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U.S. Department of Energy
Grand Junction Projects Office Remedial Action Project

Final Report of the Decontamination and Decommissioning of Building 31 at the Grand Junction Projects Office Facility

July 1996

U.S. Department of Energy
Grand Junction Projects Office

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Work Performed Under DOE Contract No. DE–AC04–86ID12584 for the U.S. Department of Energy

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July 1996

Prepared for
U.S. Department of Energy
Albuquerque Operations Office
Grand Junction Projects Office
Grand Junction, Colorado

Prepared by
Rust Geotech
Grand Junction, Colorado

Technical Coordination and Reports Project Number TCR–031–0002–00–000
Technical Coordination and Reports Document Number T0000200

Rust Geotech has been granted authorization to conduct remedial action under the Decontamination and Decommissioning Program. Remedial action was conducted in accordance with all applicable or relevant and appropriate requirements.

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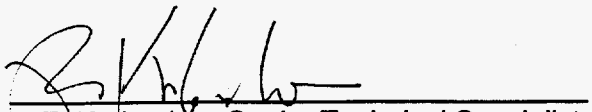
Signature Page

Prepared by:



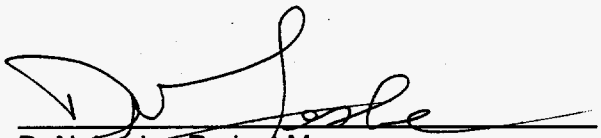
J. E. Krabacher, Senior Technical Specialist
Technical Coordination and Reports
Rust Geotech

7.25.96
Date

Approved by:

C. L. Jacobson, Program Manager
Decommissioning Programs
Rust Geotech

7/25/96
Date



D. N. Leske, Project Manager
U.S. Department of Energy
Grand Junction Projects Office

7/26/96
Date

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Abstract

The U.S. Department of Energy (DOE) Grand Junction Projects Office (GJPO) occupies a 61.7-acre facility along the Gunnison River near Grand Junction, Colorado. This site was contaminated with uranium ore and mill tailings during uranium refining activities of the Manhattan Engineer District and during pilot milling experiments conducted for the domestic uranium procurement program funded by the U.S. Atomic Energy Commission. The DOE Defense Decontamination and Decommissioning Program established the GJPO Remedial Action Project to clean up and restore the facility lands, improvements, and the underlying aquifer. The site contractor for the facility, Rust Geotech, also was the remedial action contractor.

Radiological contamination was identified in Building 31 and the building was demolished in 1992. The soil area within the footprint of the building has been remediated in accordance with the identified standards and the area can be released for unlimited exposure and unrestricted use. This area was addressed in the summary final report of the remediation of the exterior areas of the GJPO facility. This document was prepared in response to a DOE request for an individual final report for each contaminated GJPO building.

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Acronyms

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*U.S. Code of Federal Regulations*
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
FS	feasibility study
FUSRAP	Formerly Utilized Sites Remedial Action Program
GJPO	Grand Junction Projects Office
GJPORAP	Grand Junction Projects Office Remedial Action Project
IVC	independent verification contractor
LTSM	Long-term Surveillance and Maintenance
QA	quality assurance
RAC	Remedial Action Contractor
RDC	radon decay-product concentration
RI	remedial investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SFMP	Surplus Facilities Management Program
U.S.C.	United States Code

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I. Introduction and Background

This report summarizes the results of the remedial action conducted on Building 31 at the U.S. Department of Energy (DOE) Grand Junction Projects Office (GJPO) facility. This building was radiologically contaminated. The selected remedial action alternative was decontamination. Decontamination procedures were found to be ineffective, and Building 31 was demolished in 1992. The soil within the building footprint complies with applicable regulations and can be released for unrestricted use and unlimited exposure. After all Grand Junction Projects Office Remedial Action Project (GJPORAP) remedial action is completed, the facility is expected to be transferred to the Long-Term Surveillance and Maintenance (LTSM) Program to allow restoration of the aquifer. The remediation of the exterior land areas (DOE 1995a) and the other buildings and associated utilities on the DOE–GJPO facility will be summarized in separate reports.

Description of Facility

The DOE–GJPO facility is located approximately 0.6 mile (1 kilometer) south and west of populated areas of the city of Grand Junction in Sections 26 and 27, Township 1 South, Range 1 West, Ute Principal Meridian, Mesa County, Colorado (Figure 1). The facility occupies 61.7 acres* (25 hectares) of floodplain within an accretionary bend along the east bank of the Gunnison River.

The elevation of the DOE–GJPO facility is approximately 4,560 feet (1,390 meters). The facility is situated on silty sandy gravel underlain by mudstone bedrock. Two bodies of water, the North Pond and the South Pond, with associated wetlands, are located on the DOE–GJPO facility. A freshwater alluvial aquifer underlying the facility is in direct hydraulic contact with the ponds and the Gunnison River. A semi-arid climate prevails.

Access to the occupied portion of the facility is restricted by security personnel and a fence. There are approximately 40 structures on the facility. Beyond the fence are vehicle parking lots to the east and an earthen dike along the Gunnison River to the west and north. The area adjacent to the facility to the north was formerly Black Bridge Park, now owned by DOE. The facility is bordered on the east by the Southern Pacific Railroad (formerly the Denver and Rio Grande Western Railroad) right-of-way.

DOE–GJPO facility lands were acquired by the U.S. War Department in 1943 for the Manhattan Engineer District. A refinery was operated on the site from 1943 to 1946 to treat and concentrate uranium oxide. The U.S. Atomic Energy Commission operated a uranium-concentrate sampling plant and assay laboratory on site until 1974. Pilot-scale uranium ore mills were operated from 1953 to 1958, processing 30,000 tons (27,200 metric tons) of ore (DOE 1987a). Mill operations were the primary source of contaminated materials at the DOE–GJPO facility, resulting in the on-site burial of approximately 247,000 cubic yards (yd^3), or 189,000 cubic meters (m^3), of uranium ore tailings. Other potential sources of contamination included laboratory and vehicle-maintenance wastes and by-products and activities related to sampling and stockpiling uranium concentrates. Approximately 22 acres (8.9 hectares) of open land and 19 buildings were contaminated.

Description of Project

In 1984, the DOE–GJPO facility was accepted into the DOE Surplus Facilities Management Program (SFMP) for the purpose of eliminating health hazards resulting from uranium mill tailings and associated contaminated materials at the facility; and to bring contaminated portions of the facility, including the underlying aquifer, into compliance with applicable environmental regulations. In 1988, the facility was transferred to the DOE Decontamination and Decommissioning (D&D) Program. The D&D Program is responsible for the surveillance and maintenance of surplus DOE facilities, including the performance of any

*Previous to the reacquisition of Black Bridge Park, the facility occupied approximately 56.4 acres.

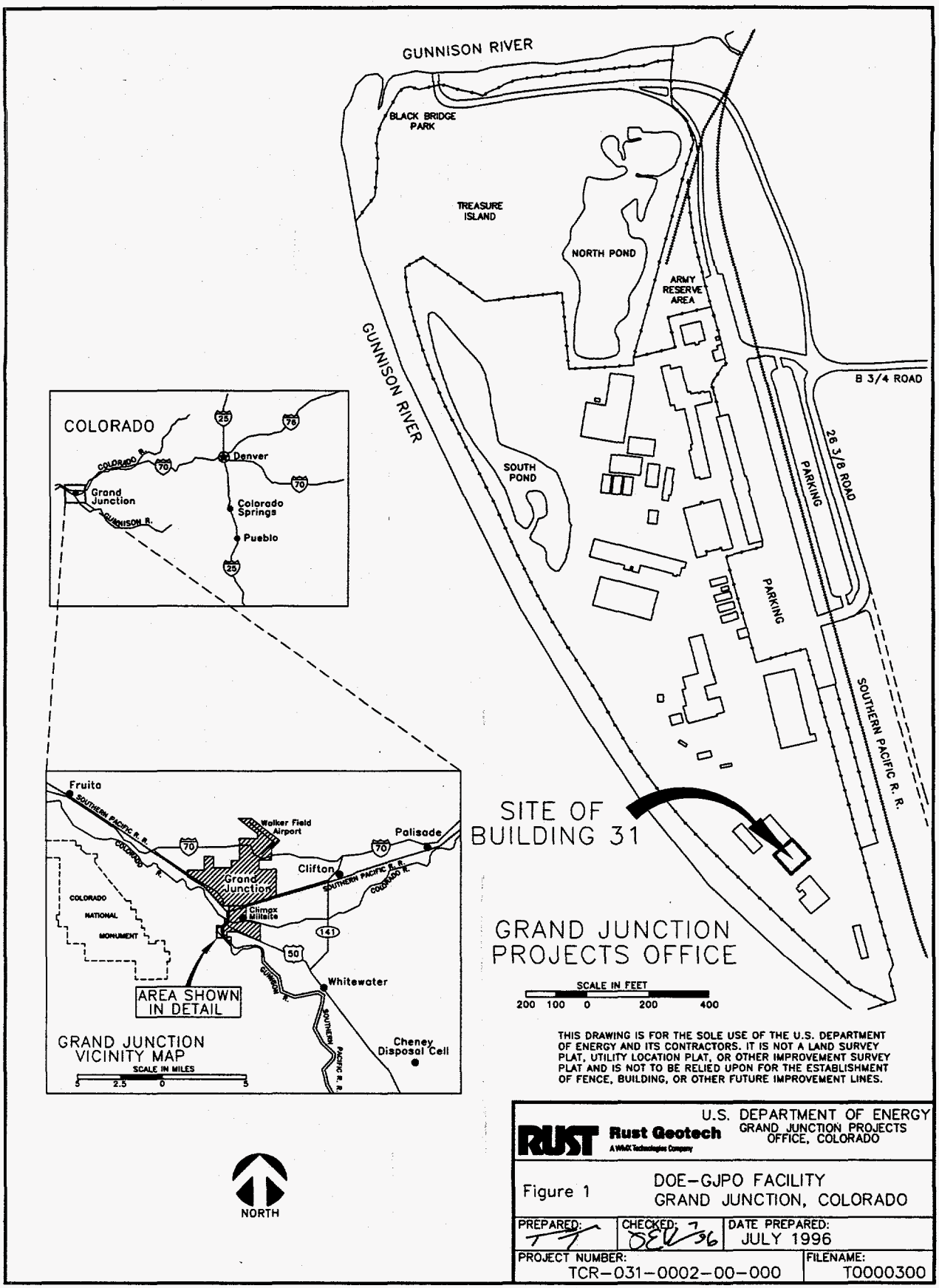

Figure 1. Site Map of the DOE–GJPO Facility, Grand Junction, Colorado

necessary decontamination and decommissioning activities. DOE–GJPO has specific responsibility for GJPORAP under the D&D Program. Rust Geotech is the Remedial Action Contractor (RAC) for GJPORAP. The GJPORAP organization and implementation strategy was defined in the *Grand Junction Projects Office Remedial Action Project Remedial Action Plan* (DOE 1990c).

Description of Building 31

Building 31 was constructed of corrugated sheet-metal siding and roofing attached to a steel frame, with a grade beam foundation and a concrete slab floor. A wood-floor mezzanine was constructed over the north half of the ground floor. The building had a footprint of 10,000 square feet (ft^2), or 929 square meters (m^2). It was constructed in 1954 to house the acid-leach circuit of a pilot-scale uranium ore mill. Milling activities commenced in 1955 and continued until 1958 (DOE 1987a). The building subsequently was used for storage, including uranium and vanadium concentrates.

Basis for Remedial Action

In 1980, the U.S. Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 *United States Code* [U.S.C.] 9601). In 1986, Congress amended CERCLA with the Superfund Amendments and Reauthorization Act (SARA). Section 120 of SARA and Executive Order 12580, *Superfund Implementation*, directed DOE to coordinate with the U.S. Environmental Protection Agency to respond to actual or potentially imminent releases of hazardous substances into the environment at federally owned DOE facilities. D&D Program policy specifies that remedial action will be conducted in accordance with DOE Order 5480.1B, *Environment, Safety, and Health Program for Department of Energy Operations*, and all other applicable environmental regulations.

The DOE–GJPO facility was evaluated using the CERCLA Hazard Ranking System. Although the resulting score of 14.6 (DOE 1989b) did not qualify the facility for placement on the National Priorities List, remedial action under GJPORAP conformed to the applicable provisions of CERCLA, as amended by SARA, and the Uranium Mill Tailings Radiation Control Act (42 U.S.C. 7901), the National Environmental Policy Act (42 U.S.C. 4321), and other applicable Federal and State regulations. Remedial action was conducted with an emphasis on maintaining all health and safety risks as low as reasonably achievable.

II. Decommissioning Criteria, Objectives, and Work Scope

Applicable Guidelines and Standards

Table 1 presents the regulations that specify the authorized limits for GJPORAP.

Remedial action activities were conducted in accordance with the Rust *Quality Assurance* [QA] *Manual* (Manual 101) and approved plans and procedures (Appendix A), which incorporated the applicable provisions of the *Quality Assurance Program for Nuclear Facilities*, NQA–1 (ASME 1989).

III. Work Performed

Remedial Investigation/Feasibility Study and Record of Decision

The Remedial Investigation/Feasibility Study (RI/FS)-Environmental Assessment for GJPORAP was released in 1989 (DOE 1989a).

Building 31 was one of the four buildings included in the original scope of GJPORAP and addressed in the FS. Radiological contamination and asbestos were identified in Building 31 during surveys conducted in 1986, 1987, and 1988 (DOE 1989a). The selected remedial action alternative, detailed in the FS, specified that asbestos would be removed from the building and the building would be decontaminated using vacuuming, pressure washing or abrasion, or

Table 1. Applicable or Relevant and Appropriate Regulations

Type of Occurrence	Standard
Contamination in Soil	40 CFR 192[a] FUSRAP/SFMP Guidelines[b] DOE Order 5400.5[c]
Surface Activity (structural surfaces)	FUSRAP/SFMP Guidelines[b] DOE Order 5400.5[c]
Gamma Exposure Rate (interior areas only)	40 CFR 192[a] FUSRAP/SFMP Guidelines[b] DOE Order 5400.5[c]
Radon Decay-Product Concentration (interior areas only)	40 CFR 192[a] FUSRAP/SFMP Guidelines[b] DOE Order 5400.5[c]

[a]Title 40, *U.S. Code of Federal Regulations* Part 192 (40 CFR 192), "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings."
[b]*Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program* [FUSRAP] *and Remote Surplus Facilities Management Program Sites* (DOE 1987b).
[c]DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

localized removal and replacement of building components. The building would be returned to unrestricted use for storage. This alternative was adopted in the Record of Decision (ROD) (DOE 1990a).

Post-ROD Changes—The selected remedial action alternative was implemented in 1989 but halted when contamination was found to be more extensive than assessed and distributed in inaccessible areas. Because achieving free release would cost more than the worth of the building, the selected alternative was changed to demolition.

An Explanation of Significant Differences will be prepared at the conclusion of GJPORAP remedial action activities to address departures from the ROD, including the demolition of Building 31.

Characterization

Building 31 was surveyed for alpha contamination in 1986; none exceeding the guidelines was detected (DOE 1986). After discovery of additional contamination, a more comprehensive assessment was conducted in 1989. This survey included measurements of gamma exposure rates; alpha and beta-gamma scans, direct measurements and smears; measurements of the radium-226 (Ra-226) content of the concrete floors; and qualitative radon decay-product concentration (RDC) measurements. Additionally, the concrete floor was cored and logged, and the soil beneath the floor was sampled and analyzed (DOE 1989c).

Radiological Contamination—The 1986 characterization survey detected fixed alpha surface activities as high as 1,440 disintegrations per minute per 100 square centimeters (dpm/100 cm^2); no activity exceeded the release guidelines. Gamma exposure rates ranged as high as 483 microroentgens per hour (μR/h). The floor was not cored because of the thickness of the slab.

The 1989 characterization survey identified contamination in the overlap of the metal sheets on the roof and walls; within the roof trusses, cross-members, and other structural members; in and on the light fixtures; in the concrete floor, trenches and sumps; embedded in the exterior walls; along piping and electrical conduits; in the cracks and crevices along interior wall surfaces and on top of stemwalls; and embedded in wooden flooring and the stairwell. Preliminary RDC measurements were approximately 0.020 Working Level (WL). Ra-226 concentrations in contaminated sediment from the concrete trenches ranged as high as 343.2 picocuries per gram (pCi/g). Gamma exposure rates ranged as high as 1,021 μR/h. Some elevated exposure rates were influenced by secondary radiation from barrels of radioactive material and geophysical logging sources stored in the building. Beta-gamma surface activities

ranged as high as 850,563 dpm/100 cm^2. Alpha surface activities ranged as high as 46,860 dpm/100 cm^2.

Nonradiological Contamination— Asbestos was identified in steam pipe insulation and as asbestos cement board backing used for electrical panels.

Remedial Design

The initial decontamination procedure for Building 31 was described in the specifications for GJPORAP Phase I (DOE 1988).

The remedial action alternatives were reassessed and presented in the *Grand Junction Projects Office Remedial Action Project, Decommissioning Project Plan for Buildings 6 and 31* (DOE 1991). The alternatives included decontamination, using conventional construction methods or high-pressure washing, and demolition. The selected alternative was demolition (DOE 1992). The building was documented in accordance with the National Historic Preservation Act (Chem-Nuclear Geotech, Inc. 1991).

The remediation process would involve demolishing the building, removing the foundation and associated utilities, and remediating the underlying soil. Radiologically contaminated materials would be impounded at the Cheney Disposal Cell. After the removal of uranium mill tailings and other associated contaminated material, the affected areas would be reconstructed.

Decontamination Operations

Summary of Remedial Action—An attempt to decontaminate Building 31 was conducted in 1989 during construction Phase IA. Contaminated sediment and debris were removed from trenches and sumps, and sections of steam pipe and electrical conduit were removed. Various solvents and high-pressure washing were used to clean the walls. Portions of the steel frame were scraped and vacuumed. Although these methods were successful on portions of the east and north interior walls, this remediation effort was suspended when it became apparent that contamination was more extensive than assessed.

Building 31 was demolished in April 1992 during construction Phase IC/ID/V. Some of the structural steel was free-released for salvage in accordance with survey and documentation procedures specified in the Rust *Health and Safety Desktop Procedures,* Manual 303. The remainder of the building debris, including the wood mezzanine, sheet metal skin, foundation members, and the floor slab were sized and disposed at the Cheney Disposal Cell. Excavation of soil beneath the building continued until gamma measurements indicated that all soil with elevated gamma activity was removed. The depth of the excavation ranged from 24 to 36 inches.

Radiological Contamination—Radiological contamination was removed from within the area of Building 31, as indicated by the results of soil sample analyses and gamma exposure rate scans (Appendix B, Table B–1).

Nonradiological Contamination— Asbestos abatement activities were conducted in 1988. Asbestos insulation on abandoned steam pipes and asbestos cement board backing for electrical panels was removed and disposed at the Mesa County Landfill (Rust 1996).

IV. Final Release Survey

The final status surveys of the soil underlying the location of Building 31 were conducted in accordance with the Rust *Health and Safety Manual* (Manual 103), Volume 1, the Rust *Field Assessments Procedures Manual,* and approved plans (DOE 1990c). This work was conducted prior to the adoption of the *Survey Plan for Releasing the Buildings at the Grand Junction Projects Office for Unrestricted Use* (DOE 1995b).

Oak Ridge National Laboratory–Grand Junction was the independent verification contractor (IVC) for GJPORAP. Oversight activities were conducted by representatives of the RAC QA

Group and the Colorado Department of Public Health and Environment.

Instrumentation

Radiation detection instruments were calibrated and used in accordance with the Rust *Field Assessments Procedures Manual.* Calibrations used traceable standards and complied with DOE Order 5480.11, *Radiation Protection for Occupational Workers*, Change 2, and DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards.*

Background Determinations

Background values determined for the DOE–GJPO facility are summarized in Table 2.

Reference Grids

Grids were established over the affected area to reference the locations of measurements and samples. Grids were established locally for each individual remediation site; each grid was tied to a permanent feature on the site such as a building corner. All permanent features are referenced to a benchmark east of the DOE–GJPO facility. For Building 31, nine verification areas (V-areas) of less than 100 m^2 each were established (Figure 2). Each V-area was gridded into 10 foot (ft) by 10 ft blocks.

Scanning Results

No structural surfaces remain in this area; therefore, scanning for alpha or beta-gamma surface activity was not conducted. One hundred percent of the exposed soil surface was scanned for gamma activity. Gross gamma exposure rates ranged from 12 to 17 µR/h (Appendix B, Table B–1). The results of the gamma scan indicated that the hot spot criteria were met.

Direct Measurements

No structural surfaces remain in this area; therefore, direct measurements for alpha or beta-gamma surface activity were not taken.

Sample Results

For each V-area, a soil sample aliquot was collected from the center of each block. The aliquots were composited into samples representing the first 6 inches (15 cm) of soil of the excavation floor. The area represented by these samples covered the footprint of Building 31 (Figure 2). The samples were analyzed for Ra-226, thorium-230, thorium-232, and potassium-40. One sample was analyzed for total uranium (Appendix B, Table B–1). As a cost-saving measure, analysis for total uranium was not conducted on the remaining samples because they exhibited less than 2,500 dpm/100 cm^2 beta-gamma activity when scanned at the time of collection. Previous sample results had shown that activities below this value indicated measurable uranium concentrations that were still below the authorized limit. Extensive sampling conducted previously in other areas had shown that uranium was probably not a contaminant of concern.

Exposure Rates

The postremedial surface was verified in

Table 2. Background Values for the DOE–GJPO Facility

Criterion	Background Value	Source of Data
Gamma Exposure Rate—Exterior	14 µR/h	DOE 1986
Radium-226 Concentration in Soil	1.0 pCi/g	DOE 1990b
Thorium-230 Concentration in Soil	2.0 pCi/g	DOE 1990b
Thorium-232 Concentration in Soil	1.0 pCi/g	DOE 1990b
Total Uranium Concentration in Soil	2.0 pCi/g	DOE 1990b

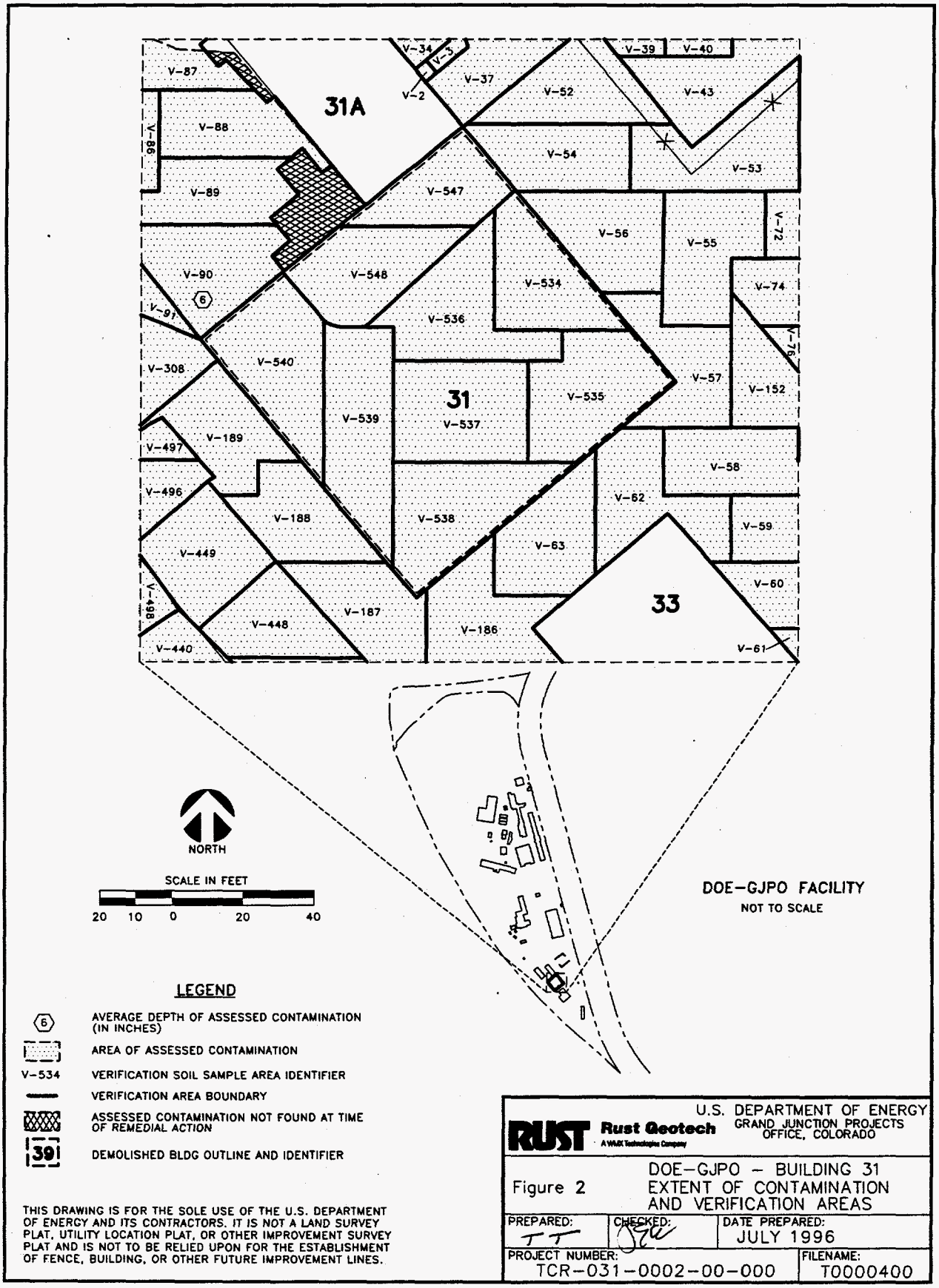

Figure 2. Extent of Contamination and Verification Areas

accordance with exterior guidelines; therefore, discrete gamma exposure rate measurements were not taken.

V. Cost and Schedule

Project costs and the schedule for remediation of Building 31 will be shown in a summary final report of the GJPORAP remediation of the interior areas of the DOE–GJPO facility.

VI. Occupational Exposure

The results of personnel and area monitoring of exposure of workers and the public to radiological and nonradiological hazards resulting from GJPORAP-related activities indicated no above-background exposures to radioparticulates, including radon daughters, ionizing radiation, or other hazards.

VII. Waste Volumes

The remediation of Building 31 generated a total of 1,250 tons (1,130 metric tons) of contaminated materials, representing a volume of approximately 780 yd^3 (596 m^3) of contaminated material, including building debris and soil. This material was disposed at the Cheney Disposal Cell.

VIII. Final Condition

All decontamination requirements identified in the ROD for GJPORAP have been met for the soil at the former location of Building 31 (Table 3). The IVC will issue a Statement of Verification to signify its concurrence that this portion of the remedial action has achieved program objectives.

Radiologically contaminated material has been removed, and all remediated areas comply with the applicable provisions of 40 CFR 192, FUSRAP/SFMP guidelines, and DOE Order 5400.5. Suspected occurrences of nonradiological contamination have been investigated, and all identified occurrences of nonradiological contamination have been remediated.

Remediated areas have been restored to comply with floodplain permits, the Endangered Species Act, and other applicable regulations. Groundwater sampling will provide further assurance that contaminated materials currently managed on site will not pose any threat to human health or the environment. Sufficient data have been collected to document the final site conditions and to demonstrate that the cleanup levels specified in the ROD were attained. These data and associated information are available to the public and will be archived in the Certification Docket.

Because of the limitations of current technology and procedures for identifying and remediating radiologically contaminated materials, unknown deposits of contamination may be found in the future. The potential for encountering contamination during future construction activities will be determined and at-risk activities will be monitored for radiological and nonradiological contamination. The DOE–GJPO facility is routinely surveyed for radiation and other hazards.

No assessed hazardous substances were left in the remediated area; the area can be released for unrestricted use and unlimited exposure. At the time of this report, contamination is still present in other interior areas of the DOE–GJPO facility; these areas will be addressed by future GJPORAP remedial actions. Access to these areas is controlled. After the interior remedial action is completed, the facility will be managed as an LTSM site by DOE until restoration of the alluvial aquifer by natural flushing action has occurred.

Table 3. Building 31 Certification Summary

Certification Criterion	Authorized Limit	Number of Observations	Results
Gamma Exposure Rate (interior areas only)	< 20 µR/h above background[a].	None	Not applicable: no interior areas.
Radon Decay-Product Concentration (interior areas only)	Annual average shall not exceed 0.02 WL, to the extent practicable, and in no case shall exceed 0.03 WL.	None	Not applicable: no interior areas.
Scans (structural surfaces only	Elevated activity will be investigated.	Gamma: scanned 100% of the surface Alpha and beta-gamma: none	Gamma: exposure rate range was 12 to 17 µR/h. Alpha and beta-gamma: not applicable—no structural surfaces.
Surface Activity (structural surfaces only)	Alpha or beta-gamma activity shall not exceed 5,000 dpm/100 cm² fixed, 1,000 dpm/100 cm² removable, averaged over 1 m².	None	Not applicable: no structural surfaces.
Radionuclide Concentrations (soil surfaces only)	Ra-226, Th-230, and Th-232: Shall not exceed 5 pCi/g above background[a] in the 15-cm surface layer, averaged over 100 m².	None	Not applicable: excavation depth > 15 cm.
	Shall not exceed 15 pCi/g above background[a] in any 15-cm-thick soil layer more than 15 cm below the surface, averaged over 100 m².	9 composite samples	Ra-226: 4.3 pCi/g maximum Th-230: 2.4 pCi/g maximum Th-232: 1.4 pCi/g maximum
	Total uranium: Shall not exceed 106 pCi/g above background[a] in any 15-cm surface layer, averaged over 100 m².	1 composite sample, other samples scanned for beta-gamma activity	One sample: 16.5 pCi/g Other samples not analyzed: surface activity < 2,500 dpm/ 100 cm².
Hot Spot Criteria	Limit = (guideline value)(100/area)$^{0.5}$	As required	Maximum concentrations below hot spot limit.

[a]Background activities are summarized in Table 2.

Note: Radionuclide concentrations and gamma exposure rates include background.

Key:

cm	=	centimeter(s)
dpm/100 cm²	=	disintegrations per minute per 100 square centimeters
m²	=	square meter(s)
pCi/g	=	picocuries per gram
Ra-226	=	radium-226
Th-230	=	thorium-230
Th-232	=	thorium-232
µR/h	=	microroentgens per hour
WL	=	working level

IX. Lessons Learned

Lessons learned during remediation of Building 31 have been incorporated into subsequent operations. These lessons will be presented in a summary final report of the GJPORAP remediation of the interior areas.

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Appendix A

Applicable Program and Quality Assurance Requirements and Procedures

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GJPORAP Program Management

Operations Management Policy Manual (Manual 104)

Project Control System Manual (Manual 107)

Management Policies Manual (Manual 100), Section 1, "General Administration," and Section 12, "Organization Functions and Responsibilities"

Remedial Action Statements of Work

Grand Junction Projects Office Desk Procedures Manual

Grand Junction Projects Office Remedial Action Project (GJPORAP), Grand Junction, Colorado, Community Relations Plan Update

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Productivity/Quality Improvement Manual (Manual 109)

GJPORAP Construction Management

Operations Management Policy Manual (Manual 104)

Operations Department Construction Procedures Manual

Engineering

Engineering Process Planning Guidelines

AutoCAD Standards Manual

Assessment/Verification

Land Survey Support Procedures

AutoCAD Standards Manual

Environmental Procedures Catalog (Manual 116)

Laboratory Services

Analytical Laboratory

Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures

Analytical Chemistry Laboratory Handbook of Analytical and Sample Preparation Procedures, Volumes I, II, and III

Gamma-Ray Spectroscopy System Operations Methods Manual

Environmental Instrumentation Laboratory

Calibration Control Program for Measurement and Test Equipment and Measurement Standards

Electronics Laboratory Procedures

Quality Assurance

Quality Assurance Desk Instructions and Administrative Procedures Manual (Manual 301)

Health, Safety, and Security

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Stores, Property, and Transportation (SPAT) Manual (Manual 114)

Rust Guide for Preparing a Purchase Requisition

Information Services

Computer Support

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Appendix B

Final Radiological Conditions

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Table B–1 summarizes the post-excavation sampling and measurement results for the verification areas (V-areas) encompassing the site of Building 31. The samples were acquired prior to backfilling. Each sample is a composite comprising individual aliquots representing the 6-inch-thick soil layer at the bottom of the excavation. Each sample was analyzed for radium-226 (Ra-226) using the Opposed Crystal System (OCS) and then analyzed by the Rust Geotech analytical laboratory for Ra-226, potassium-40 (K-40), and thorium-232 (Th-232) using gamma spectroscopy; and thorium-230 (Th-230) using alpha spectroscopy. One sample was analyzed by the analytical laboratory for total uranium, using inductively-coupled plasma mass spectrometry (ICPMS). These analyses were conducted in accordance with laboratory procedures specified in the laboratory analytical reports. The concentrations of all isotopes are expressed in picocuries per gram (pCi/g), and include background. The post-excavation gamma exposure rate ranges are expressed in microroentgens per hour (μR/h). The V-areas are shown on Figure 2.

Table B–1. Post-Excavation Sample/Measurement Results for Exterior Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–534	12 - 16	NAP 617	1.7	3.8	18.5	2.4	1.3		24
V–535	12 - 16	NAP 618	1.7	3.6	17.9	1.9	1.0		26
V–536	12 - 16	NAP 619	2.5	3.7	16.4	1.5	0.9		24
V–537	12 - 16	NAP 620	2.8	4.3	16.6	1.8	1.4		25
V–538	12 - 16	NAP 621	2.3	4.0	18.2	1.6	1.2		28
V–539	12 - 16	NAP 622	1.1	4.2	18.6	1.6	0.7	16.5	24
V–540	12 - 16	NAP 623	1.0	3.8	18.8	1.9	1.3		24
V–547	14 - 17	NAR 604	1.1	1.1	18.8	1.1	0.8		35
V–548	13 - 16	NAR 605	1.6	1.0	19.0	1.4	0.7		36

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