employed at East Tennessee Technology Park) on January 14, 2003.

- The building interior, exterior, and furnishings were surveyed in accordance with the survey plan (Appendix D). The data were analyzed to determine if any residual contamination was present and if the contamination might exceed the derived concentration guideline level (DCGL) established for each of the survey units. Survey results showed that the K-1400 study area had no areas of residual radioactivity present above DOE contamination limits or the DCGL and, therefore, can be released without radiological restrictions. The radiological survey results are discussed in Sect. 6.3 of this report.

- No soil sampling was conducted to support title transfer of the building and its underlying fee. Historical sampling in the area of K-1400 is reported in Sect. 6.2. There have been no chemical sampling events in the interior of the building.

- Based on a winter (2004) sampling event and a confirmatory sampling event conducted in the summer of 2004, sub-slab soil vapor sampling results show that the vapor intrusion pathway is not complete beneath K-1400, and, thus, there is no adverse impact to human health.

- Due to changes in soil-vapor concentrations resulting from migration of groundwater contaminants, maximum concentrations in soil vapor could increase above those currently present. Therefore, in addition to an evaluation of currently measured soil-vapor concentrations, the approach for evaluating soil vapor at ETTP includes an analysis of the sampling frequency required at a building to prevent unacceptable exposures in the future. For Bldg. K-1400, the re-sampling frequency was determined to be 15 years.

CONCLUSIONS

Based on the U. S. Department of Energy's (DOE's) review of the existing information, including discussions and interviews referenced herein, and evaluation of the data gathered in preparation of the environmental baseline survey (EBS) for Bldg. K-1400, DOE recommends the following:

1. Due to the uncertainty associated with the nature of the on-site groundwater and the need to evaluate and possibly address groundwater in the future, DOE recommends that the transfer of Bldg. K-1400 be achieved by a covenant deferral per the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Sect. 120(h)(3)(c), et seq.

2. Due to its age, Bldg. K-1400 may contain lead-based paint, and low concentrations of polychlorinated biphenyls (PCBs) may potentially be present in the fluorescent light fixtures. Paint chips and PCBs should be managed pursuant to applicable regulations. Mercury ampules potentially present in ancillary fire alarm boxes must also be managed pursuant to applicable regulations.

In addition, no evidence was found that any hazardous substances were stored in K-1400 for one year or more in quantities greater than or equal to 1000 kilograms (kg) or their respective CERCLA reportable quantities (RQs). No evidence was found that acutely hazardous wastes were stored in K-1400 for one year or more in quantities greater than or equal to 1.0 kg. No evidence was found that any hazardous substances were released or disposed of at K-1400 in quantities exceeding their respective RQs. However, the contaminated groundwater plume that extends underneath the building is considered to be a release.

LAND USE RESTRICTIONS

Land use restrictions are an important component of a CERCLA covenant deferral; they help to ensure that transfer of the property is protective for the intended use. The restrictions that will apply are summarized below. Full details are found in the Covenant Deferral Request (CDR) package.

1. Property uses shall be consistent with requirements contained in the deed.

2. Extraction, consumption, exposure, or use, in any way, of the groundwater underlying the property, or water from any streams or ponds located on the property, is prohibited without the prior approval of DOE, the U. S. Environmental Protection Agency (EPA) Region 4, and the Tennessee Department of Environment and Conservation (TDEC).

3. Development of the property must comply with all applicable federal, state, and local laws and regulations with respect to any present or future development of the property, including but not limited to, those laws and regulations that govern sewage disposal, facility water supply, and any other public health requirements. All structures, facilities, and improvements requiring a water supply shall be required to be connected to an appropriate regulatory-approved water system for any and all usage.

4. Disturbance of soils on the transferred property in areas 10 ft or less below the ground surface is prohibited unless the transferee complies with the site excavation and penetration permit program. The excavation and penetration permit program will be retained until it has been determined that all necessary soil remedial action on the property has been taken.

5. The property shall not be used or developed in a manner that is inconsistent with the land use assumptions of "unrestricted industrial use." Accordingly, use of the area of the property below 10 ft is prohibited without prior written approval of DOE, EPA Region 4, and TDEC.

6. DOE reserves the right of access to all portions of the property for environmental investigation, remediation, or other corrective action.

7. In order to ensure that the vapor intrusion pathway (i.e., the migration of volatile organic compounds in the contaminated groundwater and/or soil to indoor air) does not contribute to an unacceptable risk to human health, DOE will address the potential for vapor intrusion in the ETTP Sitewide Record of Decision (ROD), currently scheduled to be signed by 2006, and will take interim measures to ensure protectiveness until the ROD is signed.

   The interim measures include: (a) collecting samples inside the building during the summer of 2004; and (b) if needed, based on the summer results, making modifications to the building, as necessary, to ensure protectiveness. In addition, until the ROD is implemented, comprehensive changes to the building (e.g., installation of a new heating, ventilating, and air-conditioning system) may require a re-evaluation to ensure protectiveness (see Sect. 4.4 for more details).

RESPONSE TO REGULATOR COMMENTS

In May 2003, DOE received a number of comments from Region 4 of the U. S. Environmental Protection Agency (EPA) on document content and level of detail. Changes in response to those comments have been incorporated throughout this report. Responses to additional general comments from EPA, received in January 2004, are included in this final version of the report. Comments specific to the K-1400 EBS report are available in Attachment 1 of this report, and changes have been made to text in Sect. 4.3 and to Fig. 4.1 and Table 4.2 to reflect the comments.

In addition, the Site Specific Advisory Board (SSAB) and Oak Ridge Reservation Local Oversight Committee (LOC) submitted comments in March 2004 on the soil vapor results for winter sampling. Text changes and clarifications, where warranted, have been made in the respective EBS reports for these buildings. None were needed in the K-1400 EBS or Risk Screen reports. The full set of SSAB and LOC comments and the individual responses can be found in Sect. 7 of the CDR package.

Verbal comments were received from EPA Region 4 in November 2004 at a meeting held to discuss upcoming property transfers at ETTP. Responses to the comments that apply to K-1400 have been incorporated into this document. Additional information on comments received at the November meeting that apply to K-1400 is available in Attachment 1 of this document.

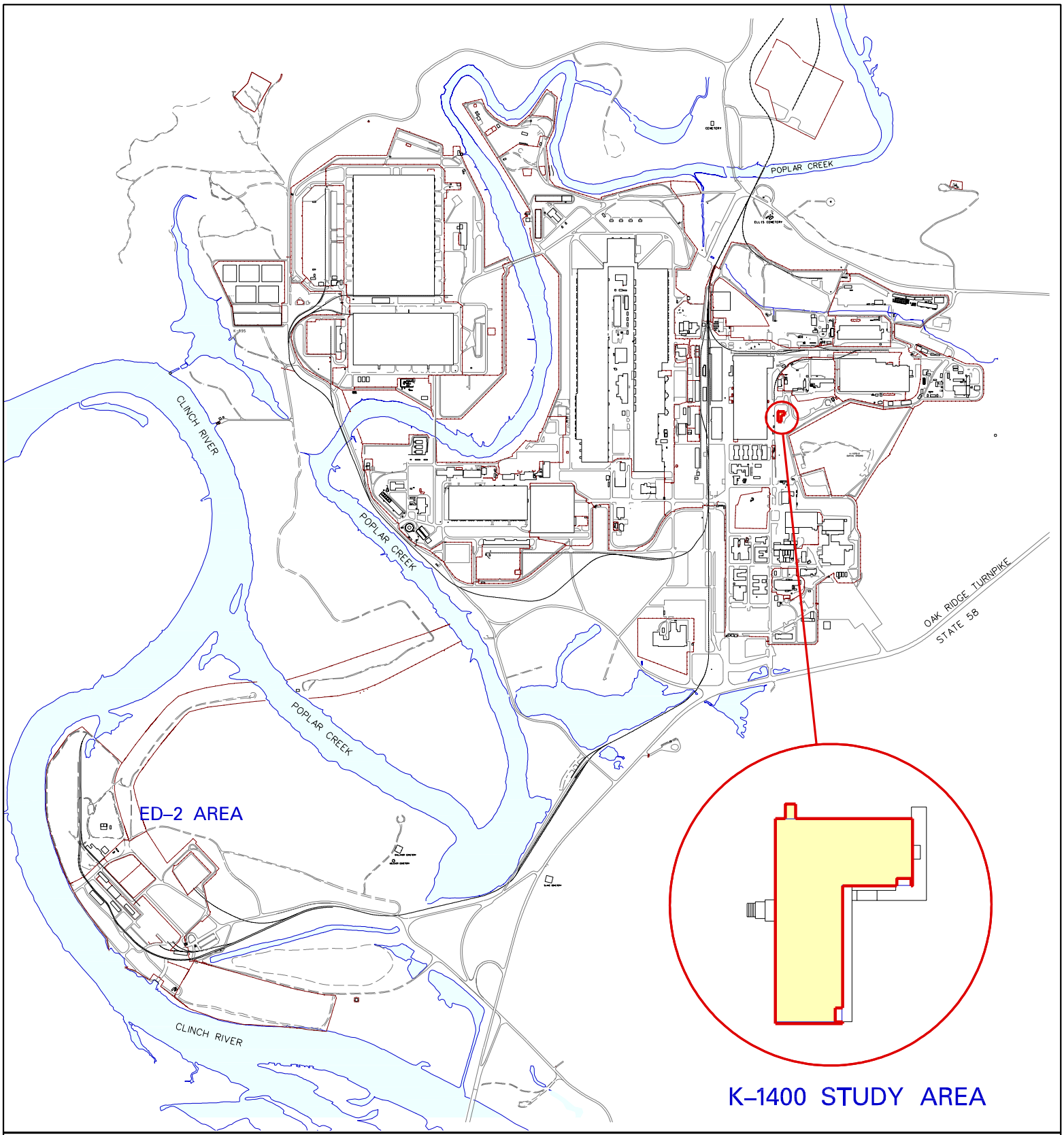
Additional comments were received from Region 4 of EPA in January 2005. For K-1400, a comment requested that instead of stating that the groundwater plume under K-1400 is considered a release, it should be stated that it is an ongoing possible source for contamination by vapor intrusion. This change has not been made because that language was inserted in response to comments from EPA Counsel. See Attachment 1 of this document for further information.

1. PROPERTY IDENTIFICATION

The K-1400 Building discussed in this Environmental Baseline Survey is located in the eastern portion of the East Tennessee Technology Park (ETTP) [formerly the K-25 Site] on the Oak Ridge Reservation (ORR) in Roane County, Tennessee. Building K-1400 is within the ETTP perimeter fence. Figure 1.1 is a map showing the relationship of Bldg. K-1400 to ETTP, and Fig. 1.2 is an ortho image showing the footprint of the K-1400 study area (the area proposed for title transfer). Figure 1.3 is an aerial photograph showing the location of K-1400 in relation to ETTP.

Preparation of this report included the review of government records, title documents, and aerial photos; visual inspections of the property and adjacent properties; and interviews with current and former employees[2] to identify any areas on the property where hazardous substances and petroleum products were stored for one year or more, known to have been released, or disposed. Furthermore, reviews were conducted to determine if acutely hazardous wastes were stored in K-1400 for one year or more in quantities greater than or equal to 1.0 kilogram (kg).

[2]BJC 2003b. Personal communications with L. W. Perkins and E. Williams (either previously or currently employed at East Tennessee Technology Park) on January 14.



East Tennessee Technology Park
K–1400 STUDY AREA

K-25 NORTH

TETRA TECH, INC.
OAK RIDGE, TENNESSEE
5/21/04 9:21:14 kvicmap01 R1.dgn

Fig. 1.1. Location of K-1400 within the East Tennessee Technology Park.

East Tennessee Technology Park
K–1400 STUDY AREA

K-25 PLANT NORTH

LEGEND

STUDY AREA

Tetra Tech, Inc.
OAK RIDGE, TENNESSEE
5/21/04 1400sp R1.dgn

Fig. 1.2. Ortho image of the K-1400 study area.

Fig. 1.3. Aerial photograph showing location of K-1400 within ETTP.

2. TITLE SEARCH

On June 4, 1996, a visit was made to the state of Tennessee Roane County Recorder's Office to conduct a review of the recorded deeds documenting previous ownership of the land tract H-719 where the K-1400 study area is located. The deeds contained no information or references to other recorded evidence that, prior to U. S. Department of Energy (DOE) ownership, the property was utilized for the storage of hazardous substances and/or petroleum products or their derivatives. Additionally, no information contained in the deeds would indicate that hazardous substances and/or petroleum products or their derivatives were released from or disposed of on the property. Prior to acquisition by the government, the area was farmland and was a combination of cultivated fields, pastures, and forested areas.

The deeds that conveyed the property from the previous owner to the U. S. Government and any deeds that conveyed the property to that previous owner were reviewed as a part of the title search. Generally, the deeds from the previous two owners of a particular ORR parcel provide information that goes back to the early 1900s or even earlier. The deeds were reviewed for any references to previous land uses (e.g., homestead, farm, school, business, etc.). Also reviewed were any easements or conveyances referenced in the deeds that might indicate that portions of the land were used for pipelines, power lines, etc. Partial disposal or acquisition conveyance deeds were also reviewed because, in some instances, the land comprising a large farm had been acquired via several separate acquisitions.

In addition, property assessment records from the County Property Assessor's Office were reviewed because these documents may also contain evidence of a particular land use. Survey or subdivision maps referenced in deeds and maintained in the Register of Deeds office were also reviewed for any indications of a previous land use. Furthermore, because the Tennessee Valley Authority (TVA) was the previous owner of several large tracts of ORR land, the TVA Real Estate Office was contacted regarding their knowledge of any previous land uses. The U. S. Army Corp of Engineers (COE) was another source of information that was contacted.

3. FEDERAL RECORDS SEARCH AND REGULATORY SUMMARY

3.1 FEDERAL RECORDS SEARCH

TVA in Knoxville, Tennessee, and the COE District Office in Nashville, Tennessee, were contacted in 1996, 1997, and again on April 6, 1998, to determine if they maintained any records reflecting past or present land use relative to the land presently comprising ETTP (TVA 1998, COE 1998). Neither TVA nor COE had any information regarding the history of past or present land use that would indicate if hazardous substances or petroleum products were stored or released on the DOE-owned property currently comprising the ETTP.

In February 1997, DOE real estate records that document previous ownership of land tract H-719, where Bldg. K-1400 is located, were examined. Page A-3 of Appendix A is a statement (DOE 2002) from the Realty Officer of the DOE Oak Ridge Operations Office (ORO) that the real estate records contained no information or references to other recorded evidence that, prior to DOE ownership, the property was utilized for the storage of hazardous substances. Additionally, no information contained in these records would indicate that hazardous substances were released from or disposed of on the property.

The following pre-construction aerial photographs and maps reflecting prior use of this land were also reviewed. Copies of these photographs and maps are maintained on file in the Bechtel Jacobs Company LLC (BJC) Real Estate Office.

Aerial Photographs:

Photograph Nos. and Date	Flight By	Source
No. 130-3-9, dated 1939	Unknown	BJC, Real Estate Office
Nos. 820-2-20 through -23 and 820-3-20 through -24, dated September 25, 1942	Aero Service Corp. for Stone and Webster	BJC, Real Estate Office

These photographs, which were taken in 1939 and 1942, show that the land where the study area is located was predominantly used for agricultural purposes. The remaining land was wooded. A map depicting pre-World War II structures, churches, and cemeteries that were present in the area of ETTP is also included on page B-3 in Appendix B.

Topographic and real estate maps:

1. A November 2, 1942, topographic map identified as Sect. A-1 of ORR was prepared by Aero Services Corporation for Stone and Webster.

2. A February 19, 1945, real estate map (sheet 9 of 16) prepared by the U. S. Army shows the boundaries of all land tracts upon which facilities at the site are currently located. The study area is on Land Tract H-719.

Neither the aforementioned photographs nor maps contained any information regarding the history of the past land use that would indicate that storage or releases of hazardous substances or petroleum products have occurred on the land where Land Tract H-719 is located. Copies of the 1942 topographic map and real estate map are maintained in the BJC Real Estate Office and the DOE-ORO Real Estate Office.

3.2 REGULATORY SUMMARY

As discussed previously, prior to ownership by DOE (and its U. S. Government predecessor agencies), the property was farmland. Any DOE operations within the footprint of K-1400 occurred under DOE's own authority, without external regulation, prior to 1984. Interviews with employees and a review of records did not identify any spills, permits, or permit violations at Bldg. K-1400.

Records (containing information about spills, permits, or permit violations) and interviews with employees or former employees[3] do not indicate that any regulatory actions have occurred within the footprint of K-1400. Therefore, no regulatory responses have been invoked.

Additional research was conducted to see whether records could be found; however, any spills at or in excess of reportable quantities (RQs) would have been identified in the databases and reports, and none have been found. In addition, the former underground storage tank (UST) manager stated that there are no regulated USTs associated the Bldg. K-1400.[4]

[3]BJC 2003b. Personal communications with L. W. Perkins and E. Williams (either previously or currently employed at East Tennessee Technology Park) on January 14.

[4]CDM 2003a. Personal communications from S. T. Goodpasture of CDM Federal (currently employed at ETTP) on October 29.

4. PAST AND PRESENT ACTIVITIES

4.1 PAST AND PRESENT ACTIVITIES IN THE TITLE TRANSFER FOOTPRINT

Prior to the acquisition of the land by the government, the entire area was farmland. Over 800 acres of land were leveled and prepared in support of the Manhattan Project (to supply enriched uranium for nuclear weapons production).

The K-1400 building was built in 1953 as the Maintenance Office Building. From the early 1970s to the 1990s, it was used by various organizations for office purposes. It was leased to the Community Reuse Organization of East Tennessee (CROET) in 2001 as part of the Reindustrialization Program.

Historic maps of the ETTP area were reviewed to determine whether former facilities had been located in the K-1400 footprint. Nothing was found during the search of these maps showing that any facilities had been located in the footprint. The maps reviewed included the following:

- J. A. Jones Drawing No. 20711, *General Layout, K-25 Area, Sanitary Water Distribution*, dated 1944;
- Kellex Corporation Drawing No. FD-01-AA-02, *K-25 and K-27 Plot Plan*, dated February 27, 1944, and Rev. 9 dated March 31, 1946;
- Carbide and Carbon Chemical Corporation (C&CCC) Drawing No. AW-10M, *K-25 and K-27 Plot Plan*, Rev. 8, dated August 17, 1951;
- C&CCC Drawing No. S-KT-K100, *Area Plot Plan*, Rev. 2, dated June 24, 1953; and
- Union Carbide Nuclear Corporation Drawing No. C1E47365, *Reroof Process Buildings*, dated February 23, 1979.

As discussed in Chap. 1, interviews with former/current employees located at Bldg. K-1400 were conducted to identify any areas on the property at which hazardous substances and/or petroleum products were stored for one year or more, known to have been released, or disposed of. Records searches were also conducted, and the Hazardous Materials Information System (database; HMIS 2003) has also been searched for information about storage of hazardous materials. No evidence was found that any hazardous substances were stored in K-1400 for one year or more in quantities greater than or equal to 1000 kg or their respective Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) RQs. No evidence was found that acutely hazardous wastes were stored in K-1400 for one year or more in quantities greater than or equal to 1.0 kg. No evidence was found that any hazardous substances were released or disposed of at K-1400 in quantities exceeding their respective RQs. However, although the contamination did not originate at K-1400, the contaminated groundwater plume that extends underneath the building is considered to be a release within the footprint.

Based on records searches and interviews, no underground tanks existed on this property. All observed floor drains were plugged in the early 1990s as part of the sitewide drain-plugging program. (The program was initiated to ensure that floor drains connected to the storm drain system were permanently plugged or rerouted to prevent discharge of materials into the storm drain system and to limit the potential for National Pollutant Discharge Elimination System permit noncompliances.)[5]

[5]CDM 2003b. Email communications from J. Murphy of CDM Federal (currently employed at ETTP) on August 14.

The sources of historical information listed below were searched for additional information about any spills at Bldg. K-1400. Additional research was conducted to see if other records could be found; however, any spills at or in excess of RQs would have been identified in the databases or reports, and none have been found.

- *Preliminary Hazard Screening (PHS) Analysis for Building K-1400*, PHS/K-1400/PK/3/R2 (Energy Systems 1997);
- Occurrence Reporting and Processing System (database; ORPS 2003);
- *Environmental, Health, and Safety Concerns for the New ORGDP Contractor* (Mitchell 1983);
- *Hazardous Waste Sites Historical Investigation* (Legeay et al. unpublished);
- *Surveillance and Maintenance Plan for Remedial Action and Post Cleanup O&M Sites at the East Tennessee Technology Park, Oak Ridge, Tennessee*, K/ER-54/R9 (BJC 2002a);
- *U. S. Department of Energy, DOE Oak Ridge Operations, ETTP Unit Map* (DOE 2000a); and
- *Independent Investigation of the East Tennessee Technology Park*, ETTP-363, Vol. 1 (DOE 2000b).

4.2 PAST AND PRESENT ACTIVITIES—ADJACENT PROPERTY

The K-1400 study area is located within the perimeter fence of ETTP. The nearest non-DOE property is Blair Road/State Highway 327, located approximately 2000 ft northeast of the area. There is no indication that activities from this non-DOE area would have contributed any contamination of the study area.

Near Bldg. K-1400 is the K-1401 Maintenance Building. This building was built in 1944 to support the uranium enrichment process at ETTP. Pieces of process equipment such as motors, converters, and compressors were brought into the facility to be cleaned and repaired. The building contained drill presses, lathes, and milling machines, as well as weld shops, a sheet metal shop, degreasers, acid baths, and a carpenter's shop. After the shutdown of the enrichment process in 1986, most of this equipment and large portions of the building were idle. In the 1990s, this equipment was decontaminated and removed. Portions of the building have been leased to CROET. Currently, there are four private-sector companies operating in the building as well as BJC personnel who support site activities.

Located in the vicinity of Bldg. K-1400 is K-1501-A, a 600,000-gal tank for the storage of fuel oil for the steam plant. This tank (which is leased along with the K-1501 Steam Plant) is surrounded by a concrete dike that serves as secondary containment. There have been no known leaks from this tank. Also near Bldg. K-1400 is the former location of the K-1404-A Acid Storage Tank, K-1404-B Degreaser Solvent Storage Tank, and K-1404 Acid Storage Building (the building was removed in 2000 as part of a surveillance and maintenance action, and the tanks in 2002). Hydrochloric acid was brought in by rail to the acid storage building and pumped into the K-1404-A storage tank. The fiberglass tank had a capacity of 10,000 gals and was surrounded by an earthen dike. The acid was used in the acid baths in K-1401 until 1987. The tank was emptied in December 1992. Near the site of Bldg. K-1404 is the former location of the K-1404-B Degreaser Solvent Storage Tank. This was a 5000-gal steel tank surrounded by a concrete pit. It was used to store trichloroethane for the degreasers in Bldg. K-1401 until it was emptied in February 1992.

Several nearby facilities have potential areas of contamination that are in close proximity to Bldg. K-1400. These areas are listed as potential environmental restoration units in *Site Descriptions of Environmental Restoration Units at the Oak Ridge K-25 Site, Oak Ridge, Tennessee* (Energy Systems 1995). This report was prepared to "baseline" conditions (at the time of the evaluation), so that decisions could be made to establish cleanup priorities. Some of these areas are being addressed for possible remediation under the ORR Federal Facility Agreement (FFA; DOE 1992). [The FFA is an agreement between DOE, the U. S. Environmental Protection Agency (EPA), and the state of Tennessee to integrate the requirements of Resource Conservation and Recovery Act of 1976 (RCRA) corrective actions and CERCLA remedial investigations at specific sites within the ORR. The specific facilities to which the FFA applies are listed in Appendix C (Oak Ridge Remediation Sites) of the FFA.] A number of facilities listed in the FFA are in the vicinity of the K-1400 study area.

Four of the units listed in the FFA are associated with the K-1401 building. These are:

- The K-1401 Acid Line runs underground, along the east side of Bldg. K-1401, and was used to transfer corrosive solutions from K-1401 to the K-1407-A Neutralization Facility. The lines were taken out of service in 1987. Waste streams that were transported through this line include degreasers, caustics, and acids used to clean equipment contaminated with uranium hexafluoride (UF_6). Known leaks occurred in 1975, 1982, and 1987. In 1990, mercury was found in a portion of the cast-iron drain line in the north-end basement. The spilled mercury was cleaned up the same day. The acid line is listed in Appendix C of the FFA and as a Solid Waste Management Unit (SWMU) under RCRA.

- The K-1401 degreasers (four each, 10 ft by 50 ft) are located inside Bldg. K-1401 and were used, beginning in 1944, to degrease parts associated with the process. Acids, alkalis, detergents, and organic vapor degreasers have been used in this process. Hydrochloric acid and trichloroethene (TCE) were both stored in tanks outside the building (10,000-gal fiberglass and 10,000-gal steel, respectively). The only identified releases were through the K-1401 acid lines. The degreasers are listed in Appendix C of the FFA and as a SWMU under RCRA.

- The K-1401-N Converter Retubing Area was added in the 1970s to support the cascade improvement program (a site process used in the enrichment of uranium). Facilities were provided to install, test, and assemble barriers in process converters. Three tanks of potassium hydroxide were used in scrubbing process gases. Mixed chemical and radioactive contaminants were released through a series of process drains associated with the acid line. These areas will be investigated according to schedules in the FFA.

- The K-1401-NB Basement Area was operated from 1944 to 1987. Process equipment in this area originally supported the converter conditioning activities on the first floor of the building. Internal building surfaces and equipment are contaminated. The basement is listed in Appendix C of the FFA. In 1998, basement sumps were rerouted to the Central Neutralization Facility as part of a CERCLA time-critical removal action (DOE 1998).

The former K-1501-S Coal Storage Yard and K-1501-E Crusher Transfer Building are located to the east of Bldg. K-1400 and were operational in the 1980s (see Fig. 1.3). The yard and building were used to store and process coal for the K-1501 Steam Plant. The crusher transfer building contained a coal crusher, vibrating screens, and a conveyor system to process mine-run coal to stoker-grade coal. Use of the yard and crusher was discontinued in 1990 when the steam plant was converted to natural gas. The coal was removed from the yard and the yard re-seeded in the early 1990s. The K-1501-E conveyors were demolished in the late 1990s. Building K-1501-E is listed in Appendix C of the FFA.

The K-1070-C/D Burial Ground is approximately 400 ft to the southeast of the study area. It is listed as a SWMU under RCRA and is also listed in Appendix C of the FFA. The burial ground operated from 1974 to 1989 and consists of several large trenches and 10 pits. The trenches were used for the disposal of classified equipment. The pits received oxidizing agents, glass containers, radioactively contaminated materials, reducing agents, organic solvents, and pesticides. Several organic chemicals have been detected in a groundwater plume emanating from the burial ground. This plume is addressed by a CERCLA remedial action referred to as "K-1070-C/D and Mitchell Branch Trench Removal Action." This project included the installation of an interceptor trench to capture and collect the contaminated groundwater from the K-1070-C/D Burial Ground.

The K-1070-D1, -D2, and -D3 Storage Dikes (located within the boundaries of K-1070-C/D) were earthen dikes areas used to store contaminated waste liquids from 1980 to 1985. A total of 856 drums of waste were stored, which included chemicals such as trichloroethane, ethylene glycol, gasoline, methylene chloride, Freons, acetone, xylene, various waste oils and solvents, paint wastes, and classified liquids and oils. At the end of operations, all drums were removed and the dikes were closed in 1986 in accordance with state regulations (documentation of closure was via a letter from T. Tiesler, Division of Solid Waste Management, Tennessee Department of Health and Environment, to W. F. Manning of DOE, dated November 20, 1986).

Two additional facilities were located during the review of historic maps of ETTP. The Kellex map, *K-25 and K-27 Plot Plan*, dated February 27, 1944, shows the K-1017-S-5 guard house about 50 ft south of the K-1400 footprint. The Union Carbide Nuclear Corporation drawing, *Reroof Process Buildings*, dated 1979, shows the K-1400-A engineering trailer located about 30 to 50 ft east of Bldg. K-1400.

To support previous leasing activities, Baseline Environmental Analysis Reports (BEARs) have been published for a number of facilities and areas in the vicinity of the K-1400 study area. These BEARs include:

Building	**Document Number**	**Date Published**
K-1098-E	K/EM-529/530	July 1997
Natural Gas Distribution System	K/EM-556	November 1997
K-1501	K/EM-574/575	December 1997
Roads and Grounds Phase I	K/EM-579	February 1998
K-1401	BJC/OR-638	September 2000
K-1098-E and Adjacent Areas	BJC/OR-866	February 2001

4.3 HYDROGEOLOGIC ENVIRONMENT

This information is being presented to lay the basis for evaluation of potential vapor intrusion.

Building K-1400 is located in the northeastern portion of the ETTP. This portion of the ETTP is underlain by bedrock of the Rome Formation (Lemiski 1994)[6] [see Fig. 4.1], which has been placed over rocks of the Chickamauga Supergroup by the K-25 thrust fault. The lower part of the Rome Formation, which is poorly exposed in the ETTP area, generally consists of thin-bedded shale and siltstone with interbedded sandstones in variegated colors of maroon, green, and yellow-brown. The upper Rome consists of maroon sandstone, siltstone, and shale. The shales are thin bedded and may be olive-green, light brown, green-gray, or maroon in color. Greenish-gray, yellowish-gray, light brown, and olive-gray siltstones and

[6]Abbreviations representing formations on Fig. 4.1 are as follows:
Cr – Rome Formation.
OCY – Catheys Formation.
OCN – Cannon Formation.

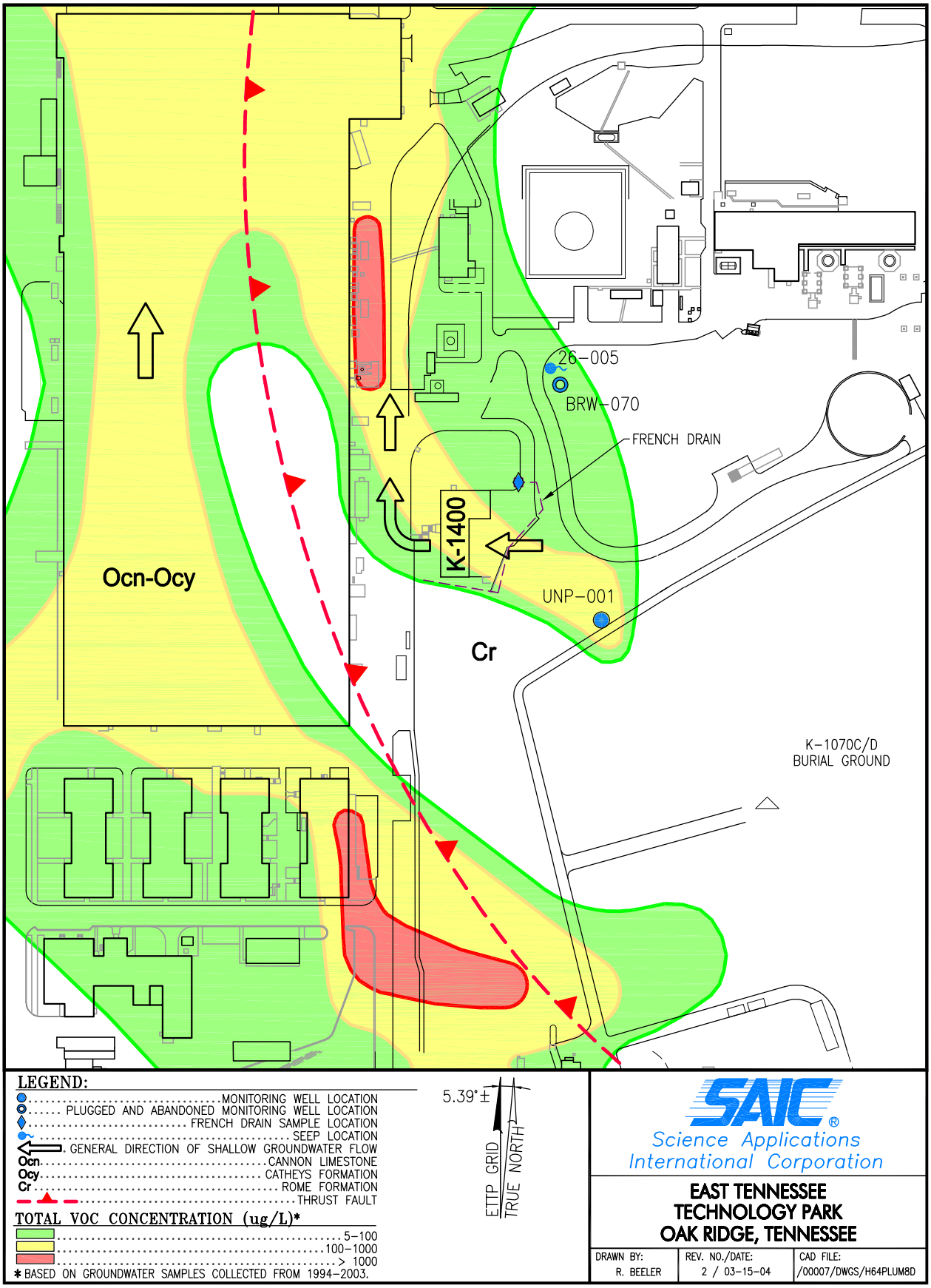


Fig. 4.1. Groundwater VOC concentrations in the vicinity of K-1400.

sandstones are interbedded with the maroon sandstones. Although the lower Rome contains a carbonate unit in some areas of northeastern Tennessee and small exposures of a weathered carbonate have been observed in the lower Rome in the vicinity of ETTP, no evidence exists of the development of karst in the Rome Formation at ETTP. In situ weathering of the Rome Formation yields saprolite consisting of weathered shale or siltstone, which commonly becomes more competent with depth. Available exposures of this weathered saprolite in the K-1070-C/D area, located immediately southeast of K-1400, reveal numerous tight, highly fractured kink folds with widely ranging orientations. This degree of variability precludes predictions of bedrock flowpaths in the Rome Formation at the ETTP.

Hydrogeologic characterization data for Bldg. K-1400 are limited because, currently, no groundwater monitoring wells exist in the immediate vicinity of the building. However, one unconsolidated zone monitoring well (UNP-001) exists approximately 200 ft southeast, and upgradient, of Bldg. K-1400, and one bedrock well (BRW-070) previously existed approximately 170 ft northeast of K-1400. The bedrock well was plugged and abandoned in 2001 after several years of monitoring revealed no contamination was present in groundwater at this well. In addition to these two wells, historical records indicate a French drain was installed along the south and east sides of Bldg. K-1400 at the time of construction. This French drain intercepts a portion of the groundwater flowing toward K-1400 from the upgradient area to the southeast. Sample collection from the catch basin that has been identified as the discharge point for the French drain has also been conducted over recent years. The hydrogeologic characterization data presented below for Bldg. K-1400 are based, in part, on the data from the nearest monitoring wells and on interpolation from other available ETTP sitewide information.

Because no monitoring points exist at Bldg. K-1400, depth to bedrock and depth to groundwater can only be interpolated from the nearby wells and ETTP-wide maps prepared from available data. Based on pre-construction topographic maps, it does not appear that any significant volume of fill material was placed in the area occupied by Bldg. K-1400 during construction of ETTP. Depth to competent bedrock, interpolated from data in the general vicinity of K-1400, is expected to be from 10 to 25 ft below ground surface (bgs). The depth to groundwater, interpolated from the nearby wells and an ETTP sitewide potentiometric map, is expected to range from 8 to 12 ft bgs. Groundwater flow is to the west in the immediate vicinity, then turns north under K-1401 (see Fig. 4.1). However, the influence of the French drain on water levels in the immediate vicinity of K-1400 is unknown. Hydrologic parameters such as hydraulic conductivity and hydraulic gradient must also be estimated for Bldg. K-1400 using available data. Hydraulic conductivity for the Rome bedrock and overburden materials developed above the Rome, as determined from slug tests conducted in numerous monitoring wells throughout ETTP, is presented in Table 4.1 with additional hydrogeologic characterization parameters for Bldg. K-1400.

Current groundwater plume maps indicate the presence of volatile organic compounds (VOCs) in shallow groundwater beneath Bldg. K-1400. The plume beneath K-1400 represents an unconsolidated zone groundwater plume. Table 4.2 summarizes the laboratory analytical results for the VOCs that have been detected in groundwater samples collected from unconsolidated zone monitoring well UNP-001, which is located hydraulically upgradient of K-1400, the French drain, which is located 20 to 30 ft south and east of the building, and a seep (26-005) located approximately 200 ft northeast of Bldg. K-1400, during the period from 1994 to 2003. Well UNP-001 has been sampled eight times, most recently in January 2004. Sample collection was not conducted at the French drain until 1999, but it has been sampled 10 times since then. Seep 26-005 has been sampled 11 times since the first sampling event in 1995. This seep likely represents shallow groundwater concentrations near the eastern margin of the plume in the vicinity of K-1400. It should be noted that VOC concentrations at these locations might not be representative of actual concentrations in groundwater beneath Bldg. K-1400 but represent concentrations within various portions of the identified plume that extends beneath the building. The VOCs that have been detected above a federal drinking water maximum contaminant level (MCL) in the vicinity of Bldg. K-1400 include 1,2-dichloroethene (1,2-DCE), methylene chloride, tetrachloroethene,

and TCE. It also appears from the data presented in Table 4.2 that concentrations of TCE in groundwater upgradient of K-1400 have declined significantly over recent years. The variability in the results from the French drain are likely due to the sample collection method that must be used to sample the catch basin and the opportunity for volatilization of the VOCs in groundwater captured by this drain, which is open to the atmosphere.

Table 4.1. Summary of hydrogeologic conditions at Bldg. K-1400

Parameter	Site conditions
Is a groundwater plume present beneath the facility?	Yes
Distance from facility to nearest upgradient plume (ft)	0
Is karst present?	No
Depth to bedrock (ft)	10-25[a]
Depth to groundwater (ft)	8-12[a]
Are fill materials present at the facility?	minimal
Composition of overburden materials present.	silty clay[a]
Shallow groundwater flow direction	west
Hydraulic conductivity of overburden materials (cm/sec)	3.44E-04[b]
Hydraulic conductivity of bedrock (cm/sec)	3.36E-05[c]
Hydraulic gradient at the site (ft/ft)	0.1[a]
Is a perched water table present at the site?	unknown

[a]Represents interpolated value based available data.
[b]Represents average hydraulic conductivity of unconsolidated zone materials at ETTP based on slug tests of wells completed in overburden developed above Rome bedrock.
[c]Represents mean hydraulic conductivity based on slug tests of ETTP wells completed in bedrock of the Rome Formation.

Concentrations of TCE at seep 26-005 have declined from concentrations detected in 1998 and 1999 despite the increased concentration reported for the August 2003 sample. Concentrations of the TCE degradation product 1,2-DCE have also increased at seep 26-005 and well UNP-001 in the most recent sampling events at these locations. The increase in 1,2-DCE concentrations indicates that natural attenuation of the parent compound TCE is occurring in this plume.

4.4 PATH FORWARD FOR EVALUATING THE POTENTIAL FOR VAPOR INTRUSION AT EAST TENNESSEE TECHNOLOGY PARK FACILITIES TARGETED FOR TRANSFER

EPA issued the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Draft Vapor Intrusion Guidance)*, EPA530-F-052, in November 2002. This guidance is intended to help determine if the vapor intrusion exposure pathway poses a significant risk to human health; it was originally written in support of the environmental indicators program. Vapor intrusion is the migration of VOCs in contaminated groundwater and/or soil to indoor air. According to the *Draft Vapor Intrusion Guidance*, in extreme cases, the vapors may accumulate in occupied buildings to levels that may pose safety hazards and/or adverse health effects. Typically, however, the chemical concentration levels are low or, depending on site-specific conditions, vapors may not be present at detectable concentrations. Generally, the *Draft Vapor Intrusion Guidance* is intended for residential settings and does not apply to occupational settings. However, due to the occurrence of VOCs in shallow groundwater in some areas at ETTP, and because a Covenant Deferral approach under CERCLA Sect. 120(h) will be used to support the transfers, EPA Region 4 recommended investigation of the vapor intrusion pathway for ETTP facilities that are targeted for transfer to CROET or other qualified parties.

Table 4.2. Summary of VOCs detected in groundwater samples from unconsolidated zone monitoring well UNP-001 and the K-1400 French drain

Analyte (μg/L)	MCL	UNP-001								French drain				
		Jan-94	Oct-94	Feb-95	Sep-95	Sep-97	May-98	Aug-98	Jan-04	Apr-99	Aug-99	Mar-00	Aug-00	Mar-01
1,1,1-Trichloroethane	200	3 J	50 U	**2 J**	**1 J**	5 U	25 U	**25 U**	6.7 U	5 U	5 U	20 U	2 U	20 U
1,1-Dichloroethene	7	5 U	50 U	**3 J**	**5 J**	**2 J**	25 U	**25 U**	2.3 J	5 U	5 U	20 U	2 U	20 U
1,2-Dichloroethene[a]	70	100	120	100	110	70	110	**560 J**	190	26	7	22	7	34
2-butanone	NA	10 U	100 U	10 U	10 U	10 U	50 U	**50 U**	33 U	10 U	10 U	500 U	50 U	500 U
Acetone	NA	15 U	100 U	10 U	10 U	10 U	50 U	**50 U**	67 U	10 U	**2 J**	500 U	50 U	500 U
Chloroform[b]	100	5 U	50 U	5 U	5 U	5 U	25 U	**25 U**	6.7 U	5 U	5 U	20 U	2 U	20 U
Methylene chloride	5	5 U	50 U	5 U	5 U	5 U	25 U	**25 U**	33 U	5 U	*19 J*	20 U	2 U	20 U
Tetrachloroethene	5	64	**25 J**	29	30	22	20 J	**25 U**	1.7 J	50	2 J	58	2 U	44
Trichloroethene	5	1100	810	970	660	520	530	**23 J**	43	150	12	130	10	180
Vinyl chloride	2	10 U	100 U	10 U	10 U	10 U	50 U	**50 U**	200	10 U	10 U	10 U	1 U	10 U

Analyte (μg/L)	MCL	French drain					26-005						
		Sep-01	Mar-02	Aug-02	Mar-03	Aug-03	Apr-95	Jun-98	Apr-99	Aug-99	Mar-00	Aug-00	Mar-01
1,1,1-Trichloroethane	200	20 U	20 U	2 U	20 U	2 U	10 U	5 UJ	1 J	5 U	2 U	2 U	2 U
1,1-Dichloroethene	7	20 U	20 U	2 U	20 U	2 U	10 U	5 UJ	5 U	5 U	2 U	2 U	2 U
1,2-Dichloroethene[a]	70	20 U	20 U	2 U	20	14	18	88 J	83	10	2 U	8	3
2-butanone	NA	500 U	500 U	50 U	500 U	50 U	20 UJ	10 UJ	10 U	2 J	50 U	50 U	50 U
Acetone	NA	500 U	500 U	50 U	500 U	**50 U**	20 UJ	10 UJ	10 U	4 J	50 U	50 U	50 U
Chloroform[b]	100	20 U	20 U	2 U	20 U	2 U	25	5 UJ	5 U	5 U	2 U	2 U	2 U
Methylene chloride	5	20 U	20 U	2 U	20 U	*2 U*	10 U	9 UJ	5 U	20 J	2 U	2 U	2 U
Tetrachloroethene	5	20 U	20 U	2 U	54	13	20	68 J	100	5 U	21	2 U	2 U
Trichloroethene	5	52	97	2	120	34	180	560	870	4 J	4	2 U	11
Vinyl chloride	2	10 U	10 U	1 U	10 U	1 U	20 U	10 UJ	2 J	10 U	1 U	1 U	1 U

Analyte	MCL	26-005			
		Sep-01	Mar-02	Mar-03	Aug-03
1,1,1-Trichloroethane	200	**20 U**	2 U	2 U	2 U
1,1-Dichloroethene	7	**20 U**	2 U	2 U	2 U
1,2-Dichloroethene[a]	70	28	2 U	4.3	140
2-butanone	NA	500 U	50 U	50 U	50 U
Acetone	NA	500 U	50 U	50 U	50 U
Chloroform[b]	100	20 U	2 U	2 U	2 U
Methylene chloride	5	20 U	2 U	2 U	2 U
Tetrachloroethene	5	20 U	7	2 U	13
Trichloroethene	5	45	15	13	150
Vinyl chloride	2	10 U	1 U	1 U	1 U

[a]Represents maximum contaminant level (MCL) for the *cis*-1,2-dichloroethene isomer.
[b]Represents MCL for total trihalomethanes.
J = estimated concentration. U = analyte not detected at indicated concentration.
MCL = maximum contaminant level. VOC = volatile organic compound.

In accordance with the *Draft Vapor Intrusion Guidance*, and through consultation with representatives from EPA Region 4, DOE-ORO has developed a process to evaluate the potential for vapor intrusion at existing ETTP properties to be transferred to the private sector under a CERCLA Sect. 120(h) Covenant Deferral Request (CDR). The following outlines that process.

ORO, EPA Region 4, and the Tennessee Department of Environment and Conservation (TDEC) agree that vapor intrusion will be addressed in the ETTP Sitewide (groundwater) Record of Decision (ROD). The Sitewide ROD is currently scheduled to be signed by 2006. Until those actions of the ROD related to vapor intrusion are implemented, ORO will implement the following interim measures to ensure that transfer of these properties is protective of human health.

All properties (buildings and land parcels) will be considered for evaluation on a case-by-case basis. However, it should be noted that sampling is not planned for facilities not suited for occupancy (e.g., the telecommunications buildings known as K-1039/K-1039-1).

1. When evaluation of the vapor intrusion pathway is required, ORO will collect soil-vapor samples on the property proposed for transfer, and will proceed as follows:

    a. EPA will review the soil-vapor planned sampling locations prior to implementation.

    b. Two sampling events will be conducted for each property, one during the winter and one during the summer, to account for seasonal variability.

    c. Individual sample results will be compared to pre-established trigger levels for soil vapor that will be developed using a hazard index (HI) of 0.1 and a risk value of 10^{-5}.

    d. If the soil-vapor analytical results are below the trigger levels, interim monitoring may be conducted if building conditions change, and/or at the necessary frequency (see below for further details).

    e. When the property proposed for transfer is a building, if the soil vapor analytical results are above the trigger levels, discussions will be held with EPA and TDEC to determine if indoor air samples should be collected to determine whether the vapor intrusion pathway is complete. Factors that will be considered to determine if air sampling is necessary will include the contaminant and how significant the exceedance is (i.e., whether the risk from the vapor intrusion pathway is greater than 10^{-4}, etc.).

    f. If air samples are collected, the results will be compared to the 25-year industrial preliminary remediation goals (PRGs). If the results exceed the PRGs, the risks will be deemed unacceptable, and the vapor intrusion pathway will be considered complete. If this occurs, ORO will consult with the transferee (e.g., CROET) to determine if they are still interested in transfer of the building. If the transferee desires the building, it will be retrofitted as necessary to eliminate or reduce the risk to acceptable levels, and confirmatory sampling will be conducted.

    g. If the results for indoor air samples do not exceed the PRGs, risks will be considered acceptable, and the building will be transferred. Annual indoor-air sampling will be conducted to ensure that the vapor intrusion pathway has not become complete due to any changed conditions in the integrity of the building structure.

    h. When the property proposed for transfer is a land parcel, if the soil vapor analytical results are above the trigger levels, the vapor intrusion pathway will be assumed complete, and the transferee

will be required, through the quitclaim deed, to incorporate engineered controls (e.g., engineered barriers) in new building construction plans to ensure protectiveness.

i. After the initial evaluation (consisting of the winter and summer sampling events), and in accordance with EPA's *Draft Vapor Intrusion Guidance* and/or other appropriate EPA guidance, re-evaluation of the vapor intrusion pathway may be conducted if the building use changes and/or as determined using the risk and hazard equations from the CERCLA risk assessment guidance. This will be done by aggregating the winter and summer sampling results and identifying the maximum detected concentration for each analyte. Next, the risk and hazard equations will be rearranged to solve for the quotient exposure duration. This approach will determine the number of years a worker would need to be exposed to the maximum detected concentrations of VOCs in order to have a cumulative risk of 1.0×10^{-6} or an HI of 1.0 and, hence, the frequency of sampling needed in order to be protective of workers. Once the frequency has been established, re-sampling will be conducted inside or immediately outside the buildings. The determination of inside or outside will depend on (1) the potential impact to the future owners, and (2) the calculated frequency. The complete approach for determining the interim monitoring frequency is contained in an agreement between EPA Region 4 and ORO titled *Approach to Interim Monitoring of the Vapor Intrusion Pathway for Transferred Facilities at the East Tennessee Technology Park (ETTP)* [DOE 2004b]. A supplement, *Site-Specific Soil Vapor Intrusion Analysis for ETTP Parcels with No Existing Buildings* (approved by EPA on August 19, 2004), was added to support the transfer of land parcels (DOE 2004c). Additionally, comprehensive changes to the building structure or infrastructure (e.g., replacement of the heating, ventilating, and air-conditioning system) that have the potential to alter previous conclusions may require re-evaluation. If such changes are made, the transferee (i.e., CROET) will notify ORO and, if necessary, ORO will re-evaluate to ensure that the pre-transfer determination has not changed. It should be noted that the buildings will continue to be used for occupational purposes in accordance with deed restrictions.

j. A re-evaluation will consist of additional soil-vapor sampling and, if necessary, indoor-air sampling. If the results of the re-evaluation indicate that vapor intrusion poses a significant risk to human health, ORO will take necessary actions to ensure protectiveness.

5. RESULTS OF VISUAL AND PHYSICAL INSPECTIONS

5.1 VISUAL AND PHYSICAL INSPECTIONS OF THE PROPERTY FOR TRANSFER

In December 2002, a walkdown of the K-1400 building was conducted by representatives from Science Applications International Corporation, CROET, and BJC to observe the condition of the building (SAIC 2002). This chapter documents the observations of this inspection.

The footprint for the K-1400 study area is shown in Fig. 1.2. The area proposed for title transfer includes the K-1400 building, the metal-sided shed on the north wall that is accessible from the outside, and the underlying property, also known as the underlying fee. No exterior laydown, parking, or soil areas are associated with the study area. The shed houses the building's fire alarms and firewater header system. The K-1400 building (see Figs. 5.1 and 5.2 for the floor plans) is a 13,000-ft^2, L-shaped, two-story, masonry structure that is used for office space. The building is built on a hill and is elevated above Avenue "D." It is divided into offices, conference rooms, restrooms, a kitchen, and a vending area. It is heated with steam heat and cooled with window air-conditioning units. The original floor tiles (known to contain asbestos) were removed from both floors in 2001. The first floor is concrete and the second floor has been carpeted. All asbestos pipe insulation was removed and replaced with fiberglass insulation in the 1990s. There is no asbestos present in the building. All insulation and ceiling tiles are of non-asbestos, man-made mineral fibers. Based on the age of the building, the presence of lead-based paint is considered possible. The lighting is provided by fluorescent light fixtures. These fixtures have the potential of containing polychlorinated biphenyl (PCB) ballasts. There are auxiliary Fire Alarm boxes in the building that may contain 2- to 10-mL ampules of mercury.

5.2 VISUAL AND PHYSICAL INSPECTION OF ADJACENT PROPERTY

The adjacent areas are owned by DOE and have been assessed to determine actual or potential releases of hazardous substances or petroleum products. Information about each of the adjacent areas that may contain contamination is provided in Sect. 4.2.

An asphalt parking area is located on the west side of Bldg. K-1400. A grassy area extends around the north and west sides of the building. The grassy area on the west side is steep and drops down to Avenue "D" and a parking area adjacent to Avenue "D." Concrete steps provide access from the building to Avenue "D." There are several mature pine trees on the west side of the building. Electrical power for Bldg. K-1400 passes through several pole-mounted transformers on the east side of the building.

An aboveground utility rack passes approximately 40 ft to the north and west of the building. It contains steam and condensate piping as well as abandoned nitrogen, air, and natural gas lines. The steam lines are insulated with asbestos that is in good condition.

The former K-1501-S Coal Storage Yard is an open, grassy area approximately 1.5 acres in size.

The K-1401 Maintenance Building has over 400,000 ft^2 of floor space. It is a steel-framed building with an open bay floor plan. It is shared by BJC employees and CROET lessees. Cleanup efforts have been initiated in the basement and are ongoing.

The K-1404 Acid Storage Building was demolished in 2000, and the K-1404-A and -B storage tanks were removed in 2002.

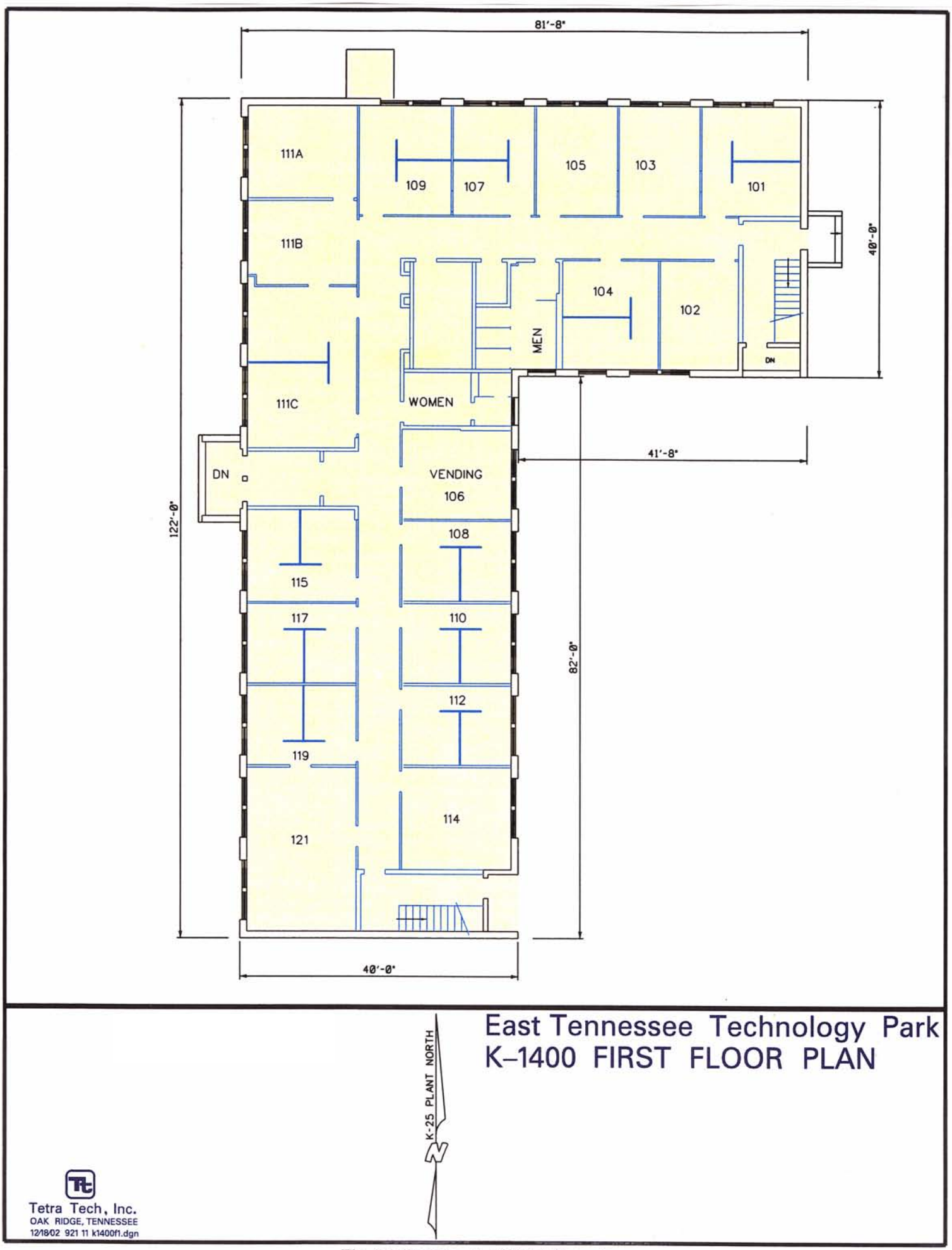


Fig. 5.1. Building K-1400 1st floor plan.

Fig. 5.2. Building K-1400 2nd floor plan.

The K-1070-C/D Burial Ground covers approximately 22 acres. It was closed in 1989 and allowed to revegetate. It is mowed regularly by the CROET lessee's contractor. Remedial action activities are ongoing in the burial ground to reduce its impact on the environment. The area is fenced and access is restricted.

The K-1070-D1, -D2, and -D3 Storage Dikes are maintained as grassy areas by regular mowing. They are within the K-1070-C/D security fence.

6. SAMPLING RESULTS

6.1 DESCRIPTION OF BUILDING K-1400

The area proposed for title transfer includes the K-1400 building and the underlying property, also known as the underlying fee. No exterior laydown, parking, or soil areas are associated with the study area. A metal-sided shed on the north wall of K-1400 that houses the building's fire alarms and firewater header system is included. The K-1400 building has been used for office space since its construction in 1953 and has two floors.

6.2 CHEMICAL AND RADIOLOGICAL SAMPLING

Based on discussions with EPA, it has been agreed that the need to collect soil samples to support title transfer activities will be determined on a case-by-case basis. Factors such as a facility's past operational history, geographic location, and historical samples will be considered. In addition, the history and knowledge of activities at adjacent properties will be evaluated.

Document reviews of the K-1400 property and adjacent areas indicate that no activities have been conducted in Bldg. K-1400 that would have contributed to contamination of the area. There are, however, locations of potential concern related to operations that took place in adjacent areas. Information was gathered on these facilities from previously published reports. These sources include site historical investigations, the K-25 Site Access and K-25 Site Decontamination and Decommissioning Facility databases, and information compiled into the *Site Descriptions of Environmental Restoration Units at the Oak Ridge K-25 Site* (Energy Systems 1995) document previously discussed in Sect. 4.2. These areas include the K-1070-C/D Burial Ground and the K-1401 Acid Line and Degreasers discussed in Sect. 4.2.

6.2.1 Soil Vapor Sampling

The results of the sampling conducted at Bldg. K-1400 are presented below (see Appendix C for the soil vapor sampling plan). Sub-slab soil vapor was collected in the winter of 2004, and again from the same locations in the summer of 2004, to determine if a potential source for VOCs exists under the building (see Fig. 6.1). For each season individually, the results were validated, and the average concentration for each VOC was calculated and compared to its respective soil vapor trigger level, a concentration calculated to be health protective. In addition, to ensure that the VOCs did not cumulatively exceed trigger levels, the average concentration for each VOC was divided by its respective trigger level to determine what fraction the concentration represented. The resulting fractions were then added for all VOCs that had at least one detection. If, collectively, the VOC concentrations had exceeded the trigger levels, the resulting value would be above 1.0 (i.e., the fractions would add up to over 1.0).

None of the VOCs detected in either the winter or summer sampling events exceeded trigger levels for Bldg. K-1400, and the sum of trigger level fractions was below 1.0 (see Tables 6.1 and 6.2). Therefore, the vapor intrusion pathway is not considered complete beneath the building, and there is a low likelihood of adverse impacts to human health.

6.2.1.1 Re-sampling frequency

Soil vapor concentrations may vary due to groundwater movement; therefore, additional sampling may be required to ensure protection of human health in the future. The approach agreed to by EPA

Fig. 6.1. Building K-1400 soil vapor sampling locations.

Table 6.1. Winter 2004 sub-slab soil vapor results for Building K-1400

Analyte	Frequency of detection	Minimum detected concentration	Maximum detected concentration	Arithmetic mean concentration	Trigger level[a]	Trigger level exceeded?	Arithmetic mean fraction of trigger level
			Volatile organic compounds (μg/m³)				
1,1,1-Trichloroethane	0/5	ND[b]	ND	ND	3.01E+05	NA[c]	NA
1,1,2-Trichloro-1,2,2-trifluoroethane	3/5	5.00E-00	7.30E+02	1.50E+02	4.04E+06	No	3.70E-05
Acetone	3/5	5.00E-00	1.20E+01	5.72E-00	4.13E+05	No	1.38E-05
Carbon tetrachloride	0/5	ND	ND	ND	3.35E+02	NA	NA
Chloroform	0/5	ND	ND	ND	1.62E+03	NA	NA
Tetrachloroethene	3/5	1.00E-00	5.80E+01	2.11E+01	6.66E+04	No	3.17E-04
Trichloroethene	2/5	6.00E-00	8.50E+01	1.85E+01	5.45E+03	No	3.40E-03
Vinyl chloride	0/5	ND	ND	ND	4.23E+03	NA	NA
cis-1,2-Dichloroethene	1/5	3.00E-00	3.00E-00	9.80E-01	4.81E+03	No	2.04E-04
trans-1,2-Dichloroethene	0/5	ND	ND	ND	9.67E+04	NA	NA
						Sum of fractions	**3.97E-03**

[a]Trigger level was developed with the Johnson-Ettinger (JE) model, assuming an indoor air preliminary remediation goal based on risk level of 1E-5 and hazard index of 0.1 for industrial exposure (250 d/year, 25 years).

[b]ND = non-detection.

[c]NA = not applicable; no detected concentrations.

Table 6.2. Summer 2004 sub-slab soil vapor results for Building K-1400

Analyte	Frequency of detection	Minimum detected concentration	Maximum detected concentration	Arithmetic mean concentration	Trigger level[a]	Trigger level exceeded?	Arithmetic mean fraction of TL
Volatile organic compounds (μg/m³)							
1,1,1-Trichloroethane	3/3	3.60E+00	7.20E+00	5.10E+00	3.00E+05	No	1.70E-05
1,1,2,2-Tetrachloroethane	0/3	ND[b]	ND	ND	6.69E+02	NA[c]	NA
1,1,2-Trichloro-1,2,2-trifluoroethane	3/3	6.00E+01	3.60E+03	1.26E+03	3.98E+06	No	3.18E-04
1,1,2-Trichloroethane	0/3	ND	ND	ND	1.91E+03	NA	NA
1,1-Dichloroethane	0/3	ND	ND	ND	6.89E+04	NA	NA
1,1-Dichloroethene	0/3	ND	ND	ND	7.42E+02	NA	NA
1,2-Dichloroethane	0/3	ND	ND	ND	1.38E+03	NA	NA
1,2-Dichloroethene	2/3	2.00E-01	3.50E+01	1.18E+01	2.52E+03	No	4.66E-03
1,2-Dichloropropane	0/3	ND	ND	ND	5.44E+02	NA	NA
2-Butanone	3/3	1.50E+00	5.70E+00	3.57E+00	6.82E+05	No	5.23E-06
2-Hexanone	3/3	2.20E-01	1.00E+00	7.00E-01	7.95E+02	No	8.81E-04
4-Methyl-2-pentanone	3/3	1.70E-01	4.00E-01	2.90E-01	4.02E+05	No	7.21E-07
Acetone	3/3	1.40E+01	2.30E+01	1.97E+01	3.85E+05	No	5.11E-05
Benzene	3/3	1.20E-01	6.80E-01	3.27E-01	3.99E+03	No	8.18E-05
Bromodichloromethane	0/3	ND	ND	ND	2.73E+03	NA	NA
Bromoform	0/3	ND	ND	ND	1.49E+04	NA	NA
Bromomethane	2/3	3.70E-01	8.90E+00	3.10E+00	6.91E+02	No	4.49E-03
Carbon disulfide	0/3	ND	ND	ND	8.99E+04	NA	NA
Carbon tetrachloride	3/3	5.00E-01	1.00E+01	3.67E+00	3.34E+02	No	1.10E-02
Chlorobenzene	0/3	ND	ND	ND	2.76E+03	NA	NA
Chloroethane	1/3	1.30E-01	1.30E-01	6.90E-02	1.38E+06	No	4.99E-08
Chloroform	2/3	1.60E-01	1.60E+01	5.41E+00	1.56E+03	No	3.46E-03
Chloromethane	2/3	1.30E+00	2.60E+00	1.35E+00	1.24E+04	No	1.09E-04
Dibromochloromethane	0/3	ND	ND	ND	1.34E+04	NA	NA
Ethylbenzene	1/3	2.00E-01	2.00E-01	1.10E-01	3.50E+04	No	3.15E-06
Methylene chloride	1/3	7.90E+00	7.90E+00	2.72E+00	7.68E+04	No	3.55E-05
Styrene	0/3	ND	ND	ND	1.39E+05	NA	NA
Tetrachloroethene	3/3	1.70E+01	9.90E+01	5.40E+01	6.68E+04	No	8.08E-04
Toluene	3/3	2.00E-01	9.90E-01	4.63E-01	5.32E+04	No	8.70E-06
Total Xylene	3/3	4.10E-01	1.90E+00	9.40E-01	1.39E+04	No	6.75E-05
Trichloroethene	3/3	1.30E+00	1.10E+03	3.75E+02	5.43E+03	No	6.91E-02
Vinyl chloride	1/3	6.90E-01	6.90E-01	2.53E-01	4.07E+03	No	6.21E-05

Table 6.2. Summer 2004 sub-slab soil vapor results for Building K-1400 (continued)

Analyte	Frequency of detection	Minimum detected concentration	Maximum detected concentration	Arithmetic mean concentration	Trigger level[a]	Trigger level exceeded?[b]	Arithmetic mean fraction of TL
cis-1,2-Dichloroethene	1/3	3.50E+01	3.50E+01	1.17E+01	4.82E+03	No	2.43E-03
cis-1,3-Dichloropropene	0/3	ND	ND	ND	2.84E+03	NA	NA
trans-1,2-Dichloroethene	2/3	1.20E-01	9.50E-01	3.73E-01	9.72E+04	No	3.84E-06
trans-1,3-Dichloropropene	0/3	ND	ND	ND	4.97E+03	NA	NA
						Sum of fractions	**9.75E-02**

[a]Trigger level (TL) was developed with the Johnson-Ettinger (JE) model assuming an indoor air preliminary remediation goal based on risk level of 1E-5 and hazard index of 0.1 for industrial exposure (250 d/year, 25 years).

[b]ND = non-detection.

[c]NA = not applicable based on sampling or toxicological data.

Region 4 and DOE-ORO for determining how often sampling will be needed to ensure protectiveness to the workers inside the transferred buildings was followed as described below.

The combined dataset was evaluated to determine the maximum detected soil vapor concentration of each constituent for the building. Next, the equations used to calculate potential impacts to human health were rearranged to solve for the allowable days of exposure that, at the maximum detected soil concentration, would result in an exposure to all detected contaminants that does not exceed health-based limits. For this analysis the acceptable risk level was 1E-6, and the acceptable hazard level was 1.0.

Once the sampling frequency has been established, re-sampling will be conducted either inside the buildings or immediately outside the buildings, depending on the potential impact to future owners and the calculated frequency. If sampling indoors is considered too intrusive to the future owners, sampling outside will be performed. The following text describes the outdoor sampling approach.

Soil piezometers, if not already present, would be installed in locations outside the building. In order to monitor sub-slab soil vapor from these piezometers, a correlation between the piezometer soil vapor measurements and the sub-slab soil vapor measurements taken outside the buildings must be established. The proposed sampling strategy is to pair interior sub-slab soil sampling locations with an exterior piezometer, with the number and locations of samples based on the size and configuration of the building. The paired interior and exterior sample results would be used to calculate a linear regression to relate the outside soil vapor concentration to the sub-slab soil vapor concentration. The number of samples that would be needed in order to establish a correlation between the indoor and outdoor soil vapor data will be determined using the Monte Carlo simulation approach.

Once the data from the outside piezometers are analyzed, the correlated concentrations for the sub-slab soil vapor can be determined and screened against the trigger levels to determine if concentrations are acceptable or unacceptable. If they are unacceptable, indoor ambient air sampling will need to be considered. All data collected to evaluate soil vapor will be used in re-calculating the re-sampling frequency.

The re-sampling frequency for Bldg. K-1400 is 15 years. The result indicates that should maximum soil vapor concentrations remain constant, a hypothetical individual working in the building would be exposed to a risk of 1E-6 and a hazard of 1.0 over the 15-year period due to all constituents combined. Primary constituents contributing to the magnitude of the re-sampling frequency were trichloroethene (maximum detected concentration of 1.1 mg/m^3 from summer sampling) and chloroform (0.016 mg/m^3 in summer sampling).

6.2.2 Reindustrialization Sampling

Surface soil sampling was conducted in November 2000 in the immediate vicinity of K-1400 prior to leasing the building to CROET. Nine individual surface soil (i.e., 0 to 6 in. from the soil surface) grab samples were collected and analyzed for PCBs, VOCs, semivolatile organic compounds (SVOCs), and metals to provide data to support a baseline environmental analysis (BJC 2001a) and screening-level human health risk assessment (SHHRA) [BJC 2001b; DOE 2004d]. In addition, sub-slab soil vapor sampling was conducted in 2003 (see Sect. 6.2.1).

6.2.2.1 Chemical soil sampling

The analytical results for the soil samples collected near K-1400 were analyzed and compared to human health risk PRGs for soil and water using residential and industrial scenarios. The chemical PRG values were obtained from EPA's Region 9 and were derived using ingestion, inhalation of particles,

inhalation of volatiles, and dermal absorption exposure pathways for soil and water. This methodology calculated a soil or water concentration using generic exposure parameters and a risk of 10^{-6} (for carcinogens) or a hazard quotient (HQ) of 0.1 (for noncarcinogens), whichever is the most conservative. The results of this assessment of the soil data are reported below in the risk analysis section.

As indicated above, analyses for PCBs, VOCs, SVOCs, and metals were performed for nine surface soil samples collected in November 2000 in preparation for CROET's proposed lease of the building. A total of 35 PCB results were reported with six results detected for two different PCBs. The maximum concentrations of the PCB results were from 78.3 μg/kg to 89.6 μg/kg. These concentrations are below their respective residential PRGs. A total of 204 VOC results were reported with four results detected. The concentrations of the VOC results were for tetrachloroethylene and toluene with the maximum concentrations of 0.89 μg/kg and 0.85 μg/kg, respectively. These concentrations are below the residential PRG.

A total of 320 SVOC results were reported with 30 results detected for 13 individual compounds. The maximum concentrations of the SVOC results ranged from 34 μg/kg to 4430 μg/kg. Seven compounds were identified to be chemicals of potential concern (COPCs): 2-methylnaphthalene, benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*a*)fluoranthene, benzo(*g,h,i*)perylene, indeno(1,2,3-*cd*)pyrene, and phenanthrene. These constituents were analyzed further in the SHHRA.

A total of 92 metals results were reported with 75 results detected. Only nickel was above the residential PRG and background criteria and listed as a COPC. Nickel was analyzed further in the SHHRA.

6.2.2.2 Radiological soil sampling

A total of 11 surface samples were taken from the grassy area surrounding Bldg. K-1400 for radionuclide analysis. All samples were analyzed for isotopic uranium ($^{233/234}$U, ^{235}U, and ^{238}U), isotopic thorium (^{228}Th, ^{230}Th, and ^{232}Th), ^{99}Tc, total activity, and gamma spectrometry, referred to as the base analysis. In addition, a single sample was selected for further analyses, i.e., transuranic (TRU) [isotopic plutonium (^{238}Pu and $^{239/240}$Pu), ^{237}Np, ^{241}Am, and total radioactive strontium].

Cobalt-60 and ^{238}U were the only radionuclides found to be above the residential PRG and background criteria. They were analyzed further in the SHHRA.

6.2.2.3 Risk analysis

An SHHRA has been conducted on the soil data collected from the K-1400 area in 2000. The results were reported in *Screening-Level Human Health Risk Assessment for Building K-1400 and Adjacent Areas at the East Tennessee Technology Park, Oak Ridge, Tennessee*, BJC/OR-882, in February 2001 (BJC 2001b). The report states that 10 COPCs, 2 radionuclides, and 8 non-radiological chemicals were identified above their respective PRGs. The estimated risk values were determined for these chemicals for an industrial office worker located at Bldg. K-1400 and found to be 5.4×10^{-6}, which is within EPA's target range of 10^{-6} to 10^{-4}. This indicates the site is safe for industrial use (as long as groundwater is not used) in accordance with EPA guidance. Even though nickel, ^{60}Co, and ^{238}U were above residential PRGs and background, when the concentrations are modeled using an industrial exposure, the resulting risks/hazards are within acceptable limits.

6.2.3 Groundwater

Groundwater samples from a monitoring well (UNP-001) in the unconsolidated zone located 200 ft to the southeast of K-1400 have been collected since 1995. A contaminated groundwater plume extends

from the southeast to the northwest under the K-1400 building (see Fig. 4.1). At this time it is believed that the contamination originates from the K-1070-C/D Burial Ground and connects with the K-1401 Acid Line plume. TCE and tetrachloroethene were above their residential PRGs. Future cleanup activities at ETTP will consider the plume.

6.3 RADIOLOGICAL SURVEYS

Radiological surveys were performed (January 9 to 21, 2003) to assess the radiological condition of K-1400. Surveys were conducted on the interior and exterior surfaces of K-1400, the building contents, and exterior sidewalk. This section presents and discusses the current radiological survey data that have been collected and reported in ETTP/PEM-0225, *Radiological Survey Report for the Transfer of the K-1400 Building at the East Tennessee Technology Park, Oak Ridge, Tennessee, to the Community Reuse Organization of East Tennessee* (BJC 2003a). A discussion of the historical survey data is presented (Sect. 6.3.1), followed by a discussion of the current survey plan, results, and quality assurance/quality control (QA/QC) of the data (Sect. 6.3.2). The final subsection (Sect. 6.3.3) presents a summary of the data review and results of the statistical analysis of the survey data set for the area.

Process history of the ETTP site indicates that uranium (whether natural, depleted, or enriched) would be the most prominent radiological contaminant potentially present in the K-1400 building due to tracking of contamination from other on-site buildings. Uranium-235 enrichment levels expected from operations since the early 1960s would be anticipated to range between 0.2 to 5.0%. Most facilities potentially would be contaminated via track-in and have enrichments of less than 3%.[7] However, because this has been an administrative building throughout its history, it is assumed that the uranium would be from natural sources and that the enrichment is approximately that of natural uranium, 0.72%.

Other radionuclides (^{60}Co, ^{137}Cs, $^{89/90}$Sr, ^{237}Np, ^{99}Tc, and $^{238/239/240}$Pu) also have been detected on-site at ETTP. These other radionuclides originated from the introduction of contaminated materials from the Oak Ridge National Laboratory or from the Hanford and Savannah River reactor returns uranium reprocessing program; however, these radionuclides are expected to be found in much lower quantities than uranium and undetectable in this area, based upon its operational history as an administrative facility. If they were present, it is assumed that they would exist at ratios of 1140:1 for uranium to transuranic (U:TRU) and 350:1 for uranium to technetium-99 (U:^{99}Tc) [both ratios are process buildings' weighted averages] (SAIC 1999).

6.3.1 Historical Surveys

A search of the BJC Radiation Control (RADCON) electronic survey data collected since 1996 indicated that 14 radiological surveys have been performed inside the building. A review of these surveys provided a basis for the classification of the individual survey units, and the results are provided for informational purposes only.

A survey of the floor surrounding each of the entry stairways was performed in February 1998 as a part of the project to replace the damaged floor tiles. No activity above background levels was observed. Other surveys are all related to surveys of offices of pregnant workers (Rooms 200 and 206) and the women's restrooms. No activity above background levels was detected in either office, with dose equivalency rates of 5, 10, and 6 μrem/h, respectively. The women's first-floor restroom had no removable activity detected. No total contamination readings or dose equivalency rates were taken, as the surveys primarily were concerned with removable contamination levels. The other women's restroom had no detectable total activity above background levels, with the dose equivalency rate ranging from 7 to 17 μrem/h.

[7]Contracted Health Physics Technician Training handouts, K-25, 1993.

In addition to the surveys described above, ETTP RADCON personnel performed eight additional surveys for the Reindustrialization Program in support of leasing the building (Appendix D) has a listing of historical surveys). These surveys were performed from September 25 to 29 and November 1 and 2, 2000, in accordance with the ETTP RADCON procedures (BJC 1996) and *Design of Radiological Surveys of Potential Lease Space at East Tennessee Technology Park, Oak Ridge, Tennessee* (BJC 2000). All areas were surveyed in an "as-found" condition. Incidental materials in the survey units that could be rearranged or moved to allow for survey access were moved. To meet the 20% scan survey of the rooms required by the survey plan, the field survey team selected five rooms on each floor for a 100% survey. On the first floor, Rooms 111, 104, and 121, the men's restroom, and the women's restrooms were chosen; on the second floor, Rooms 209, 218, the conference room, and both the men's and women's restrooms were chosen. Random readings were taken covering the entirety of each floor. Readings inside the building were all below the DOE contamination limits for uranium facilities. An area in Room 111-B was found to have elevated total beta-gamma readings that were approximately half of the DOE contamination limits. This elevated activity was attributed to contamination being tracked in from other areas of the site. The dose equivalent rate inside ranged from 2 to 7 μrem/h. Readings on the building's exterior were all below the DOE contamination limits for uranium facilities. The dose equivalent rate ranged from 3 to 6 μrem/h. Background, for comparison, is 7 μrem/h.[8] All readings on sidewalks, steps, and the asphalt and grassy areas around Bldg. K-1400 were below the DOE contamination limits for uranium facilities. Because the sodium iodide (NaI) walkover survey in the grassy area found no areas above twice the NaI background, no biased soil samples were taken. The dose equivalent rate ranged from 2 to 6 μrem/h.

One additional survey (survey number 20010522KA36144001) was performed (in order to provide radiological support when the asbestos tiles were removed) in the K-1400 building on May 22, 2001. Several large area wipe samples were collected. However, total measurements were only made in three locations in the first-floor hallway and one location in Room 102. No results were above the critical level [i.e., 37 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) for alpha and 406 dpm/100 cm^2 for beta-gamma] for any measurement.

6.3.2 Current Surveys

To support title transfer, a total of 20 surveys (including all associated QA/QC surveys) were conducted in the study area (Table 6.3). See Figs. 6.2 and 6.3 for the locations of the first and second floor interior survey units (ISUs) and Fig. 6.4 for the exterior survey units (ESUs). In addition (not shown on the figures), the roof was included as an ESU. These surveys were performed from January 9 to 21, 2003, in accordance with ETTP RADCON procedures (BJC 1996), the survey design documents that provide standard operating procedures for the Reindustrialization Program [*Design of Radiological Surveys of Potential Lease Space at East Tennessee Technology Park, Oak Ridge Tennessee* (BJC 2000) and/or the draft document entitled *Design of Radiological Survey and Sampling to Support Title Transfer or Lease Property on the Department of Energy Oak Ridge Reservation* (BJC 2002b); hereafter referred to as the "design documents"], and the survey plan (see Appendix D).

Table 6.3. ETTP current radiological survey numbers

20030109KA36145001	200301100020826001	200301140023053001	200301160023053001
20030109KA36145002	200301100023053001	200301142029335001	20030116KA36145001
20030109KA36155001	200301132029335001	20030114KA36145001	20030116PA01388001
20030109PA01388002	20030113KA36145001	200301150023053001	20030116PA01388002
20030109PA01388003	20030113PA01388001	200301150023053002	200301212029335001

[8]The 7 μrem/h background dose equivalent is a calculated value based on 3 years of external gamma dose readings from Environmental Monitoring Station 42.

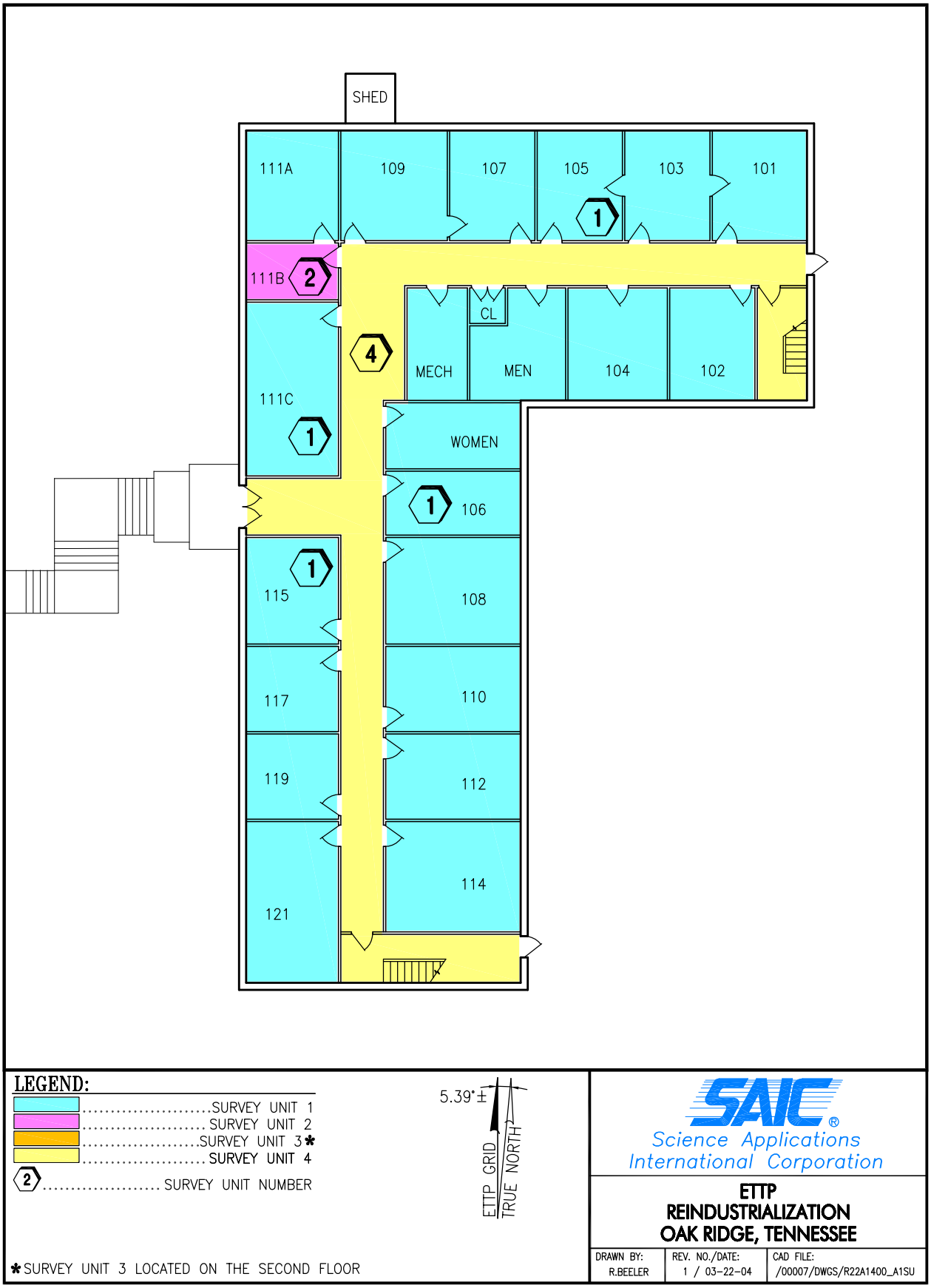


Fig. 6.2. K-1400 interior survey units for first floor.

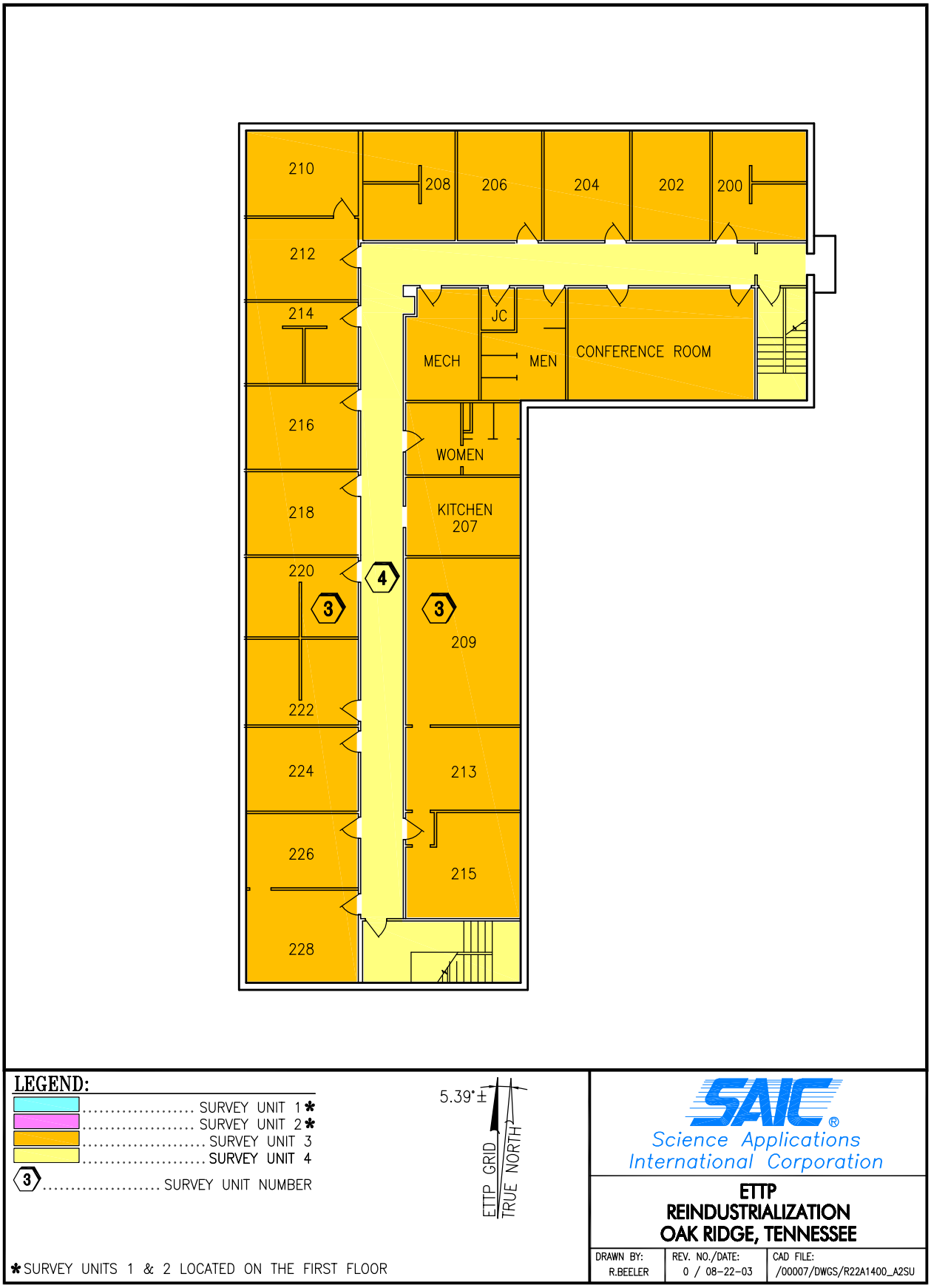


Fig. 6.3. K-1400 interior survey units for second floor.

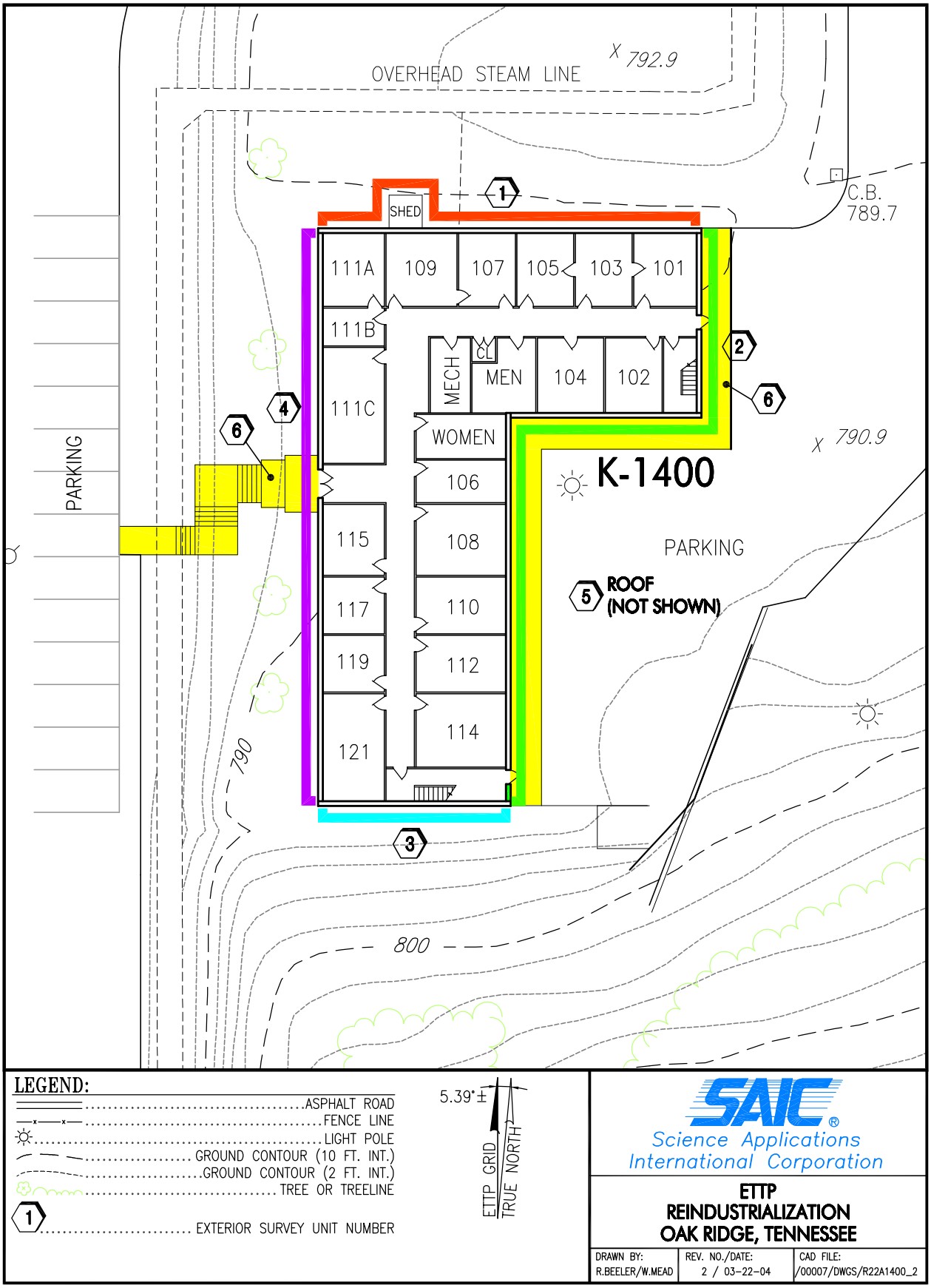


Fig. 6.4. K-1400 exterior survey units.

Radiological survey procedures and area survey units are described in the survey plan presented in Appendix D. Each area was classified as either a Class 3, 2, or 1 survey unit based upon historical data and process knowledge, as described in the design document (BJC 2000, BJC 2002b). The classification for each survey unit is discussed in the following subsections of this report.

Hand-held meter survey results were taken and compared to the following values identified in Table 6.4. These are the appropriate 10 *Code of Federal Regulations* 835 (*CFR* 1999) and DOE Order 5400.5 (DOE 1990) surface contamination gross alpha or gross beta criteria for the survey area. These values are referred to as derived concentration guideline levels (DCGLs) in the design document.

Table 6.4. Contamination limits (DCGLs) for all survey units

	DCGL (dpm/100 cm^2)	**Class 3 25% of DCGL (dpm/100 cm^2)**	**DCGL$_{EMC}$ (dpm/area)**
Total alpha	5,000	1,250	15,000
Removable alpha	1,000	250	N/A
Total beta-gamma	5,000	1,250	15,000
Removable beta-gamma	1,000	250	N/A

DCGL = derived concentration guideline level.
DCGL$_{EMC}$ = derived concentration guideline level$_{\text{elevated measurement comparison}}$.
dpm = disintegrations per minute.
N/A = not applicable.

Each survey unit dataset was first evaluated by comparing the maximum result after subtracting background to the screening level for the survey unit classification. If the net maximum survey result was less than the screening level for the specific survey unit (e.g., 25% DCGL limits for Class 3 survey units), then the unit was said to pass [i.e., the null hypothesis, (H_o), that the residual contamination in each of the individual survey units exceeds the survey unit DCGL, was rejected]. If the net maximum result was greater than the screening level for any single reading, further readings were obtained in the 1-m^2 area in order to determine the average for the square meter. If the net average reading for the square meter was greater than the screening level for the specific survey unit, then Class 3 and 2 survey units were reclassified and resurveyed under the protocol of the new classification. If the net maximum result was greater than the DCGL for Class 1 units, the non-parametrical statistical Sign test was used to evaluate the data, as outlined in the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM).

6.3.2.1 Interior survey units

All ISUs of the K-1400 building were classified as Class 3 survey units except for Room 111B, which was classified as Class 2 (based on previous surveys). The survey grid used for Room 111B is shown in Fig. 6.5. Per the design document, Class 3 survey units have an upper limit of 25% of the DCGL (i.e., 1250 dpm/100 cm^2 alpha or beta activity). The Class 3 survey criteria for ISUs were the following: 10% scan of the primary traffic areas and work surfaces with floor monitors and hand-held meters (including use of a floor monitor probe set up as a hand-held probe and calibrated to detect alpha and beta-gamma contamination for large area scans of non-floor surfaces), as appropriate; any location on the walls or ceiling that, using professional judgment, potentially could have residual radioactivity present was to be scanned over the suspected area and documented; no removal of suspended ceiling tiles or floor panels was required for this survey. Eleven measurements of total and removable contamination, at a minimum, were recorded within each survey unit at locations determined during the scan survey to have the highest activity; a general dose rate walkover survey of each survey

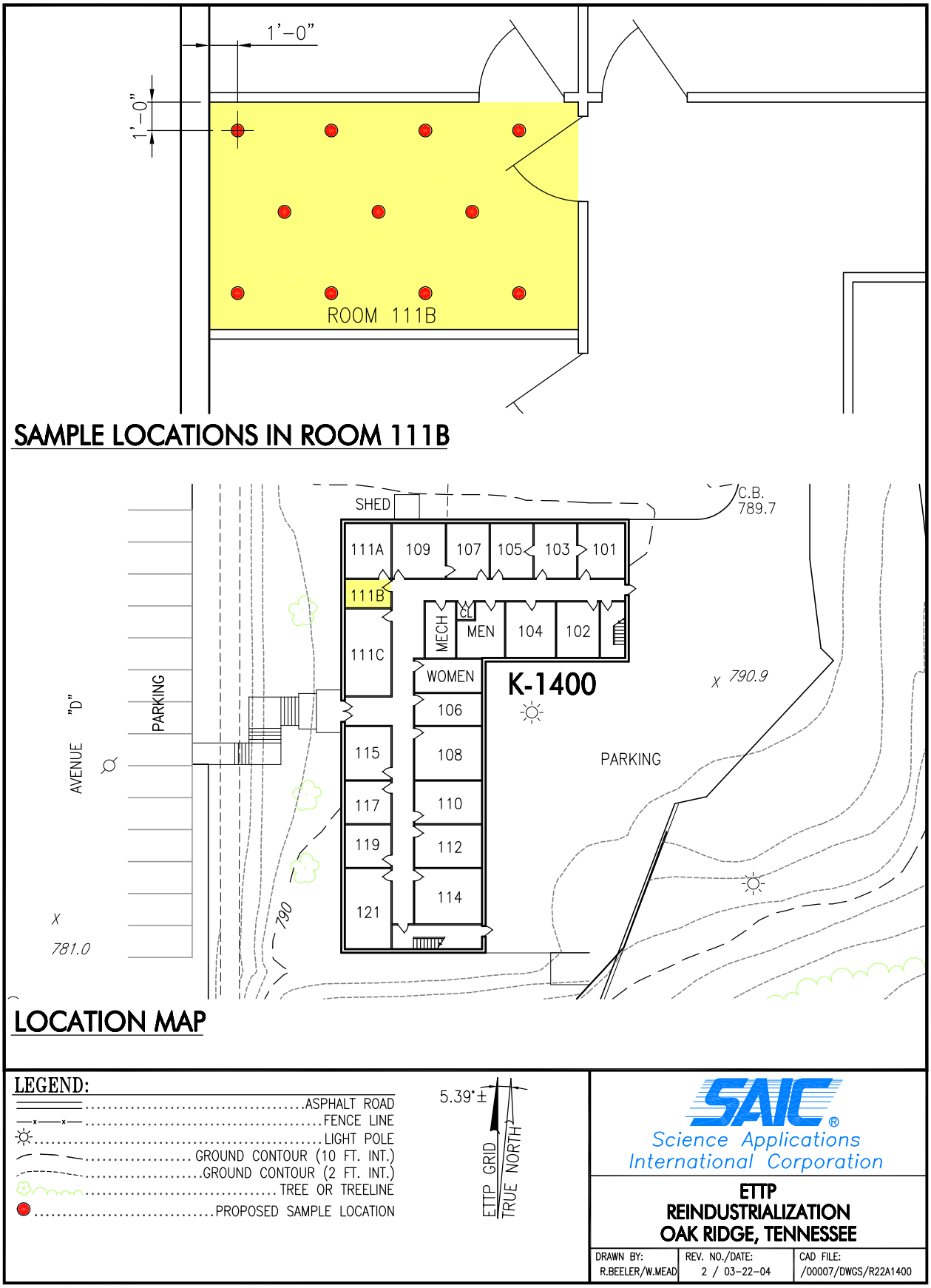


Fig. 6.5. Survey grid for Room 111B, Bldg. K-1400.

unit, using a Bicron MicroRem® meter,[9] was performed to determine if any variations exist in the penetrating radiation dose rate; and dose rate measurements were obtained at a minimum of every 20 ft in hallways and large rooms. Several of the survey units have more than the minimum number of data points (11); the critical value for the Sign test was determined using the actual number of data points for each survey unit and an alpha error (Type I error) of 0.05.

All of the ISUs had results below 25% of the DCGL. Therefore, all results were less than the screening level for Class 3 areas (as well as Class 2). Since all results were less than the screening level for Class 3 units, no further statistical analysis was performed. From an inspection of the individual surveys, including QA/QC surveys, all total activities were less than 118 dpm/100 cm^2 total alpha and 1040 dpm/100 cm^2 total beta-gamma, with all removable contamination results less than 6 dpm/100 cm^2 removable alpha and 64 dpm/100 cm^2 removable beta-gamma. The maximum tissue-equivalent dose rate was 7 μrem/h (microrem/h). See Table 6.4 for the summary of the survey results for all ISUs.

6.3.2.2 Exterior survey units

All exterior areas were initially classified as Class 3 ESUs and surveyed up to a minimum height of 8 ft with hand-held meters or with a gas-proportional probe, with an emphasis on air intakes and vents, windowsills, gutter downspouts, and any other area that the survey technician's professional judgment would indicate a higher probability of finding elevated readings. The building exterior walls and roof were included in the survey plan. In addition, the sprinkler shed located on the north wall was included in the north wall survey unit. All Class 3 ESUs were scan surveyed over a minimum of 10% of the accessible area, with 11 measurements of total and removable activity taken (alpha and beta-gamma) at locations having the highest activities, as determined during the scan survey. Tissue-equivalent dose rates were required per the survey plan every 20 ft. As with the ISUs, several of the survey units have more than the minimum number of data points (11); the critical value for the Sign test was determined using the actual number of data points for each survey unit and an alpha error (Type I error) of 0.05.

Most beta-gamma readings taken on the exterior of the building were less than 1250 dpm/100 cm^2 total activity. However, there was one location that had a total beta-gamma activity that slightly exceeded 1250 dpm/100 cm^2. The highest result obtained was 1254 dpm/100 cm^2. This measurement was made on painted brick at the edge of a window. This value is less than the screening level established in the survey plan for brick. Therefore, it is considered to be due to the naturally occurring radionuclides found in the brick, which was not accounted for by the subtraction of the ambient background. Because all results were less than the screening level for Class 3, no further statistical analysis was performed. No areas needed to be upgraded from Class 3 to Class 2. From an inspection of the individual surveys, including QA/QC surveys, all total activities were less than 166 dpm/100 cm^2 total alpha and 1254 dpm/100 cm^2 total beta-gamma, with all removable contamination results less than 6 dpm/100 cm^2 removable alpha (from a QA/QC measurement) and 64 dpm/100 cm^2 removable beta-gamma. The maximum tissue-equivalent dose rate was 8 μrem/h. See Table 6.5 for the summary of the survey results for all ESUs.

6.3.2.3 Furnishings survey units

All furnishings survey units (FSUs) were classified as either Class 3 or Class 2, based upon their as-found condition, process knowledge, and historical data, if available. Furnishings are defined as any item typical of an office, such as desks, chairs, tables, bookcases, or trash cans. Class 3 FSUs consist of the newer furnishings and were scanned over 10% of all accessible areas, with a maximum surface area not to

[9]Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof.

Table 6.5. Summary of contamination and dose rates

Location	Alpha total[a]		Alpha removable[a]		Beta-gamma total[a]		Beta-gamma removable[a]		Dose equivalent rate (mrem/h)
	Min	Max	Min	Max	Min	Max	Min	Max	
Interior survey units									
ISU 1 – First floor	< -14.7	73.5	< -2.69	< 2.69	< -183.48	1039.72	< -58.17	< 0	.005–.007
ISU 2 – Room 111B	< 29.4	117.6	< -2.69	< 2.69	< 0	703.34	< -60.94	< 13.85	.004
ISU 3 – Second floor	< -14.7	117.6	< -2.69	< 2.69	< -244.64	886.82	< -44.32	< 19.39	.004–.007
ISU 4 – Stairs and hall	< 0	117.6	< -8.07	< 0	< -672.76	550.44	< -22.16	< 44.32	.004–.006
Exterior survey units									
ESU 1 – East wall	< 0	74	< -2.69	5	< 336.38	1254	< -27.7	< 27.7	.003–.005
ESU 2 – South wall	< 0	44	< -2.69	< 2.69	< 0	734	< -22.16	< 19.39	.004–.006
ESU 3 – West wall	< -14.7	44.1	< -2.69	< 2.69	< -489.28	< 122.32	< -30.47	< 24.93	.005–.008
ESU 4 – North wall	< -14.7	< 14.7	< -2.69	< 2.69	< -703.34	< 366.96	< -44.32	63.71	.003–.007
ESU 5 – Roof	< -15.1	166	< -2.69	< 2.69	< -252.72	1106	< -33.24	< 5.54	.004–.006
ESU 6 – Sidewalks	< 0	74	< -2.69	< 6	< 0	734	< -55.4	< 8.31	.004–.007
Furnishings survey units – Class 3									
FSU 2	< -14.7	58.8	< -2.69	< 0	< -152.9	642.18	< -27.7	66.48	NR
Furnishings survey units – Class 2									
FSU 3	< 0	< 29.4	< -2.69	< 2.69	< -214.06	< 336.38	< -36.01	< 16.62	NR
FSU 4	< 0	832	< -5.38	< 0	< -294.72	3537	< -36.01	< 16.62	NR
DOE limits	5000		1000		5000		1000		20

Notes: [a]All readings are in units of disintegrations per minute (dpm)/100 cm^2.
A "<" preceding a value indicates that the result cannot be distinguished from background at the 95% confidence level.
This table does not include results from quality assurance/quality control surveys.
DOE = U. S. Department of Energy.
ESU = exterior survey unit.
FSU = furnishings survey unit.
ISU = interior survey unit.
NR = no reading (was taken in accordance with the survey plan).

exceed 5000 m^2. Class 2 FSUs consist of the older furnishings and were scan surveyed over 10% of their accessible surfaces, with a maximum FSU area of 1000 m^2. Because of the low number of Class 3 furnishings, all Class 3 furnishings on the first and second floors were combined into one Class 3 FSU. A minimum of 11 data points were collected from each FSU at the areas of the highest activity, as determined during the scan survey.

The Class 3 FSUs had no results above 25% of the DCGL. A green trash can was found in one of the Class 2 FSUs that had total beta/gamma greater than 25% of the DCGL but less than the DCGL. All other measurements made in the Class 2 FSUs were less than 25% of the DCGL. Since all results were less than the screening level for Class 3 or Class 2 units, no further statistical analysis was performed. Activities were less than 832 dpm/100 cm^2 total alpha and 3537 dpm/100 cm^2 total beta-gamma, with all removable contamination results less than 3 dpm/100 cm^2 removable alpha and 67 dpm/100 cm^2 removable beta-gamma. See Table 6.5 for the summary of the survey results for all FSUs.

6.3.2.4 Quality assurance/quality control surveys

A 5% verification survey of the data gathered from each survey unit was performed for QA/QC purposes. All QA/QC survey data gathered were in agreement with the initial survey unit data within the uncertainty of the measurements.

6.3.3 Survey Data Review and Analysis

All of these survey data were reviewed by a health physicist reviewed all survey data prior to use in this report. The health physicist confirmed all surveys were conducted in accordance with the survey plan (correct number of survey units, data points per survey unit, instrumentation data, QA/QC survey performed, etc.).

Results of the surveys and the statistical test performed on the data gathered in each survey unit indicate that the interior, exterior, and present furnishings are below the DOE surface contamination limits and within the acceptable dose equivalent rate range for building surfaces. The null hypothesis was rejected for each survey unit based upon the non-parametrical statistical Sign test. Therefore, the alternative hypothesis (H_a) was accepted, which states that the residual radioactivity in each of the survey units does not exceed the DCGL and, therefore, can be released without radiological restrictions.

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Attachment 1

Comments and Responses for the K-1400 Environmental Baseline Survey and Risk Screen Reports to Support Transfer of K-1400

EBS Comments Received May 2003

Note: The comments received from the U. S. Environmental Protection Agency (EPA), Region 4, in May 2003 were made after reviews of the K-1007 and K-1330 Environmental Baseline Surveys (EBSs) and Risk Screens and the Supplement to the Parcel ED-5 East Baseline Environmental Analysis Report. These documents were considered to be representative documents for title transfers at the East Tennessee Technology Park (ETTP). The comments are considered to be general guidance; therefore, the general comments below have been applied to the K-1400 EBS and Risk Screen.

Numerous comments were made regarding the level of detail and information to be included in EBS reports for properties proposed for title transfer. Additional information in response to these comments appears throughout the EBS, including the Executive Summary and Chaps. 2, 3, 4, and 5. The comments included the following:

- Include a conclusion section noting any land use restrictions, recommending future actions, and showing any regulator comments and their responses.

- Include a regulatory summary in Chap. 3 indicating if the records showed any tanks, etc., permit violations, etc.

- Include information from the section about past and present activities (Sect. 4.1) in the Title Search section as well. Describe how the search was conducted. Describe the past use (land use) of the site.

- Include information on the past use of the property and the regulatory environment in Sect. 3.1. For example, note that the past use of the property was agricultural prior to acquisition by the U. S. Government. For the regulatory environment, note that from its initial use in 1943 until the 1980s, activities on the property occurred under DOE authority and were not subject to external regulation.

- Note, in Chap. 1, if interviews were conducted. If none were conducted then explain why.

- In Chap. 5, discuss not only the presence but also the absence (based on record reviews, etc.) of items such as asbestos, lead paint, and asbestos-containing material (ACM). Note the condition of these items. Especially note the presence of friable asbestos and known polychlorinated biphenyl (PCB) items.

- Include maps that show the locations of groundwater monitoring wells, with the wells labeled.

- Revise Chap. 6 to note that risks were within the acceptable range.

The EPA questioned whether the U. S. Department of Energy's (DOE's) Reindustrialization activities were considered in the Land Use Control Implementation Plan (LUCIP). The LUCIP is a plan regarding how workers will be protected (e.g., deed restrictions) from residual contamination under the Land Use Control Assurance Plan. The LUCIP was developed by Environmental Management (EM) and the responsibility for implementation rests with EM. DOE's Office of Legacy Management has the mission to manage the Department's post-closure responsibilities and ensure the future protection of human health and the environment (see http://www.lm.doe.gov/).

Updating information about vapor intrusion issues was requested. Section 4.4 has been added to describe: (1) how vapor intrusion issues are being addressed, and (2) the activities planned to provide protectiveness related to vapor intrusion prior to implementation of the sitewide groundwater Record of Decision. Also, a section has been added to Chap. 6 to provide results for winter and summer (sub-slab) soil vapor sampling events.

Risk Comments Received May 2003

There was a question about the explanation in Chap. 6 of the Risk Screen, about the meaning of the risk estimates (e.g., 1×10^{-x}), and requests that the calculated cancer risk be explained so that it is clear that it represents the probability of excess individual cancer risk. Rather than indicate that 1 person in a population of 10^{x} will get cancer, it should be stated that risk values estimate the probability of an excess cancer for an individual with the exposure parameter selected (i.e., each roving worker would have an individual excess cancer risk of 1×10^{-x}). In addition, a comment was received about comparing a facility's contamination and resulting dose against the *total* radiation dose from all sources, as the 360 mrem/year dose includes all sources, both an individual's medical, home, and work exposure as well as other radionuclides not part of ETTP. In both cases the text was revised.

A comment was made that Chap. 6 should include a table that summarizes the contaminants of potential concern (COPCs) for the site. Text was added in the appropriate section (Chap. 5 of this iteration of the report) to refer the reader to Table A.3 in Appendix A.

EBS Comments Received January 2004

The following comments specific to the K-1400 EBS were made and are addressed as indicated.

Several comments were made about Fig. 4.1 and Table 4.2 in Chap. 4. Clarification was requested about the direction of groundwater flow as shown in Fig. 4.1 and discussed in related text on p. 4-4. The text reviewed stated that groundwater flow is to the west toward the K-1401 building, but Fig. 4.1 indicated groundwater flow towards the north. In the final EBS the figure and text have been revised to indicate that the groundwater flow is to the west in the immediate vicinity of K-1400 and then turns north. Another comment asked whether two springs shown in Fig. 4.1 (Nos. 26-005 and 26-010) have been sampled and requested sampling results. Sampling results for Spring 26-005 have been added to the table. Spring 26-010 is a wet area only during high-water conditions and, therefore, is not considered to be an important factor associated with K-1400. There was also a question about whether recent data were available for well UNP-001because data from 1990 to 1998 only were reported in Table 4.2. The well was sampled in January 2004 as part of a recent sampling, and the data from that sampling event have been included in Table 4.2 in the final EBS.

Finally, a comment was made that vapor intrusion language should be added to the document. In the final EBS, information about vapor intrusion issues is presented in Sect. 4.4, and results from a winter soil vapor sampling event (conducted in October 2003 for Bldg. K-1400) are reported in Chap. 6.

November Core Team Meeting Comments

Verbal comments were received from regulators at a November 11, 2004, meeting of the U. S. Department of Energy (DOE), EPA Region 4, and the Tennessee Department of Environment and Conservation. Only comments that apply to K-1400 are addressed here.

EPA commented that the Reindustrialization Program needs to match whatever the Environmental Management Program uses for "site reference levels." Section A.4 and Table A.1 of Appendix A to the Risk Screen report for K-1400 provide revised information about background at the East Tennessee Technology Park in response to this comment.

In response to another question, it was also agreed that the review of potential areas of contamination would not be limited to those listed in Appendix C of the Federal Facility Agreement and that DOE would consult with those involved with the Dynamic Verification Stragegy (DVS) team to determine whether additional areas need to be considered as well. The DVS team has been consulted. No additional areas have been found to require consideration for K-1400.

EPA requested a new restriction regarding prohibition of tampering with monitoring wells or other remediation activities or features. For K-1400, DOE responded to this comment by incorporating language in the Quitclaim Deed and Covenant Deferral Request (CDR). This information was included in the CDR submitted December 15, 2004.

EBS Comment Received January 2005

A comment requested that instead of stating that the groundwater plume under K-1400 is considered to be a "release," it should be stated that it is an "ongoing possible source for contamination by vapor intrusion." During a meeting with EPA Region 4 held on August 17, 2004, DOE received instructions from EPA Counsel that a groundwater plume such as that found below K-1400 is considered a "release" and should be noted that way per 40 *CFR* 373 reporting. For this reason the text has not been changed. Should EPA wish to modify the language, based on additional considerations, DOE would be open for discussion.

APPENDIX A

REAL ESTATE LETTER

PROPOSED TRANSFER OF ETTP BUILDINGS
OAK RIDGE RESERVATION, TN

FILES RESEARCH FOR HAZARDOUS SUBSTANCE ACTIVITY

The following statement is provided in support of guidance promulgated under Section 120(h) of the Comprehensive Environmental Response, Liability, and Compensation Act, as amended (CERCLA) 42 U.S.C. 9620(h) and in support of regulations issued by the Environmental Protection Agency at 40 CFR part 373.

The undersigned has made a complete search of existing and available Department of Energy (DOE) records, documentation, and data within the real estate files relating to the property that is subject to the proposed fee transfer action of Buildings K-1007, K-1035, K-1036, K-1225, K-1330, K-1400 and K-1580 at the East Tennessee Technology Park within the Oak Ridge Reservation, Tennessee. The proposed action would result in transfer to the Community Reuse Organization of East Tennessee (CROET) under a 10 CFR 770 Proposal. The search conducted was considered reasonable with a good faith effort expended to identify whether any hazardous substances were stored for one year or more, released, or disposed of on the property. The available real estate records of this office do not reflect any determinable reference that hazardous substance activity as defined by Section 101(14) of CERCLA took place on or in the property during the time the property was owned by the United States of America.

Lands affected by this action are identified as portions of the following original acquisition tracts in which the United States of America acquired title, (having been acquired for the Atomic Energy Commission as a forerunner of the Department of Energy) by Civil Action No. 429 filed in the United States District Court for the Eastern District of Tennessee, Northern Division:

a. Buildings K-1035, K-1036, and K-1400 are located on a portion of **Tract H-719**. Title to this land was vested in the United States of America by Declaration of Taking No. 26 dated March 19, 1943. Judgment on Declaration of Taking was filed for public record on March 30, 1943 in Vol. Y-5, page 515 in the Roane County Register's Office, Tennessee.

b. Buildings K-1225, K-1330, and K-1580 are located on a portion of **Tract H-720**; and Building K-1007 is located on a portion of **Tract H-731**. Title to this land was vested in the United States of America by Declaration of Taking No. 19 dated February 8, 1943. Judgment on Declaration of Taking was filed for public record on February 23, 1943 in Vol. Y-5, page 136 in the Roane County Register's Office, Tennessee.

This record shall be made a part of the CERCLA report currently being prepared.

Katy Kates

Katy Kates, Realty Officer
Oak Ridge Operations Office
Department of Energy
August 8, 2003

Attachment-Plat Exhibit

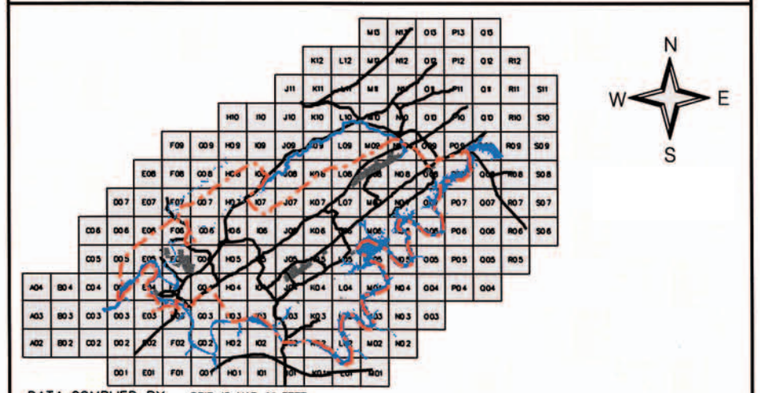
APPENDIX B

STUDY AREA MAPS FROM RECORDS SEARCH

Location of Pre–World War II Structures
and Cemeteries in or near the
East Tennessee Technology Park

LEGEND

- Pre–World War II Structures
- Cemeteries
- Buildings
- Roads
- Water Bodies
- Streams



DATA COMPLIED BY GRID IS NAD 83 FEET
ER REMOTE SENSING PROGRAM
ENVIRONMENTAL INFORMATION MANAGEMENT PROGRAM
GEOGRAPHIC INFORMATION SCIENCES AND TECHNOLOGY GROUP
ORIGINAL BY: BARGE, WAGGONER, SUMNER AND CANNON, INC.
REVISED BY: TETRA TECH, INC. 2/10/01

KMAPS ORO HISTORIC MAP GSL

APPENDIX C

SOIL VAPOR SAMPLING AND ANALYSIS PLAN FOR THE K-1400 BUILDING

BJC/OR-1555/R2
DRAFT FOR PUBLIC REVIEW

Sampling and Analysis Plan for Collection of Groundwater, Air, and Soil Vapor Samples for the K-1400 Building at the East Tennessee Technology Park, Oak Ridge, Tennessee

This document is approved for public release per review by:

12/13/2004

BJC ETTP Classification & Information Control Office — Date

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

BJC/OR-1555/R2
DRAFT FOR PUBLIC REVIEW

Sampling and Analysis Plan for Collection of Groundwater, Air, and Soil Vapor Samples for the K-1400 Building at the East Tennessee Technology Park, Oak Ridge, Tennessee

Date Issued—April 2004

Prepared for the
U. S. Department of Energy
Assets Utilization

BECHTEL JACOBS COMPANY LLC
managing the
Environmental Management Activities at the
East Tennessee Technology Park
Y-12 National Security Complex Oak Ridge National Laboratory
Paducah Gaseous Diffusion Plant Portsmouth Gaseous Diffusion Plant
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ACRONYMS

COPC	chemical of potential concern
CROET	Community Reuse Organization of East Tennessee
DOE	U. S. Department of Energy
ELCR	excess lifetime cancer risk
EPA	U. S. Environmental Protection Agency
ETTP	East Tennessee Technology Park
FFA	Federal Facility Agreement
PCE	tetrachloroethene
PRG	preliminary remediation goal
PSS	Park Shift Superintendent
RCRA	Resource Conservation and Recovery Act of 1976
SAP	Sampling and Analysis Plan
SD	storm drain
SOP	standard operating procedure
SSC	sampling subcontractor
SWMU	solid waste management unit
TCA	trichloroethane
TCE	trichloroethene
TWA	time-weighted average
VOC	volatile organic compound

1. INTRODUCTION

This Sampling and Analysis Plan (SAP) describes sampling efforts to be undertaken in order to determine whether subsurface contamination from volatile organic compounds (VOCs) has resulted in organic vapors entering the K-1400 building. This plan was developed as part of an effort to address concerns raised by U. S. Environmental Protection Agency (EPA) Region 4 regarding the potential for vapor intrusion of VOCs from shallow groundwater into buildings at the East Tennessee Technology Park (ETTP) that are proposed for transfer.

The K-1400 building was built in 1953 and has always been used for office space. Initially, K-1400 was the Maintenance Office Building. From the early 1970s to the mid-1980s, it was the Engineering Office Building. It served as the Accounting/Auditing Building for a few years in the late 1980s, and the Waste Management Division occupied the building from the early 1990s until it was leased to the Community Reuse Organization of East Tennessee (CROET) in 2001 as part of the Reindustrialization Program. Historical use of the facility has been for administrative office use only. There have been no industrial activities conducted within the building since its construction in 1953.

This SAP presents the rationale and details of air sampling to be conducted in the ETTP K-1400 building. These sampling activities are being conducted to determine the VOC concentrations that might be present in a building above the VOC plume known to exist at ETTP. The VOCs selected for analysis are those present in the water contained in the groundwater beneath, or in close proximity to, the building. The data will be used to determine the potential for vapor intrusion into the building.

Although industrial activities have not occurred within the K-1400 building, nearby operations have included industrial activities and have resulted in groundwater contamination beneath the facility. These facilities and contaminant plumes are discussed below.

2. OPERATIONS CONDUCTED WITHIN PROXIMITY OF THE K-1400 BUILDING

The K-1400 study area is located within the perimeter fence of ETTP. The nearest non-U. S. Department of Energy (DOE) property is Blair Road/State Highway 327, located approximately 2000 ft northeast of the area. There is no indication that activities from this non-DOE area would have contributed any contamination of the study area.

Near Bldg. K-1400 is the K-1401 Maintenance Building. This building was built in 1944 to support the uranium enrichment process at ETTP. Pieces of process equipment such as motors, converters, and compressors were brought into the facility to be cleaned and repaired. The building contained drill presses, lathes, and milling machines, as well as weld shops, a sheet metal shop, degreasers, acid baths, and a carpenter's shop. After the shutdown of the enrichment process in 1986, most of this equipment and large portions of the building were idle. In the 1990s, this equipment was decontaminated and removed. Portions of the building have been leased to CROET. Currently, there are four private-sector companies operating in the building as well as Bechtel Jacobs Company LLC (BJC) personnel who support site activities.

Located in the vicinity of Bldg. K-1400 is K-1501-A, a 600,000-gal tank for the storage of fuel oil for the steam plant. This tank (which is leased along with the K-1501 Steam Plant) is surrounded by a

concrete dike that serves as secondary containment. There have been no known leaks from this tank. Also near Bldg. K-1400 is the former location of the K-1404-A Acid Storage Tank, K-1404-B Degreaser Solvent Storage Tank, and K-1404 Acid Storage Building (the building was removed in 2000 as part of a surveillance and maintenance action and the tanks in 2002). Hydrochloric acid was brought in by rail to the acid storage building and pumped into the K-1404-A storage tank. The fiberglass tank had a capacity of 10,000 gals and was surrounded by an earthen dike. The acid was used in the acid baths in K-1401 until 1987. The tank was emptied in December 1992. Near the site of Bldg. K-1404 is the former location of the K-1404-B Degreaser Solvent Storage Tank. This was a 5000-gal steel tank surrounded by a concrete pit. It was used to store trichloroethane for the degreasers in Bldg. K-1401 until it was emptied in February 1992.

Several nearby facilities have potential areas of contamination that are in close proximity to Bldg. K-1400. These areas are listed as potential environmental restoration units in *Site Descriptions of the Environmental Restoration Units at the Oak Ridge K-25 Site, Oak Ridge, Tennessee* (Energy Systems 1995). This report was prepared to "baseline" conditions (at the time of the evaluation), so that decisions could be made to establish cleanup priorities. Some of these areas are being addressed for possible remediation under the ORR Federal Facility Agreement (FFA; DOE 1992). [The FFA is an agreement between DOE, EPA, and the state of Tennessee to integrate the requirements of RCRA corrective actions and Comprehensive Environmental Response, Compensation, and Liability Act of 1980 remedial investigations at specific sites within the ORR. The specific facilities to which the FFA applies are listed in Appendix C of the FFA.] There are a number of these areas in the vicinity of K-1400.

Four of the units are associated with the K-1401 building. These are:

- The K-1401 Acid Line runs underground, along the east side of Bldg. K-1401, and was used to transfer corrosive solutions from K-1401 to the K-1407-A Neutralization Facility. The lines were taken out of service in 1987. Waste streams that were transported through this line include degreasers, caustics, and acids used to clean equipment contaminated with uranium hexafluoride (UF_6). Known leaks occurred in 1975, 1982, and 1987. In 1990, mercury was found in a portion of the cast-iron drain line in the north-end basement. The spilled mercury was cleaned up the same day. The acid line is listed in Appendix C of the FFA and as a Solid Waste Management Unit (SWMU) under RCRA.

- The K-1401 degreasers (four each, 10 ft by 50 ft) are located inside Bldg. K-1401 and were used, beginning in 1944, to degrease parts associated with the process. Acids, alkalis, detergents, and organic vapor degreasers have been used in this process. Hydrochloric acid and trichloroethene (TCE) were both stored in tanks outside the building (10,000-gal fiberglass and 10,000-gal steel, respectively). The only identified releases were through the K-1401 acid lines. The degreasers are listed in Appendix C of the FFA and as a SWMU under RCRA.

- The K-1401-N Converter Retubing Area was added in the 1970s to support the cascade improvement program (a site process used in the enrichment of uranium). Facilities were provided to install, test, and assemble barriers in process converters. Three tanks of potassium hydroxide were used in scrubbing process gases. Mixed chemical and radioactive contaminants were released through a series of process drains associated with the acid line. These areas will be investigated according to schedules in the FFA.

- The K-1401-NB Basement Area was operated from 1944 to 1987. Process equipment in this area originally supported the converter conditioning activities on the first floor of the building. Internal building surfaces and equipment are contaminated. The basement is listed in Appendix C of the FFA.

In 1998, basement sumps were rerouted to the Central Neutralization Facility as part of a CERCLA time-critical removal action (DOE 1998).

The K-1400 Plume is a local area of groundwater contamination near K-1400 that is defined by well UNP-001 and a seep springs 26-005, located on the north side of the K-1070-C/D Burial Ground (see Fig. 2.1). It has been suspected that a portion of the storm drain network (SD-180) in the vicinity of K-1400, which is designated as a French drain on some ETTP drawings, served to collect contaminated groundwater present in the K-1400 area. The groundwater well immediately downgradient of K-1070-C/D, between the burial ground and K-1400, is UNP-001. The plume extends from the east side of K-1400, under the building, to the west side of the building and commingles with the K-1401 Plume located under the K-1401 building. Groundwater contamination from the K-1070-C/D facility appears to be the major contributor to VOC contamination below and near the K-1400 building. The VOCs that have been detected above a federal drinking water maximum contaminant level in the vicinity of Bldg. K-1400 include 1,2-dichloroethene, methylene chloride, tetrachloroethene (PCE), TCE, and vinyl chloride. It also appears from the data that concentrations of TCE in groundwater in the vicinity of K-1400 have declined significantly over recent years (e.g., 1900 μg/L in 1990 down to 23 μg/L in 1998).

3. EXISTING/HISTORICAL DATA

Surface soil sampling was conducted in November 2000 in the immediate vicinity of K-1400 prior to the leasing of the building to CROET. Nine individual surface soil (i.e., 0 to 6 in. from the soil surface) grab samples were collected and analyzed for polychlorinated biphenyls, VOCs, semivolatile organic compounds, and metals to provide data to support a baseline environmental analysis (BJC 2001a) and screening-level human health risk assessment (BJC 2001b). Soil gas sampling for VOCs has not been previously conducted within or near the K-1400 building.

As previously discussed, groundwater sampling of the plume near and beneath the K-1400 building has been conducted. The contaminated groundwater plume extends from the southeast to the northwest under the K-1400 building. At this time it is believed that the contamination originates from the K-1070-C/D Burial Ground and connects with the K-1401 Acid Line plume. Maximum concentrations of VOCs range from 1 to 1100 μg/L. TCE and PCE were above their residential preliminary remediation goals (PRGs) in the groundwater.

4. SCOPE

The overall scope of this SAP is to determine airborne VOC concentrations in the K-1400 building and sub-grade using EPA-approved methods with detection limits that are sufficient to meet risk assessment needs in order to evaluate the vapor intrusion pathway. In addition, to assess a potential change in site conditions, an upgradient groundwater monitoring well will be sampled.

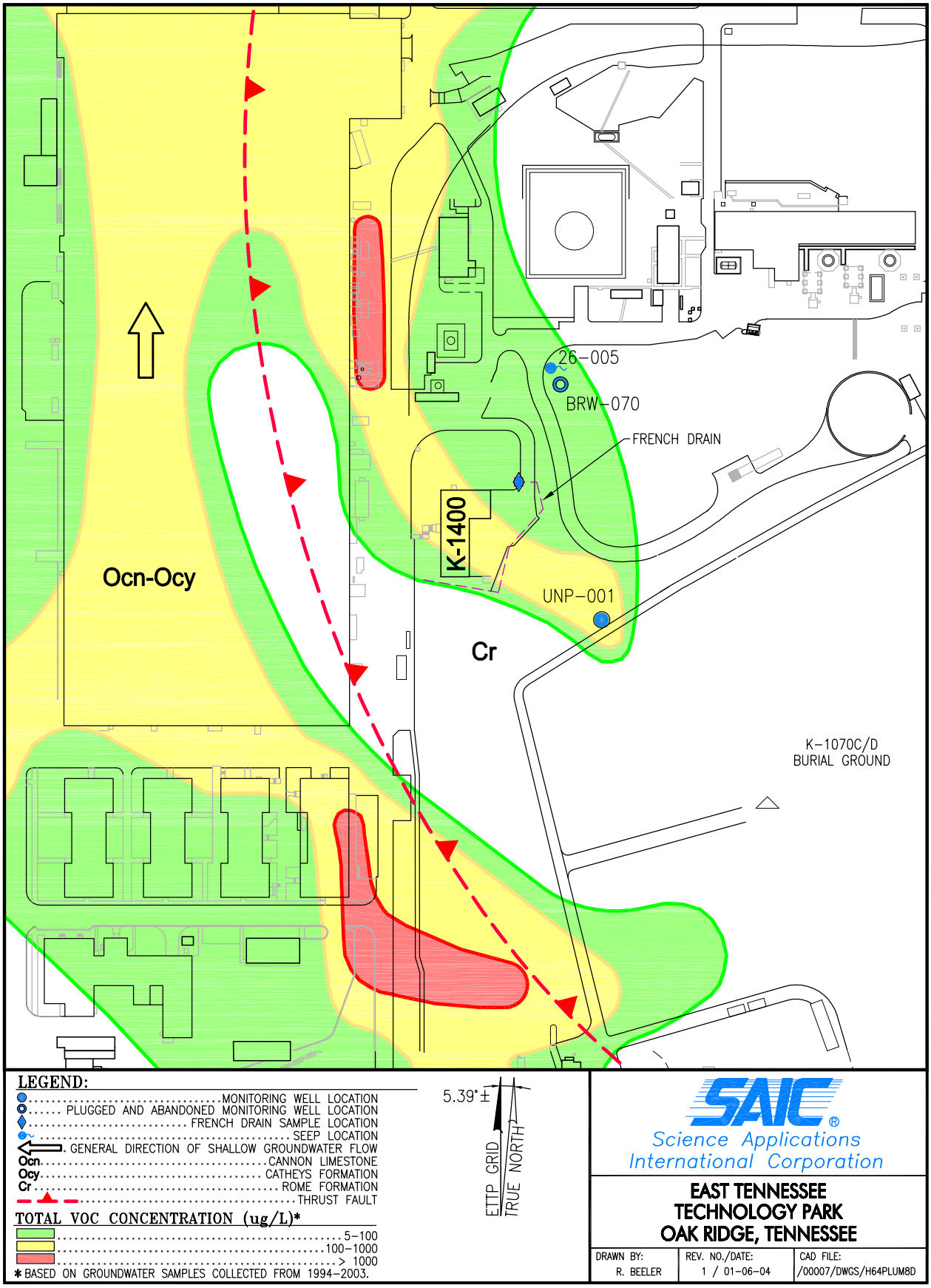

Fig. 2.1. Groundwater VOC concentrations in the vicinity of K-1400.

5. OBJECTIVES AND RATIONALE

5.1 SAMPLING OBJECTIVES

EPA recently issued *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway From Groundwater and Soils* (EPA 2002).[1] The draft guidance provides a tiered approach to determine if the vapor intrusion pathway is complete and if any exposures that occur present unacceptable risks. The three tiers in the evaluation approach are:

- Tier 1 – Primary Screening, designed to be used with general knowledge of a site and the chemicals known or reasonably suspected to be present in the subsurface;

- Tier 2 – Secondary Screening, designed to be used with some limited site-specific information about the contamination source and subsurface conditions; and

- Tier 3 – Site-Specific Pathway Assessment, which involves collecting more detailed, site-specific information and conducting confirmatory sub-slab and/or indoor air sampling.

The first tier is intended to provide a rapid screening of whether the vapor intrusion pathway is potentially complete at the site. In the Tier 1 evaluation, the user determines whether chemicals of sufficient volatility and toxicity are present in the vadose zone or groundwater at the site and if receptor locations are sufficiently close (~100 ft from the source) to present an exposure potential. If these criteria are met, the user subsequently evaluates whether conditions exist that warrant immediate action to verify whether the pathway presents unacceptable risks and, if necessary, eliminate those risks. Conditions that may warrant immediate action to verify or eliminate risks from the vapor intrusion pathway include odors within buildings, wet basements where VOCs are present in shallow groundwater, and physiological effects reported by receptors.

The second tier provides generic screening criteria based on an excess lifetime cancer risk (ELCR) range of 10^{-6} to 10^{-4} and conservative attenuation factors. The Tier 2 evaluation is intended to allow the user to eliminate the vapor intrusion pathway, if the generic screening criteria are not exceeded. Certain site conditions make the use of the generic screening criteria inappropriate. These conditions include:

- very shallow groundwater sources at depths of less than 5 ft below foundation level, or

- relatively shallow soil or groundwater sources (at depths of less than 15 ft below the foundation) and the presence of significant openings or preferential pathways in the building to the subsurface such as sumps, unlined crawl spaces, or utility corridors.

If the generic screening criteria are exceeded or the above conditions exist, a Tier 3 evaluation is required. In the Tier 3 evaluation, the draft guidance recommends determination of sub-slab soil gas concentrations and indoor air measurements.

As previously stated, EPA Region 4 has raised concerns regarding the potential for vapor intrusion of VOCs from shallow groundwater into buildings at the ETTP that are proposed for transfer. Using the draft guidance provided by EPA Region 4 personnel, it has been determined that a few buildings at ETTP, that are proposed for the transfer, meet the Tier 1 criteria (presence of VOCs and proximity to source).

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[1]Available on the World Wide Web at http://www.epa.gov/epaoswer/hazwaste/ca/eis/vapor/complete.pdf.

Although the screening criteria specified for Tier 2 are not believed to be applicable to facilities being considered for transfer, EPA has requested that soil gas samples be collected and/or that indoor air be monitored. DOE has agreed to collect samples from K-1400 because of its proximity to a VOC-contaminated groundwater plume and because its construction is typical of many buildings being considered for transfer.

The draft guidance does not require the user to begin at Tier 1 and proceed stepwise through Tier 3. A site-specific Tier 3 assessment may be performed without previous evaluation. Additionally, the draft guidance allows the use of other technically sound approaches in evaluating the vapor intrusion pathway. Therefore, DOE is proposing to obtain a data set that provides a basis for exclusion of the vapor intrusion pathway within the K-1400 building.

Although slightly higher VOC concentrations exist in other areas of ETTP [e.g., Mitchell Branch area and K-1070-C/D (7 to 9 mg/L total VOCs)], the plume concentrations either at, or in the vicinity of, other buildings proposed for transfer do not equal the plume concentrations observed adjacent to Bldgs. K-1400 and K-1401. To determine the potential for migration into the K-1400 building, the attenuation of the VOCs by the soil column and the foundation slab will be investigated as part of this SAP.

Accordingly, the overall objective of this SAP is to obtain data from the first floor of the K-1400 building and sub-slab to determine whether VOCs are present within the building and the concentration of such contaminants below the slab foundation. These data are being gathered to assess the vapor intrusion pathway for this facility. In order to achieve this overall purpose, sampling conducted under this plan must meet the following objectives:

- airborne VOC concentrations within the normal breathing zone (2 to 5 ft above the floor) must be quantitated at levels that support risk assessment, and

- soil vapor concentrations beneath the slab foundation must be quantitated to determine the potential for migration into the facility as part of the risk assessment.

In order to achieve the first objective, the sampling and analytical protocols must provide detection limits that are below the 25-year industrial PRGs indicated in Table 5.1. Sampling and analytical protocols indicated in Chaps. 5 and 6 of this SAP have method detection limits for VOCs ranging from 0.2 to 0.5 $\mu g/m^3$.

5.2 SAMPLING DESIGN

In order to evaluate the potential for VOC intrusion into the K-1400 building, the sampling approach has been divided into three distinct sampling events. The first event requires that ambient air samples be taken from the breathing zone within the building. The second phase of this sampling plan requires acquisition of vapor samples below the slab foundation of the building. An additional phase of sampling will take place in order to determine if groundwater conditions have changed since the last sampling event.

Phase 1 – Indoor Ambient Air Sampling

Three indoor air samples will be taken at 2 to 5 ft above the floor within the building. In order to ensure the samples are indicative of VOC concentrations entering the building through the vapor phase pathway, all sampling activities will be conducted with the building heating, ventilation, and

Table 5.1. Required detection limits for VOC analytes

Chemical	Industrial PRGs, 25 years mg/m^3
Carbon tetrachloride[a]	0.02700
Chloroform[a]	0.01766
Freon 113[b]	4.38000
Tetrachloroethene[a]	0.71540
1,1,1-Trichloroethane[b]	0.14600
Trichloroethene[a]	0.23847
Vinyl chloride[a]	0.00477
1,2-Dichloroethene	NA
Acetone	NA

NA = Not available; preliminary remediation goal (PRG) could not be calculated because no U. S. Environmental Protection Agency (EPA)-approved inhalation toxicity value is available.

[a]Risk = 10^{-4}.

[b]Hazard quotient (HQ) = 0.1.

VOC = volatile organic compound.

air-conditioning systems turned off as well as with the ventilation system on. The samples collected with the air-handling units off will allow for maximum VOC concentrations in the air, whereas the collection of air samples with the air-handling unit on will be representative of a typical case scenario. All air samples shall be grab samples.

A minimum of one 8-h or 24-h, time-weighted average (TWA) ambient air sample will be collected outside of the building to exclude any potential contributions from external industrial sources. This sample station will be set up near the building at an upwind location. The location of the sampling station will be made by contacting the Park Shift Superintendent's (PSS) Office to acquire wind direction from the site meteorological station. The sampling station shall be located no more than 20 ft from the building at a location that will be minimally impacted by facility operations (i.e., high-traffic areas shall be avoided to the extent possible). The final location of this sampling station shall be determined in the field during sampling activities. Sample stations for the three indoor samples are discussed in Chap. 5.

The chemicals of potential concern (COPCs) for this effort are the VOCs in Table 5.1 that have 25-year industrial PRGs. These VOCs include carbon tetrachloride, chloroform, Freon 113, 1,1,1-trichloroethane (1,1,1-TCA), PCE, and TCE. Other VOCs that are measured by the analytical method should be reported.

Phase 2 – Sub-slab Soil Vapor Sampling

In addition to the three samples taken from the breathing zone, three soil gas samples shall be taken from beneath the slab foundation. Samples will be acquired by drilling small (~ 9/16-in.-diam) penetrations into the slab foundation. Sample locations for this phase will be the same indoor locations used for the ambient air sampling effort. Background sampling will not be conducted during this event, as VOC concentrations within the air will not impact concentrations found in the soils beneath the building.

The COPCs for this effort are the VOCs in Table 5.1 that have 25-year industrial PRGs. Other VOCs that are measured by the analytical method should be reported.

Phase 3 – Groundwater Sampling

A groundwater sample shall be collected to determine current groundwater conditions. The groundwater sample shall be collected from the monitoring well in closest proximity to the subject building that exhibited the most elevated VOC concentrations in the most recent groundwater monitoring event. For Bldg. K-1400 the groundwater sample shall be collected from well UNP-001 (see Fig. 2.1) as this is the only well located within the immediate vicinity. Well UNP-001 is completed in the unconsolidated zone and is located approximately 200 ft southeast, and upgradient, of the building. The well will be purged and sampled using micropurging techniques to produce samples of lower turbidity. In order to be consistent with the groundwater program, samples will be analyzed for those VOCs typically reported under the ETTP groundwater monitoring program (see Table 5.2).

Groundwater samples shall be collected from well UNP-001 using micropurging techniques. The SSC shall locate the sampling equipment at the indicated well and place sufficient plastic sheeting around the well to prevent cross contamination. The sampling pump should be of stainless steel construction fitted with Teflon® bladders and Teflon®-lined polyethylene tubing.[2] The SSC should ensure that the Micropurge Water Analyzer and Flow Cell are calibrated in accordance with the manufacturer's instructions. In order to collect the groundwater sample, the well should be opened and the headspace monitored for organic vapors using a photo ionized detector. Water levels in the well should be measured using an electronic level indicator. After determination of the water level, the pump should be inserted to the midpoint of the water column or midpoint of the screen as required by the SSC's SOPs. The water level indicator should subsequently be reinserted and purging should be initiated. The purge rate should be adjusted to maintain the static water level in the well. Purging should continue until the parameters of temperature, pH, and specific conductance have stabilized and the turbidity has reached the desired end point (5 to 10 nephelometric turbidity units). Sampling should be conducted immediately after the well has been purged by re-directing the flow through cell to the specified sample containers.

Sample container, preservation, and holding time requirements are summarized in Table 5.3. In addition to the groundwater sample, a field blank shall also be required. All samples shall have the appropriate radiological analyses performed to comply with shipping protocols.

Groundwater samples shall be quantified by gas chromatography/mass (GM/MS) spectrometry per Method OLM 03.1 VOA. Analyses of groundwater samples shall meet the reporting limits specified in Table 5.1. Additionally the laboratory shall report up to 20 tentatively identified compounds in the groundwater sample.

6. FIELD SAMPLING PLAN

This SAP will be implemented in three phases. During Phase 1, three air samples (grab samples) will be taken from the breathing zone at independent locations within the building as shown in Fig. 6.1. In addition, a single sample shall be taken outside the building at an upwind location that will be field located based upon meteorological data from the PSS Office. As stated previously, building ventilation shall be turned off during sampling activities within the facility for one event and turned on for the second sampling.

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[2]Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

Table 5.2. Water Resources Restoration Program VOC parameter group

Analyte	Analytical method	Project quantitation level (µg/L) [a]
1,1,1-Trichloroethane	SW-8260B[b]	5
1,1,2,2-Tetrachloroethane	SW-8260B	5
1,1,2-Trichloroethane	SW-8260B	5
1,1-Dichloroethane	SW-8260B	5
1,1-Dichloroethene	SW-8260B	5
1,2-Dichloroethane	SW-8260B	5
1,2-Dichloroethene	SW-8260B	5
1,2-Dichloropropane	SW-8260B	5
2-Butanone	SW-8260B	10
2-Hexanone	SW-8260B	10
4-Methyl-2-pentanone	SW-8260B	10
Acetone	SW-8260B	10
Benzene	SW-8260B	5
Bromodichloromethane	SW-8260B	5
Bromoform	SW-8260B	5
Bromomethane	SW-8260B	10
Carbon disulfide	SW-8260B	5
Carbon tetrachloride	SW-8260B	5
Chlorobenzene	SW-8260B	5
Chloroethane	SW-8260B	10
Chloroform	SW-8260B	5
Chloromethane	SW-8260B	10
cis-1,2-Dichloroethene	SW-8260B	5
cis-1,3-Dichloropropene	SW-8260B	5
Dibromochloromethane	SW-8260B	5
Ethylbenzene	SW-8260B	5
Methylene chloride	SW-8260B	5
Styrene	SW-8260B	5
Tetrachloroethene	SW-8260B	5
Toluene	SW-8260B	5
trans-1,2-Dichloroethene	SW-8260B	5
trans-1,3-Dichloropropene	SW-8260B	5
Trichloroethene	SW-8260B	5
Vinyl chloride	SW-8260B	2
Xylenes (total)	SW-8260B	5

[a]µg/L = microgram per liter.

[b]EPA 1993. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846*, Third Edition (November 1986; Rev. 1, July 1992; Rev. 2, November 1992; and Update 1, August 1993), U. S. Environmental Protection Agency, Office of Solid Waste, Washington, D.C., August.

VOC = volatile organic compound.

Table 5.3. Sample container, preservation, holding time and analytical requirements

Sample type	Number	Parameters of concern	Analytical protocols	Container type/volume	Preservation	Holding time
Air (ambient air)	6	Volatile organics	TO-15	5-L SUMMA Canister	None	14 d
Air field blank (ambient air)	2	Volatile organics	TO-15	5-L SUMMA Canister	None	14 d
Air (soil vapor)	3	Volatile organics	TO-15	5-L SUMMA Canister	None	14 d
Air field blank (soil vapor)	2	Volatile organics	TO-15	5-L SUMMA Canister	None	14 d
Groundwater[a]	1	Volatile organics	OLM03.1VOA	Three 40-mL glass vials with Teflon®-lined septum	HCl to pH <2 Cool, 4°C	14 d
Groundwater field blank[b]	1	Volatile organics	OLM03.1VOA	Three 40-mL glass vials with Teflon®-lined septum	HCl to pH <2 Cool, 4°C	14 d

[a]Sample identification number for this sample shall be AU-00-41-1400-W.
[b]Sample identification number for this sample shall be AU-93-41-1400-B.

During Phase 2 of this sampling effort, three sub-slab vapor samples (grab samples) shall be collected during the sampling event at locations shown in Fig. 5.1. Samples will be taken by drilling small (~ 9/16-in.-diam) holes through the slab taking care not to disturb the materials underlying the slab. If a vapor barrier is part of the design, penetration of this barrier will be required. Consistent with EPA guidance, a brass or stainless steel tube will be inserted into the penetration. Immediately upon completion of the penetration, it will be sealed using non-VOC-bearing caulk or tape. When the sampling device has been set up, a line will be attached to the penetration tube and the sample taken.

In Phase 3, a groundwater sample will be collected to determine current groundwater conditions. The sample will be collected from the monitoring well nearest to K-1400 that exhibited the most elevated VOC concentrations in the most recent groundwater monitoring event, well UNP-001.

Soil gas vapors and indoor air samples will be collected using preconditioned SUMMA canisters meeting the canister cleaning and certification requirements of EPA's Office of Air and Radiation Method TO-15. These samples shall be collected in accordance with requirements for sub-atmospheric samples in Method TO-15. Flow control into the evacuated canisters may be provided by either a critical orifice or combination of a flow meter and auxiliary vacuum pump. If flow control is provided by a critical orifice for 8-h and 24-h TWA samples, the sampling subcontractor (SSC) shall obtain flow data from the manufacturer demonstrating the extent of inflow decline at the end of the sampling time period and certification that such decline does not adversely affect sample accuracy.

Upon collection of the air samples, the SUMMA canisters shall be valved closed. The sampling line shall be disconnected from the canister and the canister removed from the sampling system. If the sampling system used a flow meter and vacuum pump for sample collection, the final flow rate shall be determined and recorded as required by Method TO-15. All air samples for breathing zone and soil gas shall be grab samples.

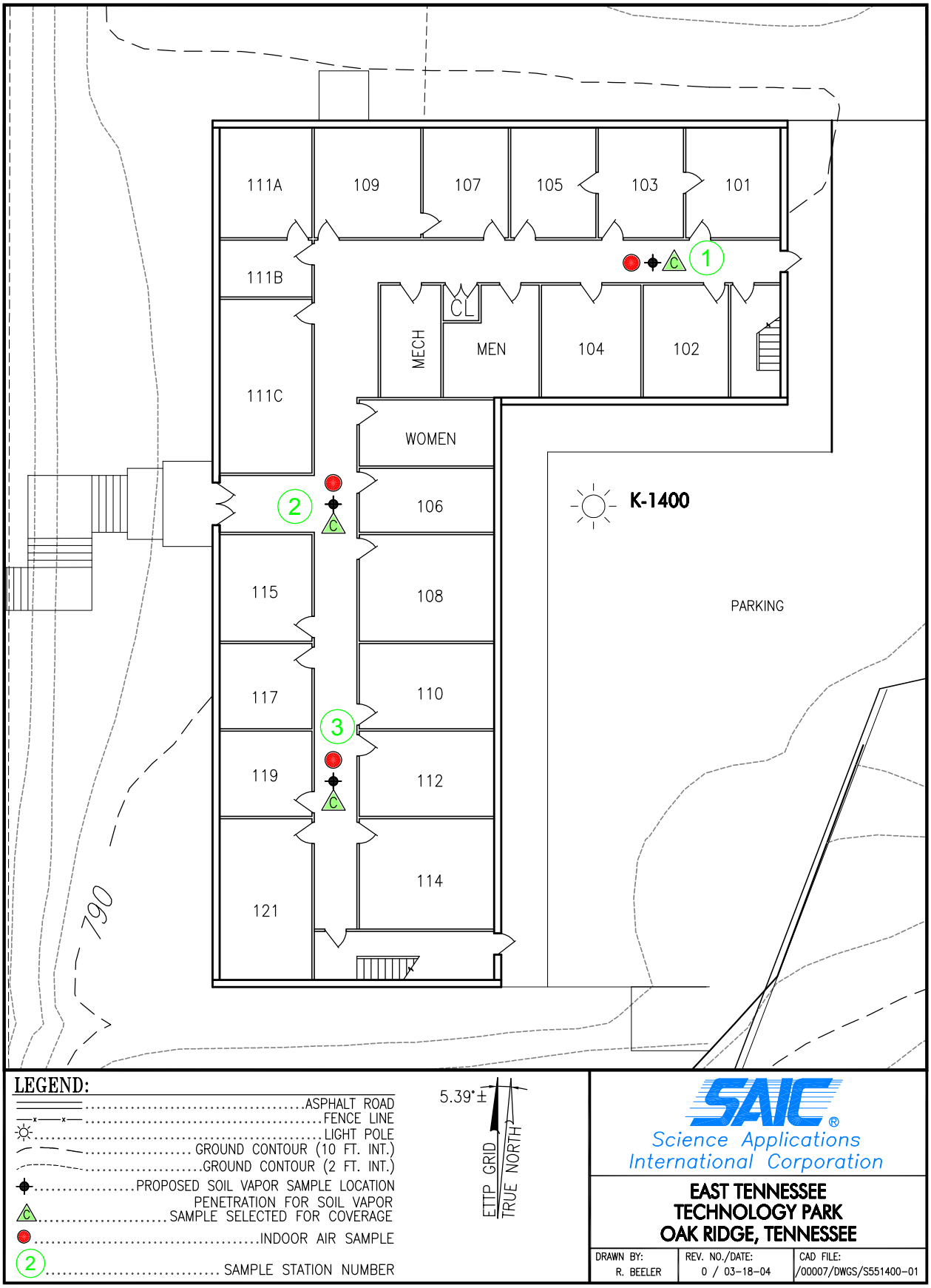

Fig. 6.1. Building K-1400 soil vapor and indoor air sampling locations.

Upon collection of the SUMMA canister, it shall be labeled as required by the SSC's standard operating procedures (SOPs). The canisters shall be shipped to the laboratory in a canister shipping case as required by the manufacturer's specifications or the SSC's SOPs.

Decontamination of sampling equipment used for collection of air samples is not required. All equipment, including the sampling inlet line, used at each sampling station shall be dedicated.

After the soil vapor sample has been collected, the floor penetration or sampling port shall be sealed by an appropriate method. The temporary seal shall ensure that the sampling port or penetration is vapor tight and does not present a tripping hazard. After completion of all soil vapor sampling events, the floor penetration shall be sealed by cutting it level with the floor or removing it and backfilling with a non-shrinking grout. A layer of non-shrinking grout should be applied to the floor, covering the penetration and immediate surrounding area, and it should be finished smooth with the surrounding surface.

The only field quality control sample required for the air samples is a field equipment blank. Two field equipment blanks are required for each sampling event.

The groundwater sample will be collected using a low flow micropurge sample collection technique. The SSC will use all appropriate protocols for sample collection.

Sample container, preservation, and holding time requirements are summarized in Table 5.3.

All samples shall have the appropriate radiological analyses performed to comply with shipping protocols.

7. ANALYTICAL REQUIREMENTS

Air samples shall be quantitated for VOCs using gas chromatography/mass spectrometry analyses as required by Method TO-15. Quantitation of VOCs in air samples shall meet the detection limits specified in Table 5.1. Groundwater samples will be quantified for VOCs using Method OLM03.1VOA. The detection limits are specified in Table 5.2.

8. DATA MANAGEMENT AND REPORTING

Data obtained from this sampling event shall be managed in accordance with the requirements of the *Data Management Implementation Plan for the Reindustrialization Program, Oak Ridge, Tennessee* (BJC/OR-865). Copies of the results will be provided to Region 4 of the EPA and the DOE-Oversight Office of the Tennessee Department of Environment and Conservation.

9. REFERENCES

BJC (Bechtel Jacobs Company LLC) 2001a. *Baseline Environmental Analysis Report for K-1400 and Adjacent Areas at the East Tennessee Technology Park, Oak Ridge, Tennessee*, BJC/OR-867, Oak Ridge, TN, February.

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DOE 1998. *Removal Action Report on the K-1401/K-1420 Sumps Removal Action at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OE/01-1754&D2, Office of Environmental Management, Oak Ridge, TN, December.

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EPA 1999. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Compendium Method TO-15, Determination Of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)*, Center for Environmental Research Information, Office of Research and Development, Cincinnati, OH, January.

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APPENDIX D

RADIOLOGICAL SURVEY PLAN FOR THE K-1400 BUILDING

1. AREA TO BE SURVEYED

The area to be surveyed includes the K-1400 building (both interior and exterior surfaces), exterior sidewalks, and the building contents, all of which are to be transferred to the Community Reuse Organization of East Tennessee (CROET). No exterior laydown, parking, or soil areas are associated with this footprint, which is illustrated in Figs. 1, 2, and 3 of this appendix.

2. HISTORY OF THE AREA

The K-1400 building, built in 1952 as the Maintenance Office Building, is a two-story building of masonry construction with a floor space of 13,104 ft^2. From the early 1970s to the mid-1980s, it was the Engineering Office Building. In the late 1980s, it was the Accounting/Auditing Building, and from the early 1990s until 2000, it was the Waste Management Division office building. Since 2000, it has been used as an office building for U. S. Department of Energy (DOE) auditors and site inspectors.

Radiological contamination, if present, is expected to be a small percentage of the applicable DOE surface contamination limits, both because of the results of the prior surveys performed in the area discussed below and because of the facility's historical usage. In general, no contamination that exceeds the DOE limits has been found within the area.

3. EXISTING SURVEY DATA SUMMARY

A search of the electronic survey data collected since 1996, and prior to the current surveys, revealed that five area radiological surveys for the study area were performed by East Tennessee Technology Park (ETTP) Radiation Control (RADCON) personnel (Table 1 in this appendix).

Table 1. ETTP historical radiological surveys

19960328KA36158001	19960826KA36170003
19960328KA36158002	19980216KA36165001
19960430KA36171001	

These surveys were all performed inside the building. A survey of the floor surrounding each of the entry stairways was performed in February 1998 as a part of the project to replace the damaged floor tiles. No activity above background levels was observed. The remaining surveys are all related to surveys of offices of pregnant workers (Rooms 200 and 206) and the women's restrooms. No activity above background levels was detected in either office, with dose equivalency rates of 5, 10, and 6 microrem per hour (μrem/h), respectively. The women's first-floor restroom had no removable activity detected. No total contamination readings or dose equivalency rates were taken, as the surveys primarily were concerned with removable contamination levels. The other women's restroom had no detectable total activity above background levels, with the dose equivalency rate ranging from 7 to 17 μrem/h.

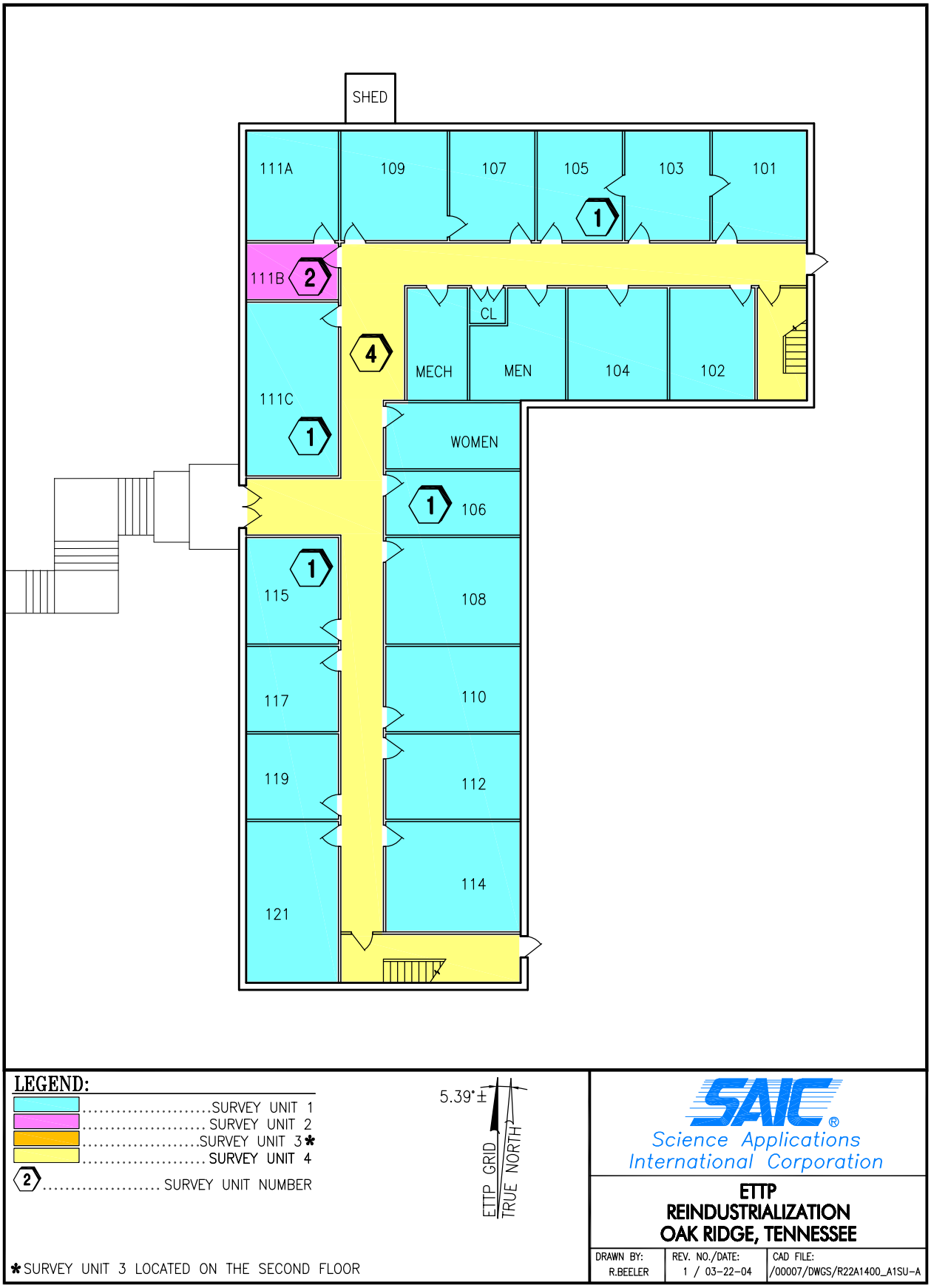

Fig. 1. K-1400 interior survey units for first floor.

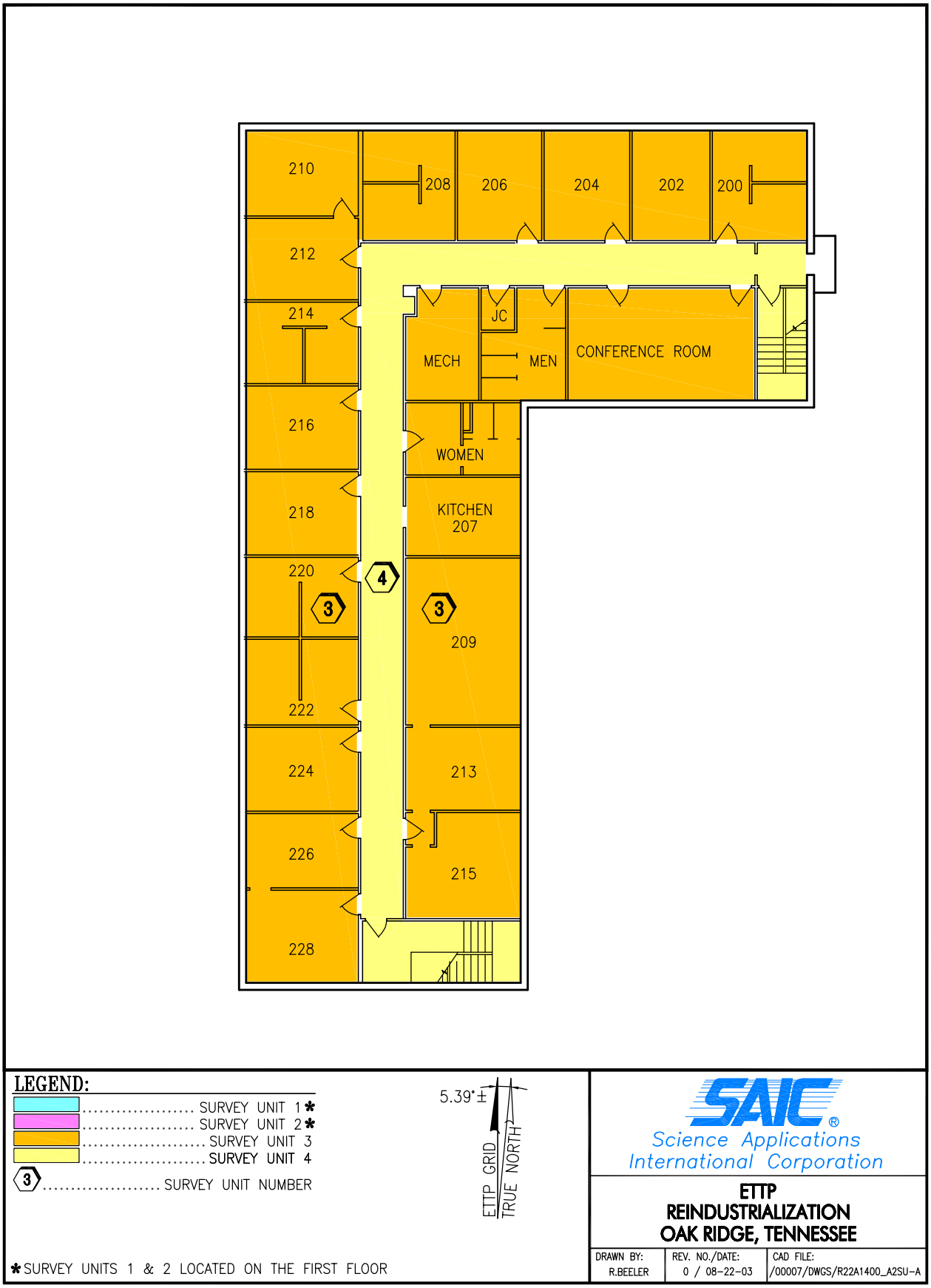

Fig. 2. K-1400 interior survey units for second floor.

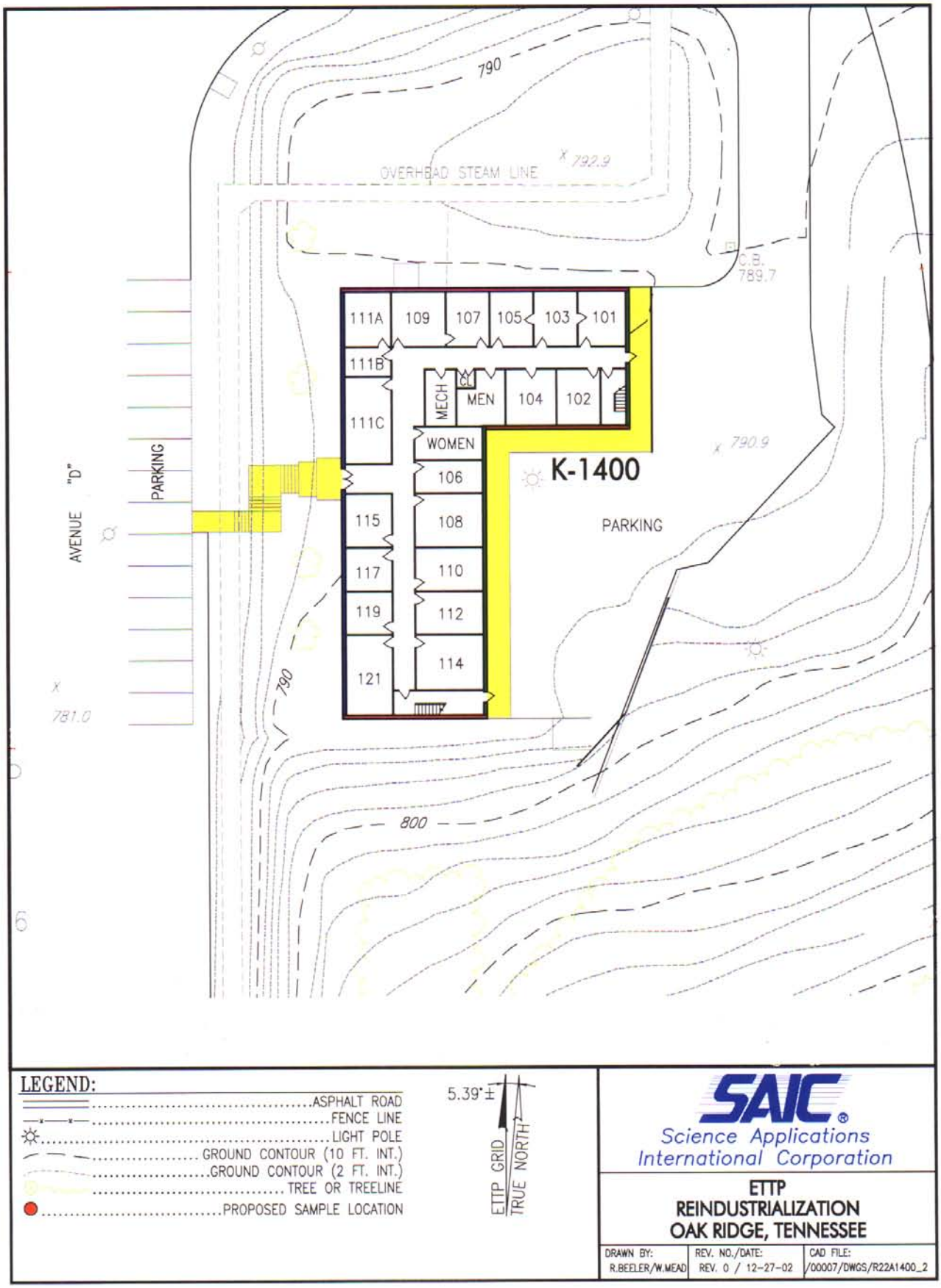

Fig. 3. K-1400 exterior survey units.

In addition to the surveys described above, ETTP RADCON personnel performed eight additional surveys for the Reindustrialization Program in support of leasing the building (Table 2 in this appendix). These surveys were performed in the survey footprint from September 25 to 29 and November 1 and 2, 2000, in accordance with the ETTP RADCON procedures[10] and *Design of Radiological Surveys of Potential Lease Space at East Tennessee Technology Park, Oak Ridge, Tennessee*.[11] All areas were surveyed in an "as-found" condition. Incidental materials in the survey units that could be rearranged or moved to allow for survey access were moved.

Table 2. ETTP radiological surveys

200009250029335001	20000928KA36153001
20000925KA38022001	20000928KA36153002
20000926KA38022001	20000929KA36153001
200009280029335001	20001101KA38022001

To meet the 20% scan survey of the rooms required by the survey plan, the field survey team selected five rooms on each floor for a 100% survey. On the first floor, Rooms 111, 104, and 121, the men's restroom, and the women's restrooms were chosen; on the second floor, Rooms 209, 218, the conference room, and both the men's and women's restrooms were chosen. Random readings were taken covering the entirety of each floor. Readings inside the building were all below the DOE contamination limits for uranium facilities. An area in Room 111-B was found that had elevated total beta-gamma readings that were approximately half of the DOE contamination limits. This elevated activity was attributed to contamination being tracked in from other areas of the site. The dose-equivalent rate inside ranged from 2 to 7 μrem/h. Readings on the building's exterior were all below the DOE contamination limits for uranium facilities. The dose equivalent rate ranged from 3 to 6 μrem/h. Background, for comparison, is 7 μrem/h.[12] All readings on sidewalks, steps, and the asphalt and grassy areas around Bldg. K-1400 were below the DOE contamination limits for uranium facilities. Because the sodium iodide (NaI) walkover survey in the grassy area found no areas above twice the NaI background, no biased soil samples were taken. The dose equivalent rate ranged from 2 to 6 μrem/h.

Since that survey one additional survey has been performed in the K-1400 building on May 22, 2001 (survey number 20010522KA36144001). A large number of large area wipe (LAW) samples were collected. However, total measurements were only made in three locations in the first floor hallway and one location in Room 102. No results were above the critical level for any measurement.

4. DATA QUALITY OBJECTIVES/PURPOSE

The purpose of this survey plan is to obtain radiological survey data to determine the presence of residual contamination in the area. The data gathered will be used to make a decision regarding the release of the K-1400 building and its contents for title transfer to the Community Reuse Organization of East Tennessee (CROET). The data quality objectives (DQOs) for this purpose have been developed and

[10]Primarily SH-B-4012, "Radioactive Contamination Control and Monitoring," found in BJC-SH-04, Vol. I, *Radiation Protection Program*.

[11]BJC 2000. *Design of Radiological Surveys of Potential Lease Space at East Tennessee Technology Park, Oak Ridge, Tennessee*, BJC/OR-554, Bechtel Jacobs Company LLC, Oak Ridge, TN, March.

[12]The 7 μrem/h background dose equivalent is a calculated value based on 3 years of external gamma dose readings from Environmental Monitoring Station 42.

are presented in *Design of Radiological Survey and Sampling to Support Title Transfer or Lease of Property on the Department of Energy Oak Ridge Reservation*.[13]

5. MEASUREMENT TECHNIQUES/SURVEY APPROACH

5.1 RADIONUCLIDES OF CONCERN

Process history of the ETTP Site indicates that uranium (natural, depleted, and/or enriched uranium) would be the most prominent radiological contaminant potentially present in the K-1400 building Because of contamination tracked in from other on-site buildings. Uranium-235 enrichment levels expected from operations since the early 1960s would be anticipated to be between 0.2 to 5.0%. Most facilities would be potentially contaminated via tracking from enrichments of less than 3%.[14] However, as this has been an administrative building throughout its history, it is assumed that the uranium would be from natural sources and the enrichment is approximately that of natural uranium, 0.72%.

Other radionuclides (^{60}Co, ^{137}Cs, $^{89/90}$Sr, ^{237}Np, ^{99}Tc, and $^{238/239/240}$Pu) have also been detected on-site at ETTP. These other radionuclides originated from the introduction of contaminated materials from Oak Ridge National Laboratory and/or from the Hanford and Savannah River reactor returns uranium reprocessing program; however, these radionuclides are expected to be found in much lower quantities than uranium and undetectable in this area, based upon its operational history as an administrative facility. If they were present, it is assumed that they would be present at ratios of 1140:1 for uranium to transuranic (U:TRU) and 350:1 for uranium to technetium-99 (U:^{99}Tc)[15] [both ratios are process buildings weighted averages].[16]

5.2 DETERMINATION OF THE RESIDUAL RADIOACTIVITY LIMITS

The overall goal of this survey is to show that residual contamination exceeding the release criteria is not present in any of the survey units. As shown by modeling, the dose and risk obtained from exposure to radioactivity at the DOE surface contamination limits, as set forth in Title 10 *Code of Federal Regulations* (*CFR*) 835[17] and also in DOE Order 5400.5,[18] is less than that from the dose and risk criteria, as explained in the design document (Appendix A). As a result of this modeling, the derived concentration guideline levels (DCGLs) for this survey will be set at the DOE contamination limits for uranium (Table 3 in this appendix), which is the dominant contaminant present on-site. A separate limit for the maximum allowable contamination that is concentrated in a smaller area, the derived concentration guideline level$_{\text{elevated measurement comparison}}$ ($DCGL_{EMC}$), is normally calculated based on modeling the dose

[13]BJC 2002. *Design of Radiological Survey and Sampling to Support Title Transfer or Lease of Property on the Department of Energy Oak Ridge Reservation*, BJC/OR-554-R1, Bechtel Jacobs Company LLC, Oak Ridge, TN, September.

[14]Contracted Health Physics Technician Training handouts, K-25, 1993.

[15]The average transuranic (TRU) composite for the East Tennessee Technology Park (ETTP) is 47% ^{237}Np, 10% ^{238}Pu, 20% $^{239/240}$Pu, and 23% ^{241}Am. The uranium to transuranic (U:TRU) ratio ranged from 43.2:1 to 62,500:1 for ETTP, with the vast majority >50:1. A ratio of 50:1 indicates that uranium radiological protective measures for surface contamination would be sufficient for the TRU content. The U:Tc ratios for ETTP range from 0.00258:1 to 1640:1, with the ratios less than 1:1 coming from the posted Tc areas within the process and main support buildings (K-25 East, K-27, K-29, K-31, K-1231, and K-1420). With a ratio greater than or equal to 1:1, the implication is that the uranium radiological protective measures would be sufficient for the Tc content.

[16]*Isotopic Distribution of Contamination Found at the U.S. Department of Energy Gaseous Diffusion Plants*, Science Applications International Corporation (SAIC) report delivered to BJC, SAIC document number 143.19991103.002, October 1999.

[17]*CFR* (*Code of Federal Regulations*) 1999. 10 *CFR*, entitled *Occupational Radiation Protection*; the values are taken from Appendix D, "Surface Radioactivity Values."

[18]DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. The values are taken from Fig. IV-1, "Surface Contamination Guidelines."

obtained from an area determined by the number of samples taken in the survey unit and the spacing between them. However, the $DCGL_{EMC}$ will be set to three times the appropriate contamination limit, which equates to the contamination averaging criteria as set forth by DOE in 5400.5 for an elevated reading within a 1-m^2 maximum size area.

Table 3. Contamination limits (DCGLs) for all survey units

	DCGL (dpm/100 cm^2)	$DCGL_{EMC}$ (dpm/area)
Total alpha	5000	15,000
Removable alpha	1000	N/A
Total beta-gamma	5000	15,000
Removable beta-gamma	1000	N/A

DCGL = derived concentration guideline level.
$DCGL_{EMC}$ = derived concentration guideline $level_{elevated\ measurement\ comparison.}$
dpm = disintegrations per minute.
N/A = not applicable.

If activity is detected at levels exceeding 80% of the DCGL [i.e., 4000 disintegrations per minute per 100 square centimeters (dpm/100 cm^2)], but less than 100%, the data will be reviewed and approved by the RADCON site project Health Physicist prior to releasing the material(s)/area(s).

5.3 IDENTIFICATION OF SURVEY UNITS AND CLASSIFICATIONS

Areas are classified as either Class 3, 2, or 1, based on historical data and process knowledge.

Survey units must be of the same or similar material type (e.g., a survey unit cannot contain both asphalt and soil). It would be divided into a survey unit of asphalt and another survey unit of soil. The design document contains complete descriptions of the different classifications of survey units. In general, a Class 3 survey unit is not expected to have residual radioactivity levels above 25% of the DCGL prior to any historical remediation (1250 dpm/100 cm^2 total activity or 250 dpm/100 cm^2 removable activity). A Class 2 survey unit is expected to have residual radioactivity levels less than the DCGL prior to any historical remediation. A Class 1 survey unit is expected to have residual radioactivity levels above the DCGL prior to any historical remediation.

This building was surveyed for lease in 2000, and only one area was found that had activity elevated above 25% of the DCGL. The area where this activity was found, Room 111B floor, was surveyed with 100% coverage. The Room 111B floor will be considered a Class 2 survey unit. Because no other areas of elevated activity were detected in this room or other rooms, the walls and ceiling of Room 111B and the remaining rooms on the first floor will be considered a Class 3 survey unit. The rooms on the second floor will be considered a separate Class 3 survey unit. To emphasize the main traffic areas, the halls and stairwells will also be considered a separate Class 3 survey unit. Because the leasing survey was performed in 2000, the second floor has been leased and occupied. Prior to occupation, the floors were carpeted; therefore, floor surveys will be performed on the carpet. Since the leasing survey was performed in 2000, the first floor has been unoccupied and the tile has been removed from the floor leaving bare concrete. Because only a limited number of rooms were surveyed for the leasing survey in 2000, this survey will be considered an initial transfer survey rather than a confirmation survey.

Each facing (north, south, east, and west) of the building's exterior will be considered a separate Class 3 survey unit, as will the roof and the exterior sidewalks. In addition, the furnishings will be broken into separate survey units by floor and by history. Newer furnishings will be Class 3 and older furnishings that may have been transferred from other parts of the plant will be Class 2. The K-1400 building will be

composed of a total of three Class 3 interior survey units (ISUs), one Class 2 ISU, six exterior survey units (ESUs), and up to four furnishings survey units (FSUs), as shown in Table 4 in this appendix.

Table 4. Survey units classification

Area	Class	
	Interior areas	Exterior areas
K-1400, first floor rooms (excluding Room 111-B) [ISU-1]	Class 3	N/A
K-1400, Room 111-B (ISU-2)	Class 2	N/A
K-1400, second floor rooms (ISU-3)	Class 3	N/A
K-1400, stairwells and halls (ISU-4)	Class 3	N/A
K-1400, building exterior, north face (ESU-1)	N/A	Class 3
K-1400, building exterior, east face (2) (ESU-2)	N/A	Class 3
K-1400, building exterior, south face (2) (ESU-3)	N/A	Class 3
K-1400, building exterior, west face (ESU-4)	N/A	Class 3
K-1400, roof (ESU-5)	N/A	Class 3
K-1400, sidewalks and steps (ESU-6)	N/A	Class 3
K-1400, first floor furnishings (FSU-1)	Class 3	N/A
K-1400, second floor furnishings (FSU-2)	Class 3	N/A
K-1400, first floor furnishings (FSU-3)	Class 2	N/A
K-1400, second floor furnishings (FSU-4)	Class 2	N/A

ESU = exterior survey unit.
ISU = interior survey unit.
FSU = furnishing survey unit
N/A = not applicable.

5.4 INSTRUMENTATION SELECTION AND SCAN SURVEY TECHNIQUES

Instrumentation selection is detailed in Appendix C. In general, alpha scintillation and beta-gamma Geiger-Müeller (GM) detectors used for static measurements will be attached to scalar rate meters and will have minimum detectable activities less than 25% of the DCGL. Gas-proportional floor monitors or floor monitors with the probe detached from the monitor cart for use as hand-held probes, calibrated and operated to detect both alpha and beta-gamma radiations, will be used for as much of the scan surveys as possible, including the primary work surfaces, walls, and ceilings. NaI meters and Bicron MicroRem® meters[19] will also be used, as specified in this survey plan. Removable contamination surveys (i.e., smear surveys) will be conducted at all locations where a fixed/total measurement is taken. All removable contamination survey smears will be counted on a gas-proportional counter, or equivalent, calibrated to detect both alpha and beta-gamma radiations.

For Class 3 areas, a minimum of 10% judgmental surface scan surveys will be performed over the primary traffic and work surfaces of the entire survey unit, as accessible. One hundred percent of the accessible floor area will be scanned in Class 2 areas. Other surfaces that are classified as Class 2 areas (such as walls, ceilings, overhead areas, including false ceilings, etc.) will have a scan coverage that varies according to how close the expected activity levels are to the DCGLs. For Room 111B, the scan coverage will equal 50%. Class 1 survey units will have a 100% scan of all surfaces. Emphasis will be placed upon entrances/high-traffic areas, suspect areas, and professional judgment for all scan surveys. (A 10% scan survey is not interpretable as surveying 100% of 10% of the offices in a particular survey

[19]Reference herein to any specific commercial product, process or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U. S. government or any agency thereof.

unit and not performing any surveys in the other 90%; 10% of all floors, of all walls, and of all ceilings will be scanned, as accessible.)

All surveys will be performed in accordance with established DOE contractor's RADCON procedures [i.e., scan rate, probe distance, source checks, etc.). Presently, the ETTP DOE contractor is Bechtel Jacobs Company LLC (BJC)].

5.5 AREA PREPARATION

All areas will be surveyed in an "as-found" condition. Materials may be rearranged or moved to allow for survey access to areas covered by material and/or equipment.

5.6 REFERENCE COORDINATE SYSTEM FOR SURVEY

Class 3 areas do not require a sample grid. A reference coordinate system will be used in each survey unit to reference measurements so they can be relocated/verified as needed, unless the measurement is at an easily identifiable location, such as "Room 100, 4 ft up on west wall, ~2 ft from south wall." The starting point of the reference grid, if needed, will be the southwest corner of each survey unit, with the distance north being Y and the distance east being X in an X-Y coordinate system [i.e., (X,Y)], with the units in feet.

Class 2 and Class 1 survey units require a sample grid with systematic measurements taken based upon a random starting point. These survey grids are based upon the survey unit's area and number of systematic sample measurements required in each. The survey grid for Room 111B floor is illustrated in Fig. 4 in this appendix. The survey grid is triangular and begins 1 ft east and 1 ft south of the northwest corner of the room.

If a survey unit has to be reclassified to a higher classification and survey requirements, a revision to this survey plan will be issued containing the sample grids of the reclassified survey units.

6. SURVEY DESIGN

6.1 QUANTIFY DATA QUALITY OBJECTIVES

The null hypothesis (H_o) for each survey unit is that the residual contamination exceeds the DCGL. The alternative hypothesis (H_a) is that the survey unit meets the DCGL. Decision error levels, as set forth in the design document, are 0.05 for Type I (α) errors and 0.10 for Type II (β) errors in all survey units as the building is expected to be releasable without remediation. The lower bound of the gray region (LBGR) is initially set to half of the DCGL. These parameters apply to all survey units, regardless of their classification. The design document discusses the DQO process and specific DQOs in greater detail.

6.2 DETERMINATION OF THE NUMBER OF DATA POINTS

Using the prescribed statistical testing methodology found in the design document (Sign test), a Δ/σ value (also known as the "relative shift") was computed (7.33) using the historical survey results,

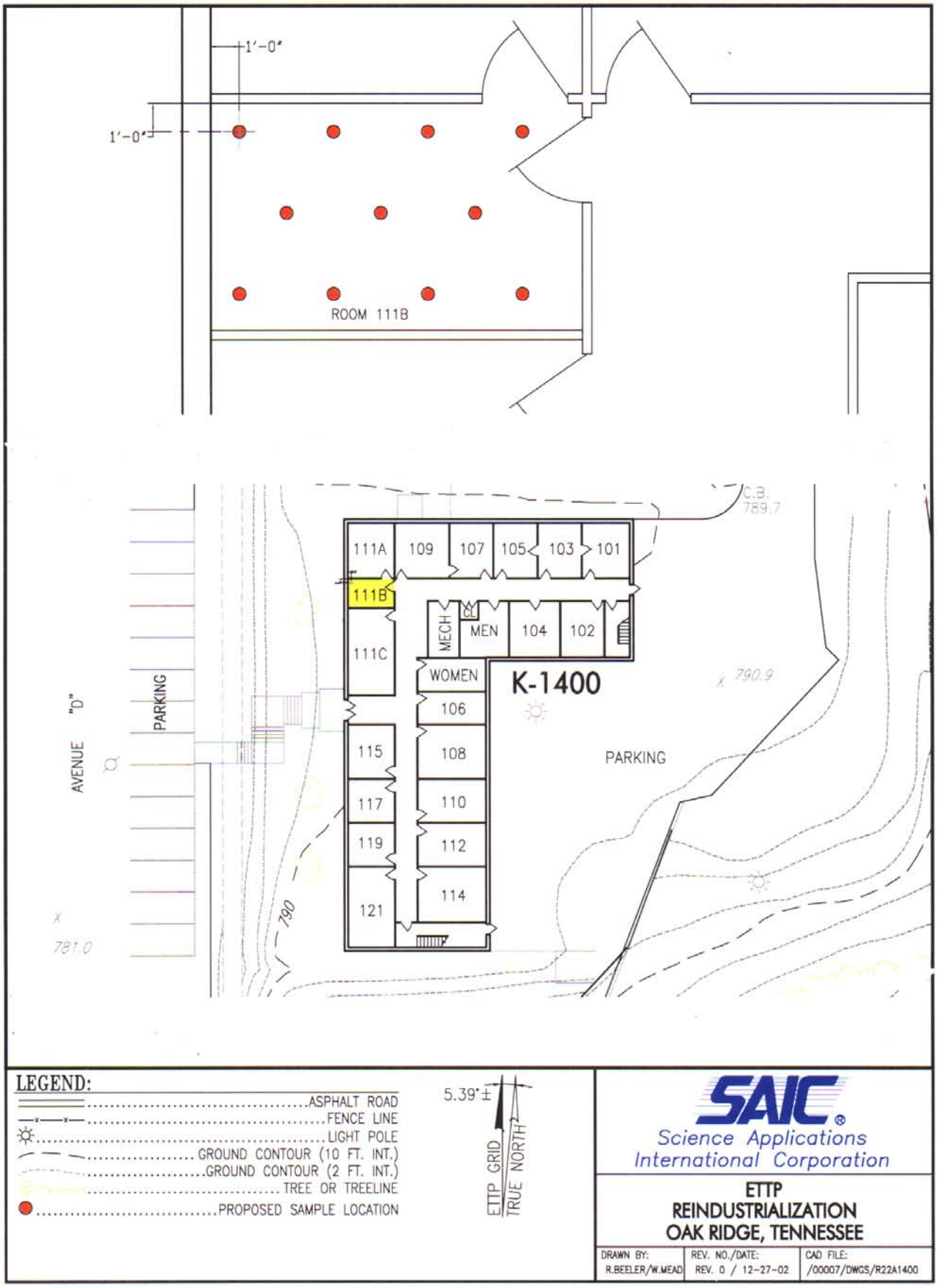

Fig. 4. Survey grid for Room 111B, K-1400.

where Δ is the DCGL–LBGR, the LBGR is 50% of the DCGL, and σ is the standard deviation of the data. [The majority of the readings were less than the instrument's Lc, the critical value at which there is 95% confidence that the value can be distinguished from background, or were recorded as "NEAD" (No Elevated Activity Detected); therefore, σ was assigned the value of the highest Lc value for the set of instruments divided by 1.65]. The *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM)[20] recommends that the relative shift be between 1 and 3; however, adjusting the LBGR so as to obtain a relative shift that follows the MARSSIM recommendation results in an alpha LBGR of 4900 dpm/100 cm^2 (2.55 relative shift) and a beta LBGR of 4300 dpm/100 cm^2 (2.83 relative shift). These values are approaching levels that are very difficult to distinguish from the DCGL; therefore, the default values suggested in the design document were used to determine the number of survey data points per survey unit. Because the facility has always been used as office space and has existing historical area survey data that, for the vast majority, were not distinguishable from background levels, it was determined that using the default values found in the design document, in lieu of actual data, was appropriate. Using the prescribed statistical testing methodology found in the design document (Sign test), a Δ/σ value (also known as the "relative shift") of 3 and an LBGR set at 50% of the DCGL (2500 dpm/100 cm^2) were chosen. The Sign test was used, as the residual contamination present within the survey units should be at a very small fraction of the DCGL. For all survey units, 11 survey data points (total and removable readings) are needed, at a minimum, not including any tool, furniture, or equipment surveys. However, to ensure a proper representation of all rooms in each ISU, a minimum of one survey data point will be located in each room.

6.3 SURVEY PROCEDURES

All surveys will be performed in accordance with this survey plan, the design document, and the DOE contractor's RADCON procedures. Survey technique is covered in the design document and will not be repeated in this plan; however, variations or clarifications of the design document will be included.

In any area where the scan survey indicates activity exceeding 5000 dpm/100 cm^2, direct alpha and beta-gamma measurements will be made following the establishment of a 1-m^2 grid to attempt to apply DOE Order 5400.5 release criteria. If, after applying DOE Order 5400.5 release criteria, the area or equipment still exceeds the guidelines, the DOE contractor's RADCON procedures will be followed for posting of the immediate area. In addition, any contamination survey location found in excess of two times the DCGL will also have a dose rate measurement taken at a distance of 3 ft.

Any activity in excess of 25% of the DCGL will require that a Class 3 survey unit be reclassified as Class 2 and surveyed appropriately. If the area exceeding 25% of the DCGL is on a glazed clay tile floor and is less than 3500 dpm/100 cm^2 total beta-gamma (or 2800 dpm/100 cm^2 total beta-gamma for a red clay brick[21]) with no alpha contamination above 25% of the DCGL, then no unit upgrading is required. This level of radioactivity is within that of the naturally occurring radioactive materials (NORM) contained in the glazed clay tile/brick matrix. Any activity in excess of the DCGL will require that a Class 3 or 2 survey unit be reclassified as Class 1 and surveyed appropriately. The RADCON supervisor must be notified so the project radiological engineer can make any appropriate changes to this survey plan.

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[20]NRC 1997a. Nuclear Regulatory Commission, Nuclear Regulatory Guide (NUREG)-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Final Edition*, December.

[21]Values computed based upon the beta-gamma background levels for brick and ceramic tile found in Table 5.1 of NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, December (NRC 1997c), and an average beta-gamma GM correction factor of 34 (dpm per 100 cm^2)/cpm for a planar radiation source.

A summary of the requirements for each type of survey unit is found in Table 5 in this appendix**,** and a survey technician summary is found in Table 6 in this appendix.

Table 5. Summary of survey unit requirements

Survey unit type	Class 3	Class 2	Class 1
Interior	• 10% scan of primary traffic and work spaces • Use professional judgment for wall and ceiling scans • 11 total and removable readings, at a minimum per survey unit, and at least 1 per room • Reading locations based on professional judgment and scan survey • Dose rate walkover survey in each survey unit • Minimum of 1 dose rate reading per office or open space • 1 dose rate reading every 20 ft of hallway • Upgrade to Class 2 if activity > 25% DCGL • Upgrade to Class 1 if activity > DCGL	• 100% scan of primary traffic and work spaces (floors) • Scan of walls, overhead areas with scan % = % of DCGL • 11 total and removable readings, at a minimum per survey unit, and at least 1 per room • Reading locations based on a grid to be determined as needed • Dose rate walkover survey in each survey unit • Minimum of 1 dose rate reading per office or open space • 1 dose rate reading every 20 ft of hallway • Upgrade to Class 1 if activity > DCGL	• 100% scan of primary traffic and work spaces • 11 total and removable readings, at a minimum per survey unit, and at least 1 per room • Reading locations based upon a grid to be determined as needed • Dose rate walkover survey in each survey unit • Minimum of 1 dose rate reading per office or open space • 1 dose rate reading every 20 ft of hallway
Exterior	• 10% scan of accessible surfaces • Scan walls up to at least 8 ft • 11 total and removable readings, at a minimum per survey unit • Reading locations based on professional judgment and scan survey • Dose rate walkover survey in/on each survey unit • 1 dose rate reading every 20 ft • Upgrade to Class 2 if activity > 25% DCGL • Upgrade to Class 1 if activity > DCGL	• Scan of surfaces with scan % = % of DCGL • Scan walls up to at least 8 ft • 11 total and removable readings, at a minimum per survey unit • Reading locations based on a grid to be determined as needed • Dose rate walkover survey in/on each survey unit • 1 dose rate reading every 20 ft • Upgrade to Class 1 if activity > DCGL	• 100% scan of all surfaces • Scan walls up to at least 8 ft • 11 total and removable readings, at a minimum per survey unit • Reading locations based on a grid to be determined as needed • Dose rate walkover survey in/on each survey unit • 1 dose rate reading every 20 ft
Furnishings	• 10% scan of all accessible surfaces • Maximum total surface area < 5000 m^2 • Activity > 25% of DCGL, remove that item and all other similar items to be placed in a new Class 2 survey unit	• 10% scan of all accessible surfaces • Maximum total surface area < 1000 m^2 • Activity > DCGL, remove item and all other similar items to be placed in a new Class 1 survey unit	• 100% scan of all accessible surfaces • Maximum total surface area < 100 m^2

DCGL = derived concentration guideline level.

Table 6. Survey technician summary of survey requirements

Class 3	Class 2	Class 1
• 10% scan interior floor/primary work areas, 10% of exterior accessible surfaces, and 10% of furnishings accessible surfaces • Professional judgment for wall and ceiling scans • Scan exterior walls up to at least 8 ft • 11 (minimum) total and removable readings and at least 1 per room • Dose rate walkover survey in each survey unit (minimum of 1 reading/office or open space, 1/20 ft of hallway or exterior) • Furnishings activity > 25% of DCGL, remove that item and all other similar items to be placed in a new Class 2 survey unit • Notify supervisor if activity > 25% DCGL	• 100% scan interior floor/primary work areas (floors) • Scan of walls, overhead areas with scan % = % of DCGL (TBD) • Furnishings scan 10% accessible surfaces • Scan exterior walls up to at least 8 ft • 11 (minimum) total and removable readings and at least 1 per room • Reading locations based upon a grid TBD • Dose rate walkover survey in each survey unit (minimum of 1 reading/office or open space, 1/20 ft of hallway or exterior) • Notify supervisor if activity > DCGL • Furnishings activity > DCGL, remove item and all other similar items to be placed in a new Class 1 survey unit	• 100% scan all surfaces • Scan exterior walls up to at least 8 ft • 11 (minimum) total and removable readings and at least 1 per room • Reading locations based upon a grid TBD • Dose rate walkover survey in each survey unit (minimum of 1 reading/office or open space, 1/20 ft of hallway or exterior)

DCGL = derived concentration guideline level.
TBD = to be determined.

6.3.1 Interior Survey Units

Any asbestos-controlled areas will be identified with any pertinent information on whether radiological contamination is suspected (i.e., ventilation hood, exhaust vents, posted radiological area, etc.) but not entered as part of this survey. No surveys will be performed above suspended ceiling tiles, in the elevator shaft, or under elevated flooring. Any ventilation exhausts and air intakes in the survey footprint will also be surveyed for contamination. At least one tissue-equivalent dose rate will be taken in each office or open area.

6.3.1.1 Class 3 interior survey units

Refer to Figs. 1 and 2 in this appendix for the first and second floor survey units. Ten percent of the primary traffic areas and work surfaces will be scanned with floor monitors and hand-held meters (including a floor monitor probe set up as a hand-held probe and calibrated to detect alpha and beta-gamma contamination for large area scans of non-floor surfaces), as appropriate. Any location on the walls or ceiling that, using professional judgment, could potentially have residual radioactivity present will also be scanned over the suspected area and documented on the survey. Tools, office furniture, and equipment will be a separate survey unit and surveyed per the guidance found in Sect. 6.3.6. No removal of suspended ceiling tiles or floor panels will be required for this survey. Eleven measurements of total and removable contamination, at a minimum, and at least one per room will be recorded within each survey unit at locations determined during the scan survey to have the highest activity.

A general dose rate walkover survey of each survey unit, using a Bicron MicroRem® meter, will be performed to determine if any variations exist in the penetrating radiation dose rate. If variations exist, then the location, distance the dose rate was taken from the wall and/or floor, and dose rate at that location are

to be recorded. Dose rate measurements will be obtained at a minimum of every 20 ft in hallways and large rooms.

6.3.1.2 Class 2 interior survey units

There is one Class 2 ISU. The potential also exists for having a Class 3 area upgraded to a Class 2. Class 2 survey protocols are as follows: 100% of the accessible floor surface will be scan surveyed using a floor monitor or hand-held meters, as appropriate; other surfaces (walls, overhead areas, and ceilings) will be scanned according to the percent of the DCGL that was found; if the data show that a maximum of 35% of the DCGL was detected, then the scan percentage is 35%. For Room 111B, 50% scan coverage will be used based of previous survey data. The measurement locations will be systematically chosen per the design document. Refer to Fig. C.4 for the Room 111B survey unit grid pattern.

6.3.1.3 Class 1 interior survey units

While there are currently no Class 1 areas, the potential exists for having a Class 3 or 2 area upgraded to a Class 1. Class 1 survey units follow the Class 2 survey protocols, with the exception that all surfaces (not just accessible) are surveyed 100%.

6.3.2 Exterior Survey Units

All exterior wall areas will be surveyed with hand-held meters or with a gas-proportional probe up to a minimum height of 8 ft. The building sidewalks will be scanned using a floor monitor or hand-held meters. No exterior grass or parking areas are covered under this survey plan. Emphasis is to be placed upon air vents/intakes, windowsills, gutter downspouts, and wherever professional judgment would indicate a higher probability of finding elevated readings. A tissue-equivalent dose rate survey will be performed over the survey units, with readings being taken every 20 ft. The ESUs are illustrated in Fig. 3 in this appendix.

6.3.2.1 Class 3 exterior survey units

Class 3 ESUs will have 10% of the accessible surfaces scanned with hand-held meters or with gas-proportional probes, as appropriate. Eleven measurements of total and removable contamination, at a minimum, will be recorded within each survey unit at locations determined during the scan survey to have the highest activity. All electrical cabinets will require either a lockout/tagout to be performed on them for the survey, or for a qualified electrician to be present during the survey, as required by the contractor's procedures. Any air intakes will need to be turned off, preferably overnight, to allow for the decay of radon and thoron daughters prior to the survey.

6.3.2.2 Class 2 exterior survey units

While there are currently no Class 2 areas, the potential exists for having a Class 3 area upgraded to a Class 2. Class 2 survey protocols are as follows: walls, up to 8 ft, will be scan surveyed using hand-held meters and/or gas-proportional meters (if possible) with the scan percentage being equal to the maximum percentage of the DCGL found prior to the reclassification as a Class 2 survey unit.

6.3.2.3 Class 1 exterior survey units

Although there are currently no Class 1 areas, the potential exists for having a Class 3 or 2 area upgraded to Class 1. Class 1 survey units follow the Class 2 survey protocols, with the exception that 100% of the accessible surface will be surveyed.

6.3.3 Equipment and Furniture (Furnishings) Surveys

The survey of equipment and furnishings will be performed along the lines of the survey protocol developed by Safety and Ecology Corporation (SEC) for the release of materials from the K-1001-A, -B, -C, and -D Bldgs. prior to their demolition.[22] The K-1001-A, -B, -C, and -D and design document requirements that affect the number of survey data points are shown in Table 7 in this appendix. It should be noted that some of the furnishings and equipment of the second floor belong to CROET or the lessee. Because these furnishings and equipment do not belong to DOE, they will not be included in this survey for transfer of property.

Table 7. Comparison of parameters for computing number of samples

Parameter	SEC K-1001-A, -B, -C, and -D furnishings survey plan	Survey design document
Type I error rate (α)	0.05	0.05
Type II error rate (β)	0.05	0.10
Non-parametrical statistical test	Wilcoxon-Rank Sum	Sign[23]
LBGR	2500 dpm/100 cm^2	2500 dpm/100 cm^2
Number of data points per survey unit	20 (10 in each survey unit, 10 in each reference background survey unit)	11

dpm = disintegrations per minute.
LBGR = Lower Bound of the Gray Region.
SEC = Safety and Ecology Corporation.

6.3.3.1 Determination of the number of data points

The existing K-1400 survey dataset was unusable to determine the number of measurements required independently because of the minimum amount of data available. Based on the historical survey data and facility usage, the default values from the design document will be used instead. Setting the LBGR at 50% of the DCGL and choosing the Δ/σ value (relative shift) to be 3 results in 11 data points needed for alpha or beta-gamma measurements. This results in a 5% probability that the survey unit will be incorrectly determined to not need additional surveys (i.e., released) when it actually does (Type I error, α) and in a 10% probability that the survey unit will be incorrectly determined to need additional surveys when it does not (Type II error, β). Using the existing limited dataset (alpha and beta-gamma data averages of 76.2 dpm/100 cm^2 and 473.8 dpm/100 cm^2, respectively, with alpha and beta-gamma standard deviations of 46.2 dpm/100 cm^2 and 287.2 dpm/100 cm^2, respectively),[24] there is 95% confidence that the alpha readings will be within the interval of -14 to 167 dpm/100 cm^2 and that the beta-gamma readings will be within the interval of -89 to 1037 dpm/100 cm^2, of which the upper bounds of the 95% confidence intervals for both are below 25% of the DCGL (the Class 3 survey unit upper boundary for reclassification as a Class 2 or 1).

6.3.3.2 Furnishings–survey unit classifications and survey procedures

As stated in Sect. 5.3, survey units are classified as either Class 1, 2, or 3, based on historical data and process knowledge providing information on the contamination potential for the unit. Furnishings (which includes all furniture, equipment racks, air conditioners, equipment, etc., for the purposes of this

[22] *Survey Protocol Unrestricted Release of Building Furnishings*, prepared by Safety and Ecology Corporation (SEC) for Bechtel Jacobs Company LLC Radiation Control (RADCON).

[23] The Wilcoxon-Rank Sum (WRS) statistical test is used when the primary contaminants are found in background. The Sign test is to be used when the contaminant is not found in background or when the contaminants are in background, but at a small fraction of the DCGL. The Sign test will be used for this survey.

[24] The alpha and beta-gamma average values quoted are actually the averages of the instrumentation's L_c values, as the readings were denoted as "NEAD" (i.e., the radioactivity levels were essentially background).

portion of the survey) are considered to have a low potential for residual contamination being present. All survey units will have NaI, alpha, and beta-gamma scan surveys performed on them, with the areas covered by the scans determined by professional judgment. In addition, direct and removable alpha and beta-gamma measurements will be taken in the areas with the highest readings, as determined during the scan surveys. A detailed listing of all the items within the survey unit is not required; a generalized item listing of survey unit classification and number, NaI scan results, and the individual survey data points is the minimum data reporting requirement.

Each building ISU (Table C.2) will be the basis for the FSU; therefore, there is the potential for each building survey unit to have up to three different FSUs. The sole exception to this is if there are very few items to make up a survey unit of a particular class; in that case, the items can be combined from the entire building to make a survey unit. The individual FSUs will be designated in a manner similar to the following example to identify the ISU and the FSU [e.g., ISU 4 FSU C3, which designates that the data are from the interior survey unit 4 (ISU 4) furnishings survey unit Class 3 (FSU C3)].

Class 3 Furnishings Survey Units

All newer furnishings will be grouped together in batches (survey units) and classified as Class 3, as they have a very low potential for having been used in other facilities or areas that are potentially contaminated. The total surface area of each Class 3 survey unit will not exceed 5000 m^2. The surface scan surveys will cover 10% of all accessible areas.

Class 2 Furnishings Survey Units

Older furnishings, which may have been used in other buildings or areas, will be grouped into survey units and classified as Class 2. The total surface area of a Class 2 FSU will not exceed 1000 m^2. The surface scan surveys will cover 10% of all accessible areas.

Class 1 Furnishings Survey Units

Only furnishings that have exceeded the Class 2 criteria, above, will be classified and surveyed as a Class 1 survey unit. The total surface area of a Class 1 FSU will not exceed 100 m^2. The surface scan surveys will cover 100% of all accessible areas.

All furnishings survey data results (in each survey unit) that meet the above criteria will be evaluated against the Sign test criteria to determine if the items can be released. The null hypothesis, H_o, to be tested is that the residual radioactivity in the survey unit exceeds the DCGL. If the null hypothesis is rejected based on the non-parametrical statistical test, then the alternative hypothesis (H_a) is accepted, which states that the residual radioactivity in the survey unit does not exceed the DCGL and, therefore, can be released.

6.3.3 Survey Unit Reclassification

Any interior or exterior Class 3 areas that exceed 25% of the DCGL will be reclassified as Class 2 areas and resurveyed accordingly. Any Class 3 or 2 areas that exceed the DCGL will be reclassified as Class 1 areas and resurveyed accordingly. All reclassified areas will be discussed in the revision to this survey plan, the Radiological Survey Report, and the Environmental Baseline Summary (EBS) for the building.

Within the Class 3 FSUs, if residual radioactivity is found in excess of 25% of the DCGL, the item with the residual activity, and all items of a similar type and history in that survey unit, will be removed from that survey unit, reclassified as a separate Class 2 FSU, and resurveyed accordingly. If residual radioactivity is found in excess of the DCGL in an FSU, the item with the residual activity, and all items

of a similar type and history in that survey unit, will be removed from that survey unit, reclassified as a separate Class 1 FSU, and resurveyed accordingly.

6.4 SPECIFICATION OF SAMPLING LOCATIONS

All recorded survey measurement locations are to be on a judgmental basis for Class 3 survey units, per the design document, and should include entrances, primary traffic areas, air vents, and primary workspaces. These are the areas that would be expected to have the highest probability of having elevated readings. Survey locations for any survey unit upgraded to Class 2 or 1 will be provided as needed.

6.5 DATA EVALUATION

All data greater than the DCGL will be evaluated using the Sign non-parametrical statistical test, as outlined in the design document, to assist in the decision to release the facility.

7. DOCUMENTATION

Survey data will be documented in accordance with the procedures and reviews required by the DOE contractor. A report will be prepared describing the survey methods, results, and evaluation. The report will include the findings of the assessment, along with a description of the materials surveyed, their condition, and a justification for the potential contamination classification assigned. The data evaluation will be included, along with the assessment of the quality assurance/quality control (QA/QC) documentation. This report, or a summary of the report, will also be included and referenced in the facility's baseline environmental conditions documentation.

8. QUALITY ASSURANCE

All appropriate QA/QC reviews to ensure the quality of the data gathered will be performed and documented.

Survey instruments and methods specified in applicable RADCON operating and technical procedures have been documented as to their ability to provide a 95% confidence level in the detection of surface contamination at levels that meet the requirements of this protocol. Supporting data are provided on each survey form.

For additional verification of survey results, Radiological Control Technicians not involved in the execution of this protocol will repeat approximately 5% of the direct and removable activity measurements on items destined for unrestricted release. To satisfy the release criteria, the results must confirm the initial findings.

A RADCON Certified Health Physicist (DOE contractor), or another designated health physicist, will review, evaluate, and validate the survey results, including assessment of the QA/QC information and data, prior to their use in generating the radiological survey report. The final radiological survey report will include the details of this assessment. The radiological survey report will be provided to the DOE contractor's project QA Manager, project manager, and site project Health Physicist for approval prior to its inclusion into the facility's baseline conditions documentation.

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