ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Decommissioning Closeout Report for the 881 Closure Project

Revision 0

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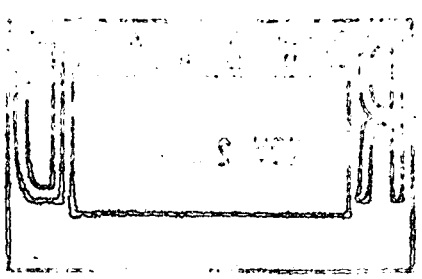

TABLES AND FIGURES

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1.0 Introduction

In accordance with the Decommissioning Program Plan, a closeout report is required for type 1 and 2 facilities. This Decommissioning Closeout Report is for the 881 Closure Project documenting the decommissioning completion for Building 881, stacks S1, S2, and S3; and facilities 830, 864, 885, 887, 890, 881F, 881G, and the 881/883 tunnel.

Building 881C and cooling towers CT2 and CT3 on the east side of Building 881 were addressed in a separate closeout report, Administrative Record (AR) document number B881-A-000029.

In accordance the Implementation Guidance Document, Appendix 3 to the Rocky Flats Cleanup Agreement (RFCA), an environmental restoration closeout report format may contain the following:

- Introduction
- Action description
- Verification that action goals were met
- Verification of treatment process (if applicable)
- Radiological analysis (if applicable)
- Waste stream disposition
- Site reclamation
- Deviations from the decision document
- Demarcation of wastes left in place
- Dates and durations of specific activities
- Final disposition of wastes (actual or anticipated)

This same format was used for this decommissioning closeout report, but it was modified as necessary to address decommissioning activities. This report was developed using the following format:

- Introduction including building history and description.
- Project description including processes used for decommissioning and dates and durations of specific activities
- Project documentation includes a reference to the Site-wide and Project-specific documentation used for the project
- Waste Disposition
- Site Reclamation including portions of the facilities and ancillary underground structures that will remain in place

No treatment technologies or waste were left in place for this project. Documentation that was submitted as part of this project will not be included in this report; instead, a reference was made to these documents and copy of the Administrative Record (AR) for this project was included in Appendix B of this report. When completed and approved by DOE and the LRA, this Decommissioning Closeout Report will be submitted to the 881 Closure Project Administrative Record Post-decisional File.

1.1 Building Description and History

Building 881 was a rectangular, concrete multi-story structure encompassing approximately 245,160 square feet. It has 17,870 square feet in the basement, 86,300 square feet on the first floor, 6,000 square feet on the first floor mezzanine, 121,460 square feet on the second floor, and 13,530 square feet on the second floor mezzanine. Additionally, there were two rooftop structures, supply and exhaust filter plenums, 3,600 and 9,470 square feet, respectively. Four additions had been built since the original construction in 1952:

- 1956, a two story Annex, 31,600 square feet including supply and exhaust ventilation and a stack added to the northwest corner to provide additional machining capability, and several radiography vaults were added in the northeast corner of the structure
- 1969, the pressure test facility was added on the east side
- 1986, the new two-stage, HEPA exhaust filter building (881F) was built on the roof of the existing structure, and an exhaust chase was added to the east side to bypass the original single-stage exhaust filters

Associated facilities within the 881 Closure Project include:

- Building 887, Sewage and Process Waste Lift Station was located south and down-gradient of the Building 881, and was a part of the original 881 Complex construction in 1952. The reinforced concrete structure had a large below-grade vault containing 7 process waste collection tanks, and was approximately doubled to its current size of 1,555 square feet in 1955.
- The 881-883 Tunnel is an underground reinforced concrete passageway to Building 883 that was added as part of the Annex construction in 1956.
- Building 885, Oil and Paint Storage, was a 960 square feet, single-story, prefabricated metal building constructed on a reinforced concrete slab that was built in 1961 south of Building 881.
- Building 881C, Cooling Tower located east of Building 881, was constructed in the 1980s. It is one of four cooling towers (C-3) that support Building 881.
- Building 890, Cooling Tower Pump House, was constructed in 1952 to support the original cooling tower. It had been out of service since the 1980's.
- Building 881H, Electrical Equipment Building, was a prefabricated metal building on a concrete slab, 1,960 square feet in area, that abuts the east side of Building 881.
- Building 830, Isolated Power Supply Building, was a prefabricated metal building on a concrete slab, 400 square feet in area, on the east side of Building 881.
- Building 881G, Emergency Generator Building, was constructed in 1973 and housed the two emergency generators for Building 881. It was approximately 1,075 square feet, prefabricated metal construction on a concrete slab, and located immediately south of Building 881.
- Building 864 was a former guard post located on the southeast of the main structure, and was a part of the original construction in 1952.

Building 881 was designed to house all Site enriched uranium weapons operations. Original operations included the uranium oxidation, fluorination, reduction, casting, machining, and pit assembly. Support operations included waste recovery, analytical and standards laboratories, radiography, stainless-steel component and maintenance machining, and laundry.

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In the 1970s and 1980s, Building 881 was reconfigured from a production facility into a building housing Site support operations as the demand for uranium components declined. All uranium operations and most of the laboratories were stripped out in 1967, and new laboratories, the central computer facility, and a number of offices and research and development activities were added. Stainless steel component machining was finally relocated to Building 460 in 1985.

Building 881 was constructed of cast concrete walls, columns, and ceilings erected on spread footings with reinforced concrete beams. The main foundations of the building are individual spread footings of concrete for the interior columns and continuous footings of concrete for the exterior walls. The spread footings have a maximum size of 11-feet-square by 2½-feet thick, and the minimum size of 4-feet-square by 1-foot thick. The structure was reinforced concrete columns and cast concrete walls and floors. The continuous footings vary from 10- to 16-inches thick. The building contained a partial basement consisting of internal tunnels. The building was partially built into the hillside, with the roof being approximately the same elevation as the grade of the northwest corner. The structure was designed to withstand forces considerably above normal static loading based on defense mission design requirements.

The north and west walls of the building were built into the hillside descending to three feet below the floor level at the south dock. There are two loading docks on the east side, also built into the hillside and a number of retaining walls. The roof was covered with rigid insulation material and membrane roofing.

1.2 Verification That Action Goals Were Achieved

Five action objectives were established for the 881 Closure Project prior to initiating decommissioning:

1. Decontamination of the facilities (as necessary) to support release for decommissioning per site approved procedures.

   The facilities were decontaminated to unrestricted release as documented in the Pre-Demolition Survey Reports.

2. Decommissioning the 881 Closure Project facilities in accordance with RFCA and applicable or relevant and appropriate requirements.

   RFCA and other relevant requirements were complied with throughout the project.

3. Complete decommissioning activities in a manner that is protective of site workers, the public and the environment.

   Decommissioning activities were completed within regulatory requirements.

4. Demolish the 881 Closure Project facilities structures, utilities and process lines to three feet below grade.

   All structures were taken to at least three feet below grade and at least three feet of soil was used over recycled concrete.

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2.0 Project Description

Decommissioning activities were initiated in the 881 complex in January 2001 through the implementation of Section 1.1.5 of the Decommissioning Program Plan. Initial activities involved the removal of loose items such as office equipment and general trash and clutter. In general, the building was dispositioned as follows:

- Scoping and reconnaissance level characterization were performed
- Facility typing was completed
- In-process surveys were conducted, and an area was designated a plutonium or uranium area.
- Components were removed and areas decontaminated, as necessary.
- Areas were prepared for demolition (expose rebar, drilling, and wall removal), as necessary.
- Final surveys were performed.
- Basements were backfilled as necessary to minimize voids.
- The floor were severed and column rebar cut
- The building was demolished using explosives.
- The demolished material was proof-rolled.
- A choking layer of gravel was placed on the demolished debris.
- Recycled concrete was placed.
- No less than 3 feet of soil was placed to final grade and reseeded.

Decommissioning activities were stopped from April 2003 to October 2003 due to funding limitations. The following outlines the actual sequence of events and major milestones:

- 885 demolition was completed on January 21, 2003
- 881A demolition was completed on April 9, 2003
- 830 demolition was completed on July 21, 2003
- Asbestos abatement was conducted in Building 881 from October 1, 2003 through May 20, 2004
- Component removal and size reduction was conducted in Building 881 from October 1, 2003 through May 27, 2004
- Component removal using explosives was conducted on February 27 and 29, 2004
- Decontamination was conducted in Building 881 from October 16, 2003 through July 9, 2004
- Pre-demolition survey was conducted in Building 881 from December 20, 2003 through July 16, 2004
- 881F demolition was completed June 5, 2004
- 881G demolition was completed June 9, 2004
- Building 881 basement backfill (soil and flowable fill) completed June 30, 2004
- Building 881 northwest annex demolition and backfill completed July 8, 2004
- Building 887 demolition was completed July 14, 2004
- Building 890 demolition was completed July 12, 2004
- Building 881 demolition was completed July 17, 2004

- Building 881 project area backfill and re-grading completed October 7, 2004
- Building 881 project area re-seeded October 20, 2004

2.1 Size Reduction

Most of the original uranium processing equipment had previously been removed from Building 881 and size reduction was limited to hoods, ventilation sections, the process scrubber, and process waste lines. In general, these items was size reduced as follows:

- The equipment was characterized, and if the equipment is contaminated, a decision is made whether to decontaminate for unrestricted release, or to disposition as low-level waste (LLW), typically using the Surface Contaminated Object (SCO) waste characterization provisions.
- If the equipment was dispositioned as LLW, contaminated surfaces were fixed, and provisions made for contamination control during size reduction. This may have included establishment of controlled areas, isolation using plastic sheeting, and use of self-contained ventilation equipment.
- The necessary tools, equipment, materials and supplies were mobilized along with support services.
- The equipment was disconnected from external equipment and utility connections, dismantled, other ancillary appurtenances removed, and packaged for disposal. The dismantlement operation included removals, cutting, and other size reduction operations that are necessary to fit the equipment or materials into appropriate containers.
- Once the equipment was removed, the controlled area is decontaminated, along with all tools, equipment and materials, or packaged for disposal.

2.2 Removal of Ventilation Systems

The primary supply ventilation systems for the Building 881 consisted of six supply-air-handling units, S-1 through S-6. S-1 through S-4 were located on the south second floor mezzanine, and S-5, and S-6 were contained in the supply filter plenum located on the roof of the east section of the Annex. Original exhaust had been provided by the main single-stage HEPA filter plenum located on the northeast corner of the first floor, and a second single-stage HEPA filter plenum located on the first floor of the Annex. Each exhaust filter plenum exhausted to a separate stack.

In 1986, the building exhaust was reconfigured to remove the main filter plenum, and isolate and continue to use the main filter plenum inlet area as the collection point for building exhaust ducts. A vertical concrete ventilation shaft was constructed on the east side of the building between Column Lines 13 and 14 connecting this collection point on the first floor to the new filter plenum constructed on the Building 881 roof. The new filter plenum consisted of two, two-stage banks of HEPA filters in the new filter plenum building (881F), 100 feet by 95 feet, with four exhaust blowers and stacks. The exhaust system for the Annex was turned off, and no ducting was reconfigured, so the exhaust was essentially un-ducted return to the new exhaust plenum. The ventilation was configured to maintain a negative differential pressure between the building interior and exterior.

As facility components were removed and/or decontaminated, workers removed the remaining utilities, including building ventilation and exhaust filtration systems. Due to the potential for

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radiological and/or chemical contamination within the ventilation systems ductwork, there was the possibility for releases of hazardous and/or radioactive materials to the environment. As a result, the removal sequence was important and planned carefully. The typical removal sequence described below was followed:

- Airflow studies was performed in accordance with Radiological Safety Practices Manual to determine feasibility of dismantlement and decontamination activities and identify potential problems and options.
- Hood/equipment removal was initiated at the hood or piece of equipment furthest away from the plenum and work will continue toward the plenum to ensure that adequate air continues to flow from areas of least contamination to areas of higher contamination. There were exceptions to this rule depending on access restrictions.
- Once equipment was removed, the building areas serviced by that ventilation could be decontaminated to the unrestricted release criteria.
- The inactive exhaust plenum and all exhaust ductwork were removed.
- Room 144A, the ventilation shaft, and the main filter plenum, was fixed, and the base material removed and disposed of as LLW.
- Airflow was balanced, if necessary, using temporary ventilation and filtration systems.

The filter plenum building was constructed with all contaminated plenum areas completely enclosed within the uncontaminated structure, so that decontamination of contaminated plenum structure was performed without construction of external containment structures. Any unnecessary plenum interfaces (i.e., electrical, instrumentation) were removed and sealed, and exhaust fans were shutdown. Plenum disassembly were initiated by decontaminating areas upstream of the filters and the removing the HEPA filters. Temporary HEPA-filtered ventilation was initiated external to the filter plenum or building to maintain the building below ambient pressure. Filters was packaged in appropriate waste containers. Remaining areas of the plenum were either dismantled and packaged as LLW or decontaminated and surveyed. Loose contamination in the plenums was removed using wet wiping techniques and pressure washed.

2.3 Component Removal using Explosives

Explosive component removal was demonstrated in Building 125. Depending on the component, explosive removal can allow for a more efficient, time saving and safer operation as compared to mechanical removal methods. As a result, several components in Building 881 were selected for a large-scale demonstration of this technology. The components selected were generally overheads that would require extensive hoisting and rigging.

This method of component removal involved preparation by structurally modifying horizontal supporting members. Cut-points for subsequent explosives placement were generally at either end of each beam, adjacent to supporting columns. Modification of each cut-point consisted of cutting areas of no structural support and modifying the web section of the structural member to allow explosives to be placed on the supporting flanges. The following are the components that were removed with explosives in Building 881:

- The overhead cranes in Room 296 were supported by wide flange structural shapes that were approximately 8 inches by 8 inches by 35 lb. per foot. There were approximately

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four lines of five structural shapes, supported on reinforced concrete sills on structural concrete building columns.

- The plenum in Room 144 was approximately 4 feet high by 11 feet wide by 35 feet long. This duct was hung by eighteen (18), 3 inch by 3 inch by ¼ inch angles.
- The first floor "E" Mezzanine was structural steel framework bolted to reinforced concrete structural supporting columns. The main supporting beams were wide flange 10 inch by 10 inch members with 1 inch thick flange. There was decking on top of the mezzanine that consisted of 3/8 inch steel plate (51 lb. per square foot), covered with 14-gauge stainless steel plate (3.2 lb. per square foot).
- There were four (4) levels of stair landings associated with Room 199 that were 20 feet by 20 feet square and supported by four (4), 10 inches by 8 inches by ½ inch structural shapes. There was decking on each landing that consisted of 3/8 inch steel plate (51 lb. per square foot), covered with 14-gauge stainless steel plate (3.2 lb. per square foot).
- Room 233 had stainless steel flooring that has been welded to angle iron within the concrete floors. The stainless steel was in 3 foot by 8 foot sections and is 11 gauge having a thickness of 1/8 inch.

The explosives component removal was conducted in two phases. Phase 1 consisted of the first floor "E" mezzanine, Room 199 stair landings, Room 144 plenum and Room 296 cranes. This phase was completed in two shots with the first two components followed by the second two without reentering the building. Phase 2 was conducted two days later and consisted of the remaining portion of the Room 199 stair landing and the stainless steel floor in Room 233. The work was conducted in two phases because the stair landings involved a large amount of metal that would be falling into a subsurface structure making it difficult to remove.

Overall, this large-scale demonstration of explosive component removal was successful. This method reduced the cost of removal by half and reduced the timeframe by 75%. However, there were lessons learned that should be considered prior to implementing this technology that include:

- The explosive charges are expensive. The larger the quantity purchased the more economical the charges. However, the charges will require storage, which is an additional cost. The more components removed in each event, the more economical the process becomes.
- Careful consideration has to be given to when this method is used during the decommissioning process. The component removal results in a large amount of overpressure. Although this can be controlled by reducing how much explosives go off at once, overpressure in a confined building will always be an issue. Consideration should be given to the overpressure tolerance of the ventilation system, containments, and building doors.
- All charges should be covered to minimize damage from projectiles.

2.4 Decontamination

Structural decontamination involved the removal of residual contamination from the structure; removal of remaining utility systems; decontamination of the remaining structure, and the initial confirmatory survey of release.

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2.4.1 General Approach to Structural Decontamination

Room or area walls were used as containment barriers, or temporary containment barriers were installed to ensure that decontamination activities was isolated from the balance of the structure. Mobile HEPA ventilation was installed to ventilate the areas being decontaminated. The decontamination of 881 Closure Project structures was performed in the following general sequence.

- Remaining electrical systems (conduit, switches, and distribution of electricity) were removed. Temporary electrical services were installed as necessary.
- Remaining safety systems were removed back to the area boundary, and any necessary modifications performed to replace required safety items.
- Remaining utility supply systems (water, air, etc.) were removed to the area boundary; and temporary services (for support of the decontamination activities) installed for supply to the area.
- Floor drains and below-slab services were isolated.
- Floor tiles (asbestos) were removed and selected areas were dry shaved and chipped, as necessary
- Areas exhibiting residual contamination following the initial pre-demolition surveys were physically isolated, decontaminated, and re-surveyed.
- All waste were removed from the area.

The Building 881 Basement was stripped of equipment and systems. Process waste lines were removed. Sanitary lines serving the building was flushed, tapped and isolated, and the outlet header grouted-in-place at the exterior wall penetration. Remaining electrical and HVAC systems were removed. Following removal of contaminated systems, initial PDS surveys were performed. As indicated by the surveys, areas were isolated, containments installed, and decontaminated.

The Building 881 first floor laboratory areas had laboratory hoods dismantled, and the HVAC systems removed to the area boundary. The remaining electrical systems, equipment/fixtures, partitions, and suspended ceilings were removed from the laboratory, office and support areas, and the structures surveyed to identify contamination. Selected decontamination of structural surfaces was required in this area, and the laboratory had been designated as an External Beryllium Contaminated area. Asbestos containing partitions and other asbestos-containing materials were removed from interior areas. After decontamination was complete, PDS surveys were conducted.

The Building 881 first floor Central Computer Facility areas had HVAC systems removed to the area boundary. The remaining electrical systems, equipment/fixtures, partitions, raised flooring, and suspended ceilings were removed from the office and support areas, and the structures surveyed to identify contamination. Selected decontamination of structural surfaces was required in this area. Asbestos containing partitions and other asbestos-containing materials was removed from interior areas. This area had been designated as External Beryllium Contaminated. After decontamination was complete, PDS surveys were conducted.

The Building 881 first floor maintenance and utility areas had HVAC systems removed to the area boundary. The remaining electrical systems, equipment/fixtures, partitions, and suspended ceilings were removed from the shop, office and support areas, and the structures surveyed to

identify contamination. Decontamination of structural surfaces was required in this area; some of the rooms in the shop areas were designated as External Beryllium Contaminated areas. Asbestos containing partitions and other asbestos-containing materials was removed from interior areas. After decontamination was complete, PDS surveys were conducted.

The Building 881 first floor old filter plenum area was one of the final areas to be decontaminated. Surfaces in Room 144 were characterized, including painted-over areas, and decontaminated. Exhaust duct terminating into Room 144A was removed, as was the wall between Rooms 144 and 144A, and all surfaces decontaminated.

The Building 881 first floor Annex and adjacent areas had non-functional exhaust ducts removed to the filter plenum. The remaining electrical systems, equipment/fixtures, partitions, and suspended ceilings were removed from the shop, office and support areas, and the structures surveyed to identify contamination. Decontamination of structural surfaces was required, particularly in the old filter plenum. Asbestos-containing partitions and other asbestos-containing materials were removed from interior areas. After decontamination was complete, PDS surveys were conducted.

The Building 881 second floor laboratory areas had the laboratory hoods dismantled, and the HVAC systems removed to the area boundary. The remaining electrical systems, equipment/fixtures, partitions, and suspended ceilings were removed from the laboratory, office and support areas, and the structures surveyed to identify contamination. Selected decontamination of structural surfaces was required in this area, and the laboratory areas had been designated as External Beryllium Contaminated. Asbestos-containing partitions and other asbestos-containing materials were removed from interior areas. After decontamination was complete, PDS surveys were conducted.

The Building 881 second floor NDA Vaults and associated areas had HVAC systems removed to the area boundary. The remaining electrical systems, equipment/fixtures, partitions, and suspended ceilings were removed from the vault, office and support areas, and the structures surveyed to identify contamination. Decontamination of structural surfaces was required in this area and some of the rooms had been designated as External Beryllium Contaminated areas. Asbestos-containing partitions and other asbestos-containing materials were removed from interior areas. After decontamination was complete, PDS surveys were conducted.

The Building 881 south second floor and mezzanine supply air and support areas had HVAC systems removed to the area boundary. The remaining electrical systems, equipment/fixtures, partitions, and suspended ceilings were removed from the office and support areas, and the structures surveyed to identify contamination. Decontamination of structural surfaces was required in this area; some of the rooms had been designated as External Beryllium Contaminated areas. Asbestos containing partitions and other asbestos-containing materials were removed from interior areas. The mezzanine structural portions were decontaminated, not stripped out as a dismantlement activity. After decontamination was complete, PDS surveys were conducted.

The Building 881 second floor and mezzanine Annex and adjacent areas had non-functional exhaust duct removed to the filter plenum. The remaining electrical systems, equipment/fixtures, partitions, and suspended ceilings were removed from the tunnel, office and support areas, and the structures surveyed to identify contamination. Decontamination of structural surfaces is anticipated in this area. Some of the rooms had been designated as External Beryllium

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Contaminated areas. Asbestos containing partitions and other asbestos-containing materials were removed from all interior areas. After decontamination was complete, PDS surveys were conducted.

Building 887, the Sewage and Process Waste Lift Station, had all tanks, pumps, and piping and other equipment associated with the process waste systems dismantled and packaged as LLMW. Tanks were characterized, sealed and disposed of as single packages. The process waste line between Building 881 and 887 was excavated and removed with the appropriate radiological controls. Sanitary lines leaving the building were removed. The remaining electrical systems, equipment/fixtures, partitions, and suspended ceilings were removed from the office and support areas, and the structures surveyed to identify contamination. Decontamination of structural surfaces was conducted, predominantly on the floor.

Building 885, Oil and Paint Storage building, did not contain contaminated systems/equipment. Remaining equipment in Building 885 was removed. Decontamination efforts were not required for this area.

This area, consisting of Building 881C (Cooling Tower), Building 890 (Cooling Tower Pump House), Building 881H (Electrical Equipment Building), Building 830 (Isolated Power Supply Building), Building 881G (Emergency Generator Building), and Building 864 (Guardpost), were essentially vacant and did not contain contaminated systems/equipment. Remaining equipment in these buildings was removed as necessary. Decontamination efforts were not required for this area.

2.4 Preparation for Demolition

In order to prepare the facility for demolition, all non-load bearing walls were removed. Demolition preparation consisted of roof, exterior wall, and interior column drilling and load bearing wall modifications. In addition, the floor and column rebar was severed and stairs were removed prior to initiating demolition.

2.4.1 Roof and Exterior Walls

Vertical holes were drilled in exterior walls for subsequent explosives placement. Holes were drilled on approximate 3 foot horizontal centers in the exterior walls of the building. Holes were drilled 2- to 3-feet beyond the desired removal limit. All holes in the roof were drilled with a TR300 self-contained hydraulic track drill.

2.4.2 Drilling of Interior Columns and Load Bearing Wall Modifications

All columns and modified load bearing, reinforced concrete walls existing on the 2nd floor Mezzanine, 2nd floor, 1st floor Mezzanine and 1st floor were drilled with horizontal 1¾-inch to 2-inch diameter holes for subsequent explosives placement. The number of holes per element depended on the column dimension. Holes were drilled with handheld pneumatic jackleg drills or the TR300 self-contained hydraulic track drill. In certain areas around vaults and hallway walls, there were continuous poured reinforced concrete walls. Prior to drilling operations, these walls were modified by arching them with pneumatic or hydraulic hammers to create columns for subsequent drilling.

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2.5 Backfill Prior to Demolition

Several rooms/areas were backfilled prior to demolition because the demolition method would not adequately fill these areas resulting in the potential for an unacceptable amount of surface subsidence. Many of the areas was backfilled to minimize large voids. Backfill consisted of 5,310 cubic yards of soil and 3,570 cubic yards of flowable fill. The following areas were backfilled prior to demolition:

- The basement, management units M and F
- The lowest level of Room 199
- The vaults (Rooms 247, 248, 248A, 249, and 249A)
- The electrical pit (Room 286)
- The concrete stack (S1) base
- The elevator shafts
- The building drainage system/sumps
- B887 waste transfer station

An engineering analysis was conducted on several of the areas to determine whether these areas could be left with no fill. The engineering analysis contained several very conservative assumptions and is considered a worst-case evaluation. As a result of the evaluation, the following areas were not backfilled:

- The boiler tunnel and stack foundation (located basement southeast corner column L-1)
- The first floor exhaust stack tunnel (located at the north side column J-20 to H-20)
- The second floor exhaust stack tunnel (located at the northeast column K-18)
- The second floor tunnel from B881 to B883 (located at column A-20)

Cinderblock walls were placed at the interface of the tunnels and on both the 881 and 883 side of the 881-883 tunnel. The cinder block walls were placed to ensure backfill material did not fall back into the tunnels during backfilling. Engineering had assessed this method and determined these walls was sufficient for this purpose and would maintain integrity through demolition. A cinder block wall was also placed at the entrance to the vaults to facilitate backfilling.

All stack foundations were backfilled by an excavator using soil. Water was used throughout the activity to control dust and facilitate placement. When the fill was within 3 feet of the final grade, the soil around the stack was excavated; the stack foundation was removed within 3 feet of final grade; and the area backfilled with at least 3 feet of soil.

2.5.1 Stainless Steel Floors and Other Miscellaneous Remnants

Insignificant quantities of metals and other material were left in Building 881 during the demolition and be included in the demolition backfill. Materials include the following:

- Stainless steel floors, where the stainless steel and concrete underneath the stainless steel has been shown to meet the unrestricted release criteria
- Reinforcing steel in the concrete that is demolished in Building 881
- Embedded metal pans in ceiling/floors that are part of original construction
- Metal edges resulting from component removal activities
- Minor amounts of non-friable asbestos mastic remaining on loading-bearing walls and ceiling after asbestos removal

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Stainless steel floors were installed in the original construction of Building 881. The stainless steel and concrete under the stainless floor was verified at unrestricted release, which is documented in the Pre-Demolition Survey Reports. The stainless steel material is approximately 20 to 30 feet below final grade.

The floor material is a type 304 austenitic stainless steel, alloyed with chromium (~18 weight percent) and nickel (~8 weight percent).[1] This alloy promotes a stable chromium oxide surface layer that protects the base material and exhibits excellent corrosion resistance in industrial and rural atmospheres, similar to conditions that would be expected following demolition. Conditions for corrosion (i.e., dissolution) include exposure to aqueous solutions containing significant levels of chlorides, exposure to organic films, or galvanic coupling to another metal. Mechanisms for corrosion do not exist in this application and service corrosion data suggests that the floors would be effectively inert with no impact to the environment for an indefinite period.[2] [3]

The overall quantity of stainless steel and other remnants of decommissioning activities are de minimis when compared with the entire backfilled area. The total quantity of backfill estimated to achieve final land configuration requirements in the building footprint is 108,000 cubic yards of material, and the following is an estimate of the anticipated backfill constituents:

- Soil, 48%
- Choking layer/granular fill, 11%
- Concrete demolished and backfilled in place, 9%
- Concrete (recycled) processed and placed with equipment, 26%
- Flowable fill, 3.3%
- Other steel including reinforcing steel in the concrete demolished and backfilled in place and resulting from embedded items and remnants from component removal, 2%
- Stainless steel, 0.006%
- Mastic, 0.0009%

2.6 Demolition

Initial demolition activities involved stripping remnant equipment, supplied air units, and other miscellaneous materials from rooftops that were not removed earlier during decontamination. As part of demolition site preparation, existing features associated with Site utility systems were located, marked, and evaluated for isolation purposes.

Protective barriers were erected around permanent Site features designated to remain during demolition. Run-off surface water control features were implemented, particularly on the south-southeast portion of the project area. Dust control during demolition consisted of a combination of fencing and geotextile on the structure and water cannons during demolition.

[1] Steel Products Manual; Stainless and Heat Resisting Steels, Pp. 18-20, American Iron and Steel Institute, 1000 16th Street, N.W., Washington , D.C. 20036, December, 1974.
[2] Corrosion and Corrosion Control, Herbert H. Uhlig, R. Winston Revie, Third Edition, John Wiley and Sons, 1985
[3] Metals Handbook, Volume 3, Properties and Selection: Stainless Steels, Tool Materials, and Special Purpose Metals, Ninth Edition, American Society for Metals, 1980

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2.6.1 Floor Severance

Following all other preparation activities in the building, reinforced concrete floor slabs were severed from exterior walls. Floor severance was made with hydraulic hammers mounted on skid steer loaders. Following the floor severance (which was approximately 4-inches wide), selected reinforcing rod in floors and beams were pre-cut with oxygen acetylene torches.

2.6.2 Test Shot

Loading and demolition was conducted over a five (5) day period. On the first day of explosive delivery, prior to production loading, a test blast was conducted on certain interior elements of the structure to determine the optimum loading densities for production blasting. Several interior columns and some exterior wall holes were used in the test shot.

2.6.3 Loading and Demolition

Production loading commenced on the 1st floor of the structure, then moved vertically to the top areas of the building. Necessary signage was posted prior to the commencement of loading operations. Charges were assembled and placed into holes drilled in reinforced concrete columns and walls.

All explosives were handled and placed by trained professionals. On the final day prior to the demolition, the exterior walls of the structure, which are accessed from the roof, were loaded.

2.6.4 Protective Measures During Demolition

The Southern end of Building 881 and other exposed exterior walls were covered with one or more layers of geotextile fabric, secured so as to prevent premature displacement prior to the detonation sequence.

2.6.5 Air Sampling During Demolition

An air sampling study was conducted to quantify airborne dust concentrations downwind of the Building 881 demolition. Through this study, future modeling of RFETS building demolitions are expected to improve in their predictive power based on knowledge gained of the plume height, plume density (airborne dust concentration at known distances), plume dispersion rate, and plume duration. This study was designed to obtain answers to these questions.

Atmospheric dispersion modeling of the 881 demolition was performed to assess the potential short-term atmospheric impacts of 881 demolition. The model was run using the EPA Industrial Source Complex, Short Term (ISCST3) model, incorporating information from several papers published by researchers at Johns Hopkins Medial Institutions that examined air impacts from building demolitions using explosives in Baltimore, MD. A relevant study was published in the Journal of the Air and Waste Management Association (AWMA) in October 2003 (*Impact of a Building Implosion on Airborne Particulate Matter in an Urban Community*. Beck, et al., 2003.) Researchers reported measurements of PM_{10} at four locations around the demolition of a 22-story building. Downwind peak PM_{10} concentrations varied with distance (54,000-589 $\mu g/m^3$), exceeding pre-demolition levels for sites 100 m and 1,130 m downwind by 3,000-fold and 20-fold, respectively. Peak PM_{10} concentrations were short-lived; most sites returned to background within 15 minutes. A similar pattern was expected for the 881 demolition plume.

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Prior to the demolition, 12 total suspended particulate (TSP) samplers were deployed along 30 degree radials surrounding the demolition project. The three truck-mounted TSP samplers and PM_{10} nephelometers were deployed to sampling locations in the expected plume path within the 1.5 hours preceding the demolition. A hold point was written into the demolition Standing Order to ensure that demolition did not proceed unless truck-mounted samplers had been confirmed to be operating downwind of the source. In addition, several optical particle counters were used, and a met station was positioned near the demolition to record wind speed and direction; other parameters for modeling were taken from the NREL tower.

Two of the sampling locations appear to have been near the plume center line (locations 8 and 13), to the west-southwest of 881. Three other locations appeared to have sampled a portion of the plume-locations 15 and 7 to the southwest of 881 and location 10 to the northwest. Based on its location, sampler 9 should also have sampled the plume; however, the concentrations at that location are similar to those recorded at "upwind" samplers. Based on these results, something was shielding this sampler or perturbed the flow so that the plume broke around it. As a result, sampler 9 results were discounted.

Based on the average TSP concentrations at each sampler, an emission rate of 600-900 grams per second (g/s) was calculated. However, this relates to the entire sampling duration, which varied from approximately 30 to 90 minutes depending on the sampler. An average "background" concentration based on the upwind samplers was calculated to isolate the mass contribution at each sampler from the event. The particle counters showed the duration of elevated concentrations to be on the order of 6 minutes.

The resulting calculated emission rates for the explosive demolition "event" were higher but of shorter duration. The overall range from the various modeling efforts is approximately 1,300-3,700 g/s for 15 minutes. This relates to an estimated peak concentration at the most impacted sampler (256 m downwind) of approximately 17,000 ug/m^3 (6-minute average) or 6,800 ug/m3 (15-minute average).

For comparison, the literature search turned up papers documenting peak respirable dust concentrations downwind of a building implosion in Baltimore of 54,000 ug/m^3 at 100 m distance, with peak concentrations exceeding pre-implosion levels by 3,000-fold at 100 m and exceeding pre-implosion levels by 20-fold 1,130 m downwind. The 17,000 ug/m^3 concentration noted above at 256 m downwind represents a 1,300-fold increase above background. Appendix D contains the complete sampling report.

2.7 Demolition of Outbuildings

Building 887 (Sewage and Process Waste Lift Station) housed seven tanks that collect Building 881 process waste prior to it being pumped to Building 374 through the process waste system, and pumps building sanitary waste to the Sewage Treatment Plant. It was constructed of cast-in-place reinforced concrete walls and slab roof, with cast concrete pads to support tanks and equipment. The building layout consists of tank and pump vaults 10-15 feet below grade with an access house aboveground on the north end.

The building had all systems and equipment removed, and the concrete was shaved and rinsed. After the RCRA clean closure standards were met, an excavator with a shear/crusher attachment exposed the building and vault interior, remove any residual items, and reduced to rubble the

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access house, vault roof, and walls to a depth of greater than three feet below grade. The vault area was backfilled with soil to final grade.

3.0 Project Documentation

This section describes the documentation that was prepared to satisfy the requirements in the Rocky Flats Cleanup Agreement for decommissioning the 881 Closure Project. In accordance with the *RFETS Decommissioning Program Plan (DPP)*, the 881 Closure Project Type 1 facilities were decommissioned using Site procedures upon notification to CDPHE and the Type 2 facilities were decommissioned in accordance with the Site's approved RFCA Standard Operating Protocols (RSOPs). Documentation that was submitted as part of this project will be referenced; a copy of the AR for this project was included in Appendix B of this report.

3.1 Characterization

Facilities within the 881 Closure Project were characterized using a four-step approach: scoping characterization, reconnaissance level characterization (RLC), in-process characterization, and pre-demolition survey (PDS). The 881 Closure Project Characterization was conducted in accordance with the following Site-wide documents:

- RFETS Decontamination & Decommissioning Characterization Protocol (DDCP), which contains the In-process and RFETS Reconnaissance Level Characterization Plan (RLCP), AR Document Number IA-A-001051
- Site-Wide Pre-Demolition Survey Plan (PDSP), AR Document Number IA-A-001050

3.1.1 Scoping

During scoping characterization, existing records and documents were collected, and current and former Building 881 employees were interviewed to determine the radiological, chemical, and physical conditions of Building 881 and associated support facilities. Based on the information collected, the 881 Closure Project team proceeded to conduct the RLC in accordance with the requirements of the RLCP. Table 3-1 summarizes the project documentation for this phase of the project.

Table 3-1. 881 Closure Project Scoping Characterization Documentation

Document	Date	AR Document Number
Regulatory contact record with scoping meeting minutes	August 15, 2001	B881-A-000007
Regulatory contact record with scoping meeting minutes	August 15, 2001	B881-A-000008
Regulatory contact record with scoping meeting minutes	August 15, 2001	B881-A-000009

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3.1.2 Reconnaissance Level

The purpose of RLC is to provide an initial assessment of the contamination, hazards, and other conditions associated with a facility. The Type 1 facilities were characterized in accordance with the requirements for PDS, pursuant to the DDCP. To ensure these facilities remain free of contamination and the PDS data remain valid, isolation controls have been established, and the facilities posted accordingly. Isolation controls restrict the transfer, storage, and use of radioactive materials. Verification surveys was performed before the release of these structures to confirm that radioactive material has not been introduced to these areas. Table 3-2 summarizes the project documentation for this phase of the project.

Table 3-2. 881 Closure Project Reconnaissance Characterization Documentation

Document	Date	AR Document Number
Reconnaissance Level Characterization Report (RLCR) 800 Area Type 1 Cluster Closure Project (Building 830, 863, 864, 885, T883D, and tanks slabs 020, 021, and 026) Revision 0	June 15, 2001	B800-A-000008
CDPHE concurrence on Reconnaissance Level Characterization Report (RLCR) 800 Area Type 1 Cluster Closure Project (Building 830, 863, 864, 885, T883D, and tanks slabs 020, 021, and 026) Revision 0	no date given	B800-A-000013
Reconnaissance Level Characterization Report (RLCR) 881 Cluster Closure Project (Buildings 881, 881F and 887 and Stacks S1, S2, and S3), Revision 0	November 6, 2001	B881-A-000017
DOE transmittal of 881 Cluster Closure Project (Buildings 881, 881F and 887 and Stacks S1, S2, and S3) RLCR	November 28, 2001	B881-A-000011
CDPHE concurrence of 881 Cluster Closure Project (Buildings 881, 881F and 887 and Stacks S1, S2, and S3) RLCR and facility typing	December 20, 2001	B881-A-000012
Group 11 and Group 15 Closure Projects Reconnaissance Level Characterization Report (RLCR) Revision 0	February 22, 2002	IA-A-000931

3.1.3 In-Process and Pre-Demolition

Additional characterization was conducted during decommissioning, as facility components were removed and building surfaces exposed. This type of characterization is referred to as in-process characterization. Data from in-process characterization was used to identify additional hazards; refine approaches to component removal, size reduction, and decontamination; revise waste volume estimates; and modify environmental, safety and health (ES&H) controls, as necessary. In-process characterization was also conducted to verify that decontamination activities have achieved the applicable performance specifications, such as release or reuse criteria and waste acceptance criteria (WAC) of the receiving disposal facility.

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The characterization and final survey was conducted in accordance with the *B881 Project-Specific In-Process Radiological Characterization Plan* and the PDSP. Since Building 881 has had both plutonium and uranium processing within the building in the past, a project-specific In-process Radiological Characterization Plan was prepared. Since some areas are known to have transuranic contamination above the 100 dpm/100 cm^2 action limit, a sampling approach was developed to identify the extent of the transuranic contamination. This approach used knowledge of the building history along with previously collected samples to characterize survey units as transuranic or uranium only.

The building history was discussed with site employees that were aware of the processes performed in the building. Maps were generated that displayed the areas of transuranic processing at any time in the building's history. Process piping and ventilation were mapped to determine if they would also cause further transuranic contamination in other areas of the building. Survey units within the areas of highest potential for transuranic contamination were sampled in a biased manner so that the most likely contaminated locations were selected. Survey units with sample results above 100 dpm/100 cm^2 are classified as transuranic contaminated for decontamination purposes.

When the in-process survey process was completed, a map was generated annotating areas throughout the building as uranium or plutonium contaminated. This map was used for decontamination and pre-demolition surveys. Table 3-3 summarizes the project documentation for this phase of the project.

Table 3-3. 881 Closure Project In-Process/Pre-Demolition Characterization Documentation

Document	Date	AR Document Number
Pre-Demolition Survey Report for Building 881 Stack S1	October 14, 2003	B881-A-000032
Regulatory contact record for the clarification of biased in-process media samples in Building 881	October 22, 2003	B881-A-000036
CDPHE approval of Pre-Demolition Survey Report for Building 881 Stack S1	October 23, 2003	B881-A-000030
Pre-Demolition Survey Report for Building 881 Stack S1	October 31, 2003	B881-A-000034
Regulatory contact record for performance of in process surveys prior to block wall removal	November 14, 2003	B881-A-000035
Regulatory contact record documenting CDPHE review and informal approval of the pre-demolition survey data for Room 10 and the elevator (100A) in Building 881	May 20, 2004	B881-A-000041
Regulatory contact record documenting CDPHE review and informal approval of the pre-demolition survey data for Rooms 247 through 249 in Building 881	May 27, 2004	B881-A-000044
Regulatory contact record documenting CDPHE review and informal approval of the pre-demolition survey data for the Building 881 exclusion dock	June 3, 2004	B881-A-000046

Table 3-3. 881 Closure Project In-Process/Pre-Demolition Characterization Documentation

Document	Date	AR Document Number
Regulatory contact record documenting project processes for maintaining isolation controls between pre-demolition surveys and building demolition preparation activities	June 3, 2004	B881-A-000047
Regulatory contact record documenting CDPHE review and informal approval of the pre-demolition survey data for 881F	June 10, 2004	B881-A-000048
Regulatory contact record documenting CDPHE review and informal approval of the pre-demolition survey data for Rooms 160, 169, 170, 170A, 171, 171A, and 159B and portions of Rooms 168 and 161	June 17, 2004	B881-A-000054
Regulatory contact record documenting CDPHE review and informal approval of the pre-demolition survey data for the first and second floor and basement of Building 881	June 23, 2004	B881-A-000053
CDPHE approval of the Building 881F PDSR	June 25, 2004	B881-A-000042
CDPHE approval of the Building 881 Volume 1 (second floor, second floor mezzanine, and 881/883 tunnel) and Volume 2 (Basement Area) PDSRs	June 28, 2004	B881-A-000043
Regulatory contact record documenting CDPHE review and informal approval of the pre-demolition survey data for Building 887	July 1, 2004	B881-A-000055
CDPHE approval of the Building 887 PDSR	July 5, 2004	B881-A-000060
Pre-Demolition Survey Reports for Building 881 first floor and first floor mezzanine and Building 887	July 15, 2004	B881-A-000058
CDPHE approval of the Building 881 first floor and first floor mezzanine PDSR	July 15, 2004	B881-A-000059

3.2 Decommissioning

Since the 881 Complex included Type 1 and 2 facilities, the decommissioning was conducted in accordance with the following RFCA decision documents and clarified through Regulatory Contact Records:

- Decommissioning Program Plan, AR Document Number SW-A-003231
- RFCA Standard Operating Protocol for Component Removal, Size Reduction and Decontamination Activities, AR Document Number IA-A-000717
- RFCA Standard Operating Protocol for Facility Disposition, AR Document Number SW-A-004122
- RFCA Standard Operating Protocol for Recycling Concrete, AR Document Number SW-A-004038

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Table 3-4 summarizes the project documentation for the component removal (pre-demolition activities) phase of the project. RCRA closure activities were also conducted as part of this phase of the project, which are documented in Appendix C.

Table 3-4. 881 Closure Project Documentation for Component Removal

Document	Date	AR Document Number
Regulatory Contact record to invoke Section 1.1.5 of the DPP for the removal of sinks, urinals, and toilets	January 26, 2001	B881-A-000001
Regulatory Contact record to invoke Section 1.1.5 of the DPP for the removal of heater exchange pump and table	March 29, 2001	B881-A-000002
Regulatory Contact record to invoke Section 1.1.5 of the DPP for the removal of chilled water re-circulation system	June 7, 2001	B881-A-000003
Regulatory Contact record to invoke Section 1.1.5 of the DPP for the removal of process sink and vacuum pump areas	June 18, 2001	B881-A-000004
RFCA Standard Operating Protocol (RSOP) notification for Component Removal, Size Reduction and Decontamination Activities for Buildings 881, 881F, 887 and Stacks S1, S2, and S3	December 20, 2001	B881-A-000014
CDPHE agreement for the utilization of the RSOP notification for Component Removal, Size Reduction and Decontamination Activities for Buildings 881, 881F, 887 and Stacks S1, S2, and S3	January 8, 2002	B881-A-000015
Regulatory contact record for the construction of an access door on the south side of Building 881 into the basement	October 17, 2003	B881-A-000033

Table 3-5 summarizes the project documentation for the demolition phase of the project.

Table 3-5. 881 Closure Project Documentation for Demolition

Document	Date	AR Document Number
CDPHE agreement on the RFCA Standard Operating Protocol (RSOP) notification for Facility Disposition for the demolition of Building 881 Stack S1	October 30, 2003	B881-A-000031
Regulatory contact record for the removal of appurtenances (south dock and L-north and south) associated with Building 881 for improved access	April 1, 2004	B881-A-000037
Regulatory contact record for the removal of asbestos flashing and parapet associated with the Building 881 roof	April 1, 2004	B881-A-000038

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Table 3-5. 881 Closure Project Documentation for Demolition

Document	Date	AR Document Number
RFCA Standard Operating Protocol (RSOP) notification for Facility Disposition for the demolition of Building 881, 881F, and 887	April 13, 2004	B881-A-000039
CDPHE agreement of the RFCA Standard Operating Protocol (RSOP) notification for Facility Disposition for the demolition of Building 881, 881F, and 887	May 6, 2004	B881-A-000040

The Buildings 881 footprint was backfilled in accordance with the *RSOP for Concrete Recycling*. The backfill specification was consistent with the RSOP with two exceptions. The RSOP indicates that in general, the resulting backfill will contain fragments ranging in size from 6 inches to less than 0.1 inches. The RSOP allows some flexibility, and the backfill specification was written to allow concrete up to 12 inches in size with some larger fragments if special placement methods are used.

The RSOP also indicated that backfill placement and compaction methods would result in a soil compaction of 80% +/- 10% and that the backfill be geotechnically tested prior to and during backfill operations. Granular fill is commonly used for utility trenches and pipelines, where mechanical compaction is difficult but firm support (i.e., limited settlement) is desired, because it is relatively dense when initially dumped into place. Vibratory compaction can be applied to further densify the material if desired. Method specifications using vibratory rollers are commonly used for compaction of granular materials such as rock fill dams where settlement needs to be limited.

Because the sources of fill anticipated for use during backfilling at Buildings 881 was comprised of unclassified granular soils layered with recycled concrete material, obtaining meaningful and reproducible measurements of relative compaction was determined impractical. Taking into consideration that the future land use for these areas is undeveloped open space, a method specification that defines the standard placement procedures is more suited to provide a relatively uniform fill free of detrimental voids. As a result, a method specification was utilized to ensure compaction.

4.0 Waste Disposition

The 881 Closure Project generated the following waste types including sanitary, hazardous, asbestos, low-level, low-level mixed, low-level TSCA, and transuranic. Table 4-1 documents the quantity and disposal site for these waste types and materials.

Table 4-1. Waste Stream Disposition Summary

1. Sanitary Waste	
Disposal Site:	Front Range Landfill, BFI Tower Road Landfill, and BFI Foothills Landfill
Projected volume (m^3):	4,531
Actual volume (m^3):	10,971
Note:	The projected volume for sanitary waste included asbestos and recycle waste

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Table 4-1. Waste Stream Disposition Summary

2. Asbestos Waste	
Disposal Site:	Front Range Landfill, BFI Tower Road Landfill, and BFI Foothills Landfill
Projected volume (m^3):	See note under sanitary waste
Actual volume (m^3):	46
3. Hazardous Waste Recycle – batteries, chemicals and waste oils	
Disposal Sites:	On-site[4], Exide Technologies, and Onyx Superior Special Services
Projected volume (m^3):	See note under sanitary waste
Actual volume (m^3):	5.5
4. Hazardous Waste	
Disposal Site:	On-site, Onyx Environmental Services, Superior Special Services
Projected volume (m^3):	7.46
Actual volume (m^3):	5.3
Note:	The projected volume for hazardous waste included TSCA waste
5. TSCA Waste	
Disposal Site:	Onyx Environmental Services
Projected volume (m^3):	See note under hazardous waste
Actual volume (m^3):	0.29
6. Low Level Waste	
Disposal Sites:	On-site, Nevada Test Site, Envirocare of Utah, Inc., Diversified Science Services Inc, and Duratek Bear Creek
Projected volume (m^3):	4,246
Actual volume (m^3):	15,093.6
7. Transuranic Waste	
Disposal Site:	WIPP, Carlsbad, NM
Projected volume (m^3):	0
Actual volume (m^3):	0.63
8. Low Level Mixed Waste	
Disposal Sites:	On-site, Envirocare of Utah, Inc., and Perma-fix Materials and Energy Corp.
Projected volume (m^3):	39
Actual volume (m^3):	31.8

[4] The designation of on-site for the disposal means that the waste is in a storage area on-site waiting to be shipped for disposal and/or until there is an adequate quantity to ship the waste off-site.

5.0 Site Reclamation

In accordance with the *RSOP for Facility Disposition*, the soil under and around Building 881 had to be evaluation prior to executing a demolition with explosives. Individual Hazardous Substance Site (IHSS) Group 800-2 was within the 881 Closure Project Area and included under building contamination (UBC) 881, Laboratory and Office; potential area of concern (PAC) 800-1205, Building 881 East Dock; and IHSS 000-121, old process waste line (OPWL) Tank 39.

IHSS Group 800-2 was characterized in accordance with the Industrial Area Sampling Analysis Plan Addendum, IA-02-04. Environmental Restoration RSOP notification 02-05 was prepared in the event that any remediation would be required. Based on the characterization and investigation results, no remediation was required. A data summary report was prepared for IHSS Group 800-2, and approved by CDPHE July 16, 2003. Approval of the data summary report constituted regulatory agency concurrence that the IHSS Group is a No Further Accelerated Action site.

After the demolition, the resulting depression was backfilled. The material in the building area was not removed after demolition, which is why such care was taken during the demolition preparation to minimize voids and the potential for material to hang-up after demolition. After demolition, the fill was proof-rolled according to the engineering specification prepared for Building 881 backfill. The proof-rolling activity was used to evaluate the success of the demolition on flattening the demolished fill in place. Following the proof-rolling, a choking layer of gravel was placed, followed by recycled concrete and soil.

In accordance with the RSOP for Recycling Concrete, placement requirements for recycled concrete were established based on the design requirements for the backfill. The goal of the backfill operations was to create a stable area, consistent with a Wildlife Refuge, with minimal long-term maintenance. Based on this goal and the requirements in the RSOP, a backfill specification was prepared by a Colorado registered professional engineer. One exception and one clarification of the RSOP requirements were made in this project-specific backfill specification and are outlined in Section 3.2.

The total quantity of backfill estimated to achieve final land configuration requirements in the building footprint is 108,000 cubic yards of material, and the following is an estimate of the backfill constituents:

- Soil – 52,580 cubic yards
- Choking layer/granular fill – 11,880 cubic yards
- Concrete demolished and backfilled in place – 9,780 cubic yards
- Concrete (recycled from 850 and 980 pads) processed and placed with equipment – 28,080 cubic yards
- Flowable fill – 3,570 cubic yards
- Miscellaneous materials including reinforcing steel and stainless steel flooring – 2,110 cubic yards

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Table 5-1 summarizes the project documentation for items remaining in place.

Table 5-1. 881 Closure Project Documentation

Document	Date	AR Document Number
Regulatory Contact record to document CDPHE approval for leaving a small piece of old process waste line on the South side of Building 881	May 27, 2001	B881-A-000045

Figure 5-1 documents the final remaining elevation of the Building 881 walls, the elevation of the final lift of recycled concrete, and remaining underground utilities.

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L2

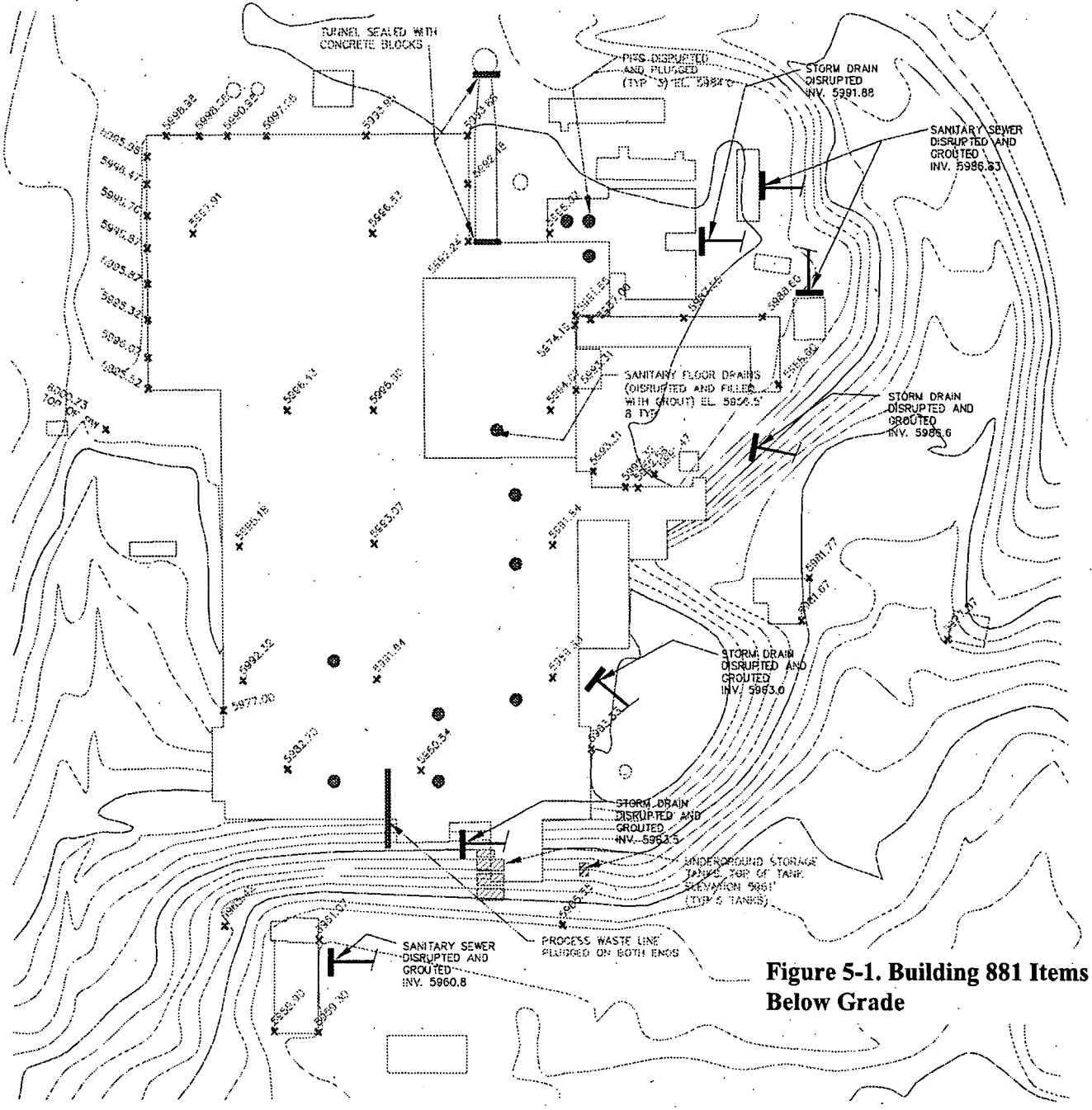
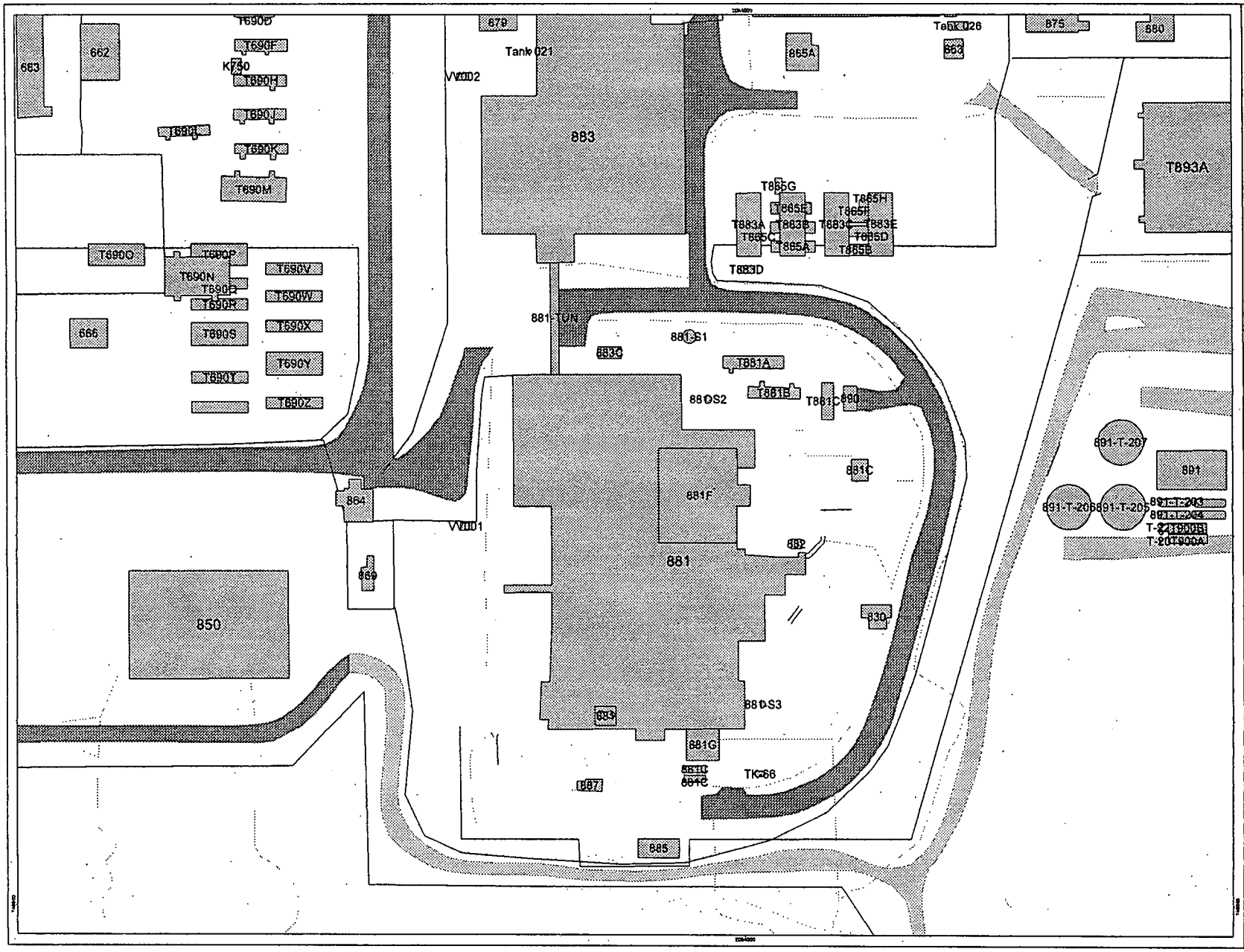


Figure 5-1. Building 881 Items Remaining Below Grade

Appendix A. 881 Closure Project Map



Rocky Flats Environmental Technology Site

881 Location Map

Map Features

- Buildings Remaining
- Paved Roads
- Dirt Roads
- Lakes
- Streams
- Fences
- Railroad Removed
- Railroad Remaining

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. (303) 966-7707

Prepared By: KAISER-HILL COMPANY

Prepared For: KAISER-HILL COMPANY

w:\projects\fy2005\05-0011\881Location Map.mxd

Appendix B. Administrative Record File for the 881 Closure Project

BUILDING 881
AR INDEX TO DATE, 08/30/04

There are 59 records in this set and a total of 1529 pages.

Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000001 01/26/2001 1 Pages PUBLIC	YES, ROUTINE	N/A	KRUCHEK, DAVID TOWER, STEVE	DISTRIBUTION	Purpose of Contact: Building 881 in which two agreements were reached. The first is the work proposed for the removal of janitor sinks, urinals and toilets. The second agreement was that work conducted under the Resource Conservation and Recovery Act (RCRA) Closure Description Document (CDD) does not also need to be approved under section 1.1.5 of the Decommissioning Program Plan (DPP).
B881 A 000002 03/29/2001 1 Pages PUBLIC	YES, ROUTINE	N/A	KRUCHEK, DAVID	SHULER, KARL	Purpose of Contact: Provides information on the document discussion regarding the removal of the heater exchange, pump and table sitting to the left of the annular tank in Building 881 Room 286.
B881 A 000003 05/31/2001 3 Pages PUBLIC	YES, ROUTINE	N/A	DORR, KENT A.	KRUCHEK, DAVID	Purpose of Contact: Documents Building 881 Status Meeting. The approval of the Closure Description Document (CDD) was discussed. Also, two areas in Group 16, which are state regulated excluded from the Performance Measure, were discussed
B881 A 000004 06/07/2001 3 Pages PUBLIC	YES, ROUTINE	N/A	KRUCHEK, DAVID	DORR, KENT A.	Regulatory Contact Record: Discusses insulation removal and water removal from the chilled water re-circulation system. The historical flooding on the room was discussed and that the Permacon may still be handled as a Property Utilization and Disposal (PU&D) item.
B881 A 000005 06/18/2001 16 Pages PUBLIC	YES, ROUTINE	N/A	KRUCHEK, DAVID	DORR, KENT A.	Regulatory Contact Record: This record discusses the walk down of Building 881. The items and resolutions discussed were the extent of piping to be removed in the process sink and vacuum pump areas. The determination of the removal of the rid welding vent hoses and the air receiver tank removal were also items of discussion. Colored photographs attached.

BUILDING 881
AR INDEX TO DATE, 08/30/04

There are 59 records in this set and a total of 1529 pages.

Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000006 06/18/2001 1 Pages PUBLIC	YES, ROUTINE	N/A	SCHIEFFELIN, JOE	LEGARE, JOSEPH A. NESTA, STEVE	The Colorado Department of Public Health and Environment (CDPHE) gives approval of the Closure Description Document for Partial Closure of Resource Conservation and Recovery Act (RCRA) Tank Storage Unit 887.2, Phase II at Building 881.
B881 A 000007 08/15/2001 1 Pages PUBLIC	YES, ROUTINE	N/A	KRUCHEK, DAVID	DORR, KENT A.	Regulatory Contact Record: Building 881 Scoping Meeting Minutes. The discussion consisted of Tanks 13, 14 and 15 and Building 882 Pad being deleted from report. Also discussed was the accuracy and clarification of the Resource Conservation and Recovery Act (RCRA) Regulated Units report. A review concerning the B881 stacks and survey and sampling of stainless steel floors were discussed.
B881 A 000008 08/15/2001 9 Pages PUBLIC	YES, ROUTINE	N/A	NOT INDICATED	DISTRIBUTION	Building 881 Scoping Meeting dated August 15, 2001. This gives the operating history and physical description of the building.
B881 A 000009 08/15/2001 1 Pages PUBLIC	YES, ROUTINE	N/A	DORR, KENT A.	KRUCHEK, DAVID	Regulatory Contact Record: Building 881 Scoping Meeting Minutes held on August 15, 2001.
B881 A 000010 09/06/2001 2 Pages PUBLIC	YES, ROUTINE	N/A	DORR, KENT A.	KRUCHEK, DAVID	Confirmation of e-mail from the Colorado Department of Public Health and Environment (CDPHE) to Kaiser-Hill Company, L.L.C. (K-H) regarding Building 881 Work Packages.

BUILDING 881
AR INDEX TO DATE, 08/30/04

There are 59 records in this set and a total of 1529 pages.

Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Pages	Title / Subject
B881 A 000017 11/06/2001 PUBLIC	YES, ROUTINE	Ref: 01-RF-02661; DWF-015-01	NOT INDICATED	DISTRIBUTION	310	Reconnaissance Level Characterization Report (RLCR), 881 Cluster Closure Project (Buildings 881, 881F and 887, and Stacks S1, S2 and S3), Revision 0 dated November 6, 2001. This Type 2 facility characterizes the physical, chemical and radiological hazards.
B881 A 000016 11/07/2001 PUBLIC	YES, ROUTINE	01-RF-02661; DWF-015-01	FERRERA, D. W.	TOWER, STEVE	1	Submits the attached [000017] Reconnaissance Level Characterization Report (RLCR), 881 Cluster Closure Project (Buildings 881, 881F and 887, and Stacks S1, S2 and S3), Revision 0 dated November 6, 2001. This Type 2 facility characterizes the physical, chemical and radiological hazards.
B881 A 000011 11/28/2001 PUBLIC	YES, ROUTINE	01-DOE-02135; 00764-RF-01	LEGARE, JOSEPH A.	GUNDERSON, STEVE	1	Forwards the attached [000017] Reconnaissance Level Characterization Report (RLCR) for Buildings 881, 881F, 887 and B881 Stacks S1, S2 and S3. These buildings have been characterized as Rocky Flats Cleanup Agreement (RFCA) Type 1 and 2 facilities. It is notable that no transuranic contamination, such as Plutonium (Pu), was found during the characterization of Building 881. While the Uranium contamination is widespread inside the building, it is fairly straightforward to deal the compared to Pu as U decontamination requires no special technologies, these aspects support typing 881 as a RFCA Type 2 facility.
B881 A 000013 12/13/2001 PUBLIC	YES, ROUTINE	N/A	DORR, KENT A.	KRUCHEK, DAVID	3	Confirmation of a walkdown conducted on December 13, 2001, for Building 881 16 Non-Resource Conservation and Recovery Act (RCRA) Fume Hoods. This is a revised record, due to an error in date.

BUILDING 881
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There are 59 records in this set and a total of 1529 pages.

Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000019 12/14/2001 19 Pages PUBLIC	YES, ROUTINE	01-RF-02898; FEG-011-01	GIBBS, FRANK E.	TOWER, STEVE	Rocky Flats Cleanup Agreement Standard Operating Protocol (RSOP) notification letter for Buildings 881, 881F, 887 and Stacks S1, S2 and S3 component removal, size reduction and decontamination along with an activities checklist.
B881 A 000012 12/20/2001 1 Pages PUBLIC	YES, ROUTINE	N/A	GUNDERSON, STEVE	LEGARE, JOSEPH A.	The Colorado Department of Public Health and Environment (CDPHE) concurs with the Type 2 designation for Buildings 881, 881F, 887 and Stacks S1, S2 and S3, after reviewing the Reconnaissance Level Characterization Report (RLCR) for B881 Cluster Closure Project.
B881 A 000014 12/20/2001 2 Pages PUBLIC	YES, ROUTINE	01-DOE-02280; 00826-RF-01	LEGARE, JOSEPH A.	GUNDERSON, STEVE	US Department of Energy, Rocky Flats Field Office (DOE/RFFO) forwards the Rocky Flats Cleanup Agreement Standard Operating Protocol (RSOP) for Component Removal notification form for Buildings 881, 881F, 887 and Buildings 881 Stacks S1, S2 and S3.
B881 A 000015 01/08/2002 1 Pages PUBLIC	YES, ROUTINE	N/A	GUNDERSON, STEVE	LEGARE, JOSEPH A.	The Colorado Department of Public Health and Environment (CDPHE) agrees with the intent to utilize the Component Rocky Flats Cleanup Agreement Standard Operating Protocol (RSOP) for Component Removal, Size Reduction and Decontamination activities that are to occur in Buildings 881, 881F, 887 and Stacks S1, S2 and S3. Notification of Intent.
B881 A 000018 01/17/2002 2 Pages PUBLIC	YES, ROUTINE	N/A	SCHIEFFELIN, JOE	LEGARE, JOSEPH A. NESTA, STEVE	Approval of Closure Description Document (CDD) for Partial Closure of Resource Conservation and Recovery Act (RCRA) Tank Storage Unit 887.2 (Hook Sink Removal) at Building 881.

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Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000020 02/27/2002 21 Pages PUBLIC	YES, ROUTINE	02-DOE-00306	LEGARE, JOSEPH A.	GUNDERSON, STEVE	Rocky Flats Cleanup Agreement Standard Operating Protocol (RSOP) for Component Removal, Size Reduction and Decontamination Activities: This Notification Letter is for Resource Conservation and Recovery Act (RCRA) Unit Closure of RCRA Unit 887.2 in Buildings 881 and 887.
B881 A 000021 04/24/2002 2 Pages PUBLIC	YES, ROUTINE	N/A	DEMOS, NICK S.	KRUCHEK, DAVID	Purpose of Contact: Discussion of the Potential Area of Concern (PAC) 800-1205 (800-5) and the Under Building Contaminant (UBC) 887 Relocation and Boundary Change. The present location is inaccurate as shown on Historical Release Report (HRR) coverages (map) Plate 4, KH 2001.
B881 A 000022 05/03/2002 7 Pages PUBLIC	YES, ROUTINE	02-RF-01099; DPS-014-02	SNYDER, D. P.	BOSTIC, RON	Submits the enclosed Technical Safety Requirement page change No. PGC-881-02.1502-ARH, Revision 0 for approval. This page change proposes editorial changes to the Building 881 and Related Facilities, Safety Analysis, Revision 2 [Reference (a)], as approved with Technical Direction [Reference (b)] by US Department of Energy, Rocky Flats Field Office (DOE/RFFO).
B881 A 000023 05/28/2002 2 Pages PUBLIC	YES, ROUTINE	N/A	GUNDERSON, STEVE	LEGARE, JOSEPH A.	Rocky Flats Environmental Technology Site (RFETS/Site) Notification to Invoke the Facility Component Removal, Size Reduction, and Decontamination Activities Rocky Flats Cleanup Agreement Standard Operating Protocol (Component RSOP) for Closure of Resource Conservation and Recovery Act (RCRA) Tank Unit 887.2 in Buildings 881 and 887. The Colorado Department of Public Health and Environment (CDPHE) Hazardous Waste Management Division (HZMD) hereby formally - conditionally - agrees that the appropriate activities described in the notification may proceed utilizing the Component RSOP.

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Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000024 05/31/2002 1 Pages PUBLIC	YES, ROUTINE	02-DOE-00842; 00343-RF-02	LEGARE, JOSEPH A.	GUNDERSON, STEVE	US Department of Energy, Rocky Flats Field Office (DOE/RFFO) forwards the Rocky Flats Cleanup Agreement Standard Operating Protocol (RSOP) for Routine Soil Remediation Fiscal Year 2002 (FY02) Notification 02-05, Individual Hazardous Substance Site IHSS Group 800-2 (Building 881) and Group 800-5 (B887). A red-lined version of this notification was sent to the Colorado Department of Public Health and Environment (CDPHE) on May 15, 2002.
B881 A 000025 06/25/2002 1 Pages PUBLIC	YES, ROUTINE	N/A	PRIMROSE, ANNETTE L.	KRUCHEK, DAVID	Purpose of Contact: Discusses the Building 881 Under Slab Sampling, Individual Hazardous Substance Site IHSS Group 800-2 and requires two sample intervals at each location.
B881 A 000027 01/16/2003 2 Pages PUBLIC	YES, ROUTINE	00021-RF-03	GUNDERSON, STEVE	DISALVO, RICHARD	Notification to invoke the Rocky Flats Cleanup Agreement Standard Operating Protocol (RSOP) for Facility Component Removal, Size Reduction, and Decontamination Activities for Closure of Permitted Hazardous/Mixed Waste Treatment Unit 881.3B in Building 881.
B881 A 000028 03/03/2003 3 Pages PUBLIC	YES, ROUTINE	03-DOE-00228; 00209-RF-03	DISALVO, RICHARD	GUNDERSON, STEVE	Forwards the enclosed sketch of the intended new entry to Building 881. As part of the Rocky Flats Cleanup Agreement (RFCA) consultative process, this letter provides notification of a proposed project at Building 881. B881 is currently working under the Component Removal Rocky Flats Cleanup Agreement Standard Operating Protocol (RSOP) for Facility Disposition. This project will create an opening in the lower level of the facility to allow removal of large components from the building.

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Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000029 08/12/2003 2 Pages PUBLIC	YES, ROUTINE	03-RF-01137; FEG-022-03	GIBBS, FRANK E.	TOWER, STEVE	Submits the enclosed Closeout Report for Building 881C. This includes two Cooling Towers, CT2 on the south side of 881, and CT3 on the east side.
B881 A 000032 10/14/2003 3 Pages PUBLIC	YES, ROUTINE	03-RF-01544; DWF-075-03	FERRERA, DENNIS W.	TOWER, STEVE	Submits: Review and approved is the enclosed subject report for the Building 881 Stack S1 structure. This report characterizes the physical, chemical and radiological hazards associated with this facility, summarizes the characterization the activities, defines the Data Quality Objective (DQO) developed for this characterization, and presents the data quality assessment, verification and validation of results. Based upon this Pre-Demolition Survey Report (PDSR) and subject to concurrence by the Colorado Department of Public Health and Environment (CDPHE), the B881 Stack S1 is considered a Rocky Flats Cleanup Agreement (RFCA) Type 2 facility pursuant to the Rocky Flats Environmental Technology Site (RFETS/Site) Decommissioning Program Plan (DPP; K-H 1999) and is acceptable for demolition.
B881 A 000033 10/17/2003 2 Pages PUBLIC	YES, ROUTINE	N/A	FOSS, DYAN	KRUCHEK, DAVID	Purpose of Contact; the Building 881 Project needs to construct an access door on the south side of B881 to allow for the removal of equipment from the basement. The work is being done to Colorado Department of Public Health and Environment (CDPHE) along with the routine surveys for Building 11
B881 A 000036 10/22/2003 2 Pages PUBLIC	YES, ROUTINE	N/A	PARSONS, DUANE	KRUCHEK, DAVID	Purpose of Contact: During a phone conversation on October 22, 2003 between Colorado Department of Public Health and Environment (CDPHE) and Remediation, Industrial Building D&D and Site Services Project, RISS, media (paint) sampling in Building 881 was discussed. The topic of discussion was collecting in-process paint samples at biased samples location versus systematically gridded sample locations. Per

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Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000030 10/23/2003 1 Pages PUBLIC	YES, ROUTINE	00998-RF-03	GUNDERSON, STEVE	LEGARE, JOSEPH A.	The Colorado Department of Public Health and Environment (CDPHE), Hazardous Materials and Waste Management Division has reviewed the Pre-Demolition Survey Report (PDSR) for B881 Stack S1 Closure Project, Revision 0 dated October 9, 2003, sent to us on October 22, 2003. Based on the information contained in this PDSR, hereby approving the PSDR, for B881 Stack S1.
B881 A 000031 10/30/2003 2 Pages PUBLIC	YES, ROUTINE	01023-RF-03	GUNDERSON, STEVE	LEGARE, JOSEPH A.	The Colorado Department of Public Health and Environment (CDPHE) Hazardous Material (HM) Waste Management (WM) Division has reviewed the Facility Disposition Rocky Flats Cleanup Agreement Standard Operating Protocol (RSOP) Notification for Building 881 Stack S1 and the Evaluation of Demolition Methods for 771 and 881 Concrete Stacks, dated October 22, 2003. Based on the information contained in this notification and evaluation, and considering that B881 Stack S1 will meet the free-release levels for contaminants found, we agree that B881 Stack S1 may be disposition utilizing the Facility Disposition RSOP, and as identified in this Notification explosives may be used to demolish this stack.
B881 A 000034 10/31/2003 39 Pages PUBLIC	YES, ROUTINE	03-RF-01544; DFW-075-03	NOT INDICATED	DISTRIBUTION	A Pre-Demolition Survey (PDS) was performed to enable compliant disposition and waste management of the Building 881 Stack S1. Because of the Type 2 structure will be demolished, the characterization was performed in accordance with the PDS (MAN-127-PDSP). Building surfaces characterized as a part of this PDS included the walls and floor. Environmental media beneath and surrounding the facility was not within the scope of this PDS and will be addressed in accordance with the Soil Disturbance Permits and in compliance with Rocky Flats Cleanup Agreement (RFCA).

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Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000035 11/14/2003 2 Pages PUBLIC	YES, ROUTINE	N/A	PARSONS, DUANE	KRUCHEK, DAVID	Purpose of Contact: During a telephone conversation on November 11, 2003 between Colorado Department of Public Health and Environment (CDPHE) and Remediation, Industrial Building D&D and Site Services Project, RISS, in-process survey of Building 881 block walls was discussed. The topic of discussion was performing in-process unrestricted release surveys of the block walls in order to make room inside the building to perform other stripout and decontamination work more efficiently.
B881 A 000037 04/01/2004 1 Pages PUBLIC	YES, ROUTINE	N/A	FOSS, DYAN	KRUCHEK, DAVID	Purpose of Contact: Removal of Appurtenances. The removal of several areas on the exterior (south edge and top) of Building 881 will allow improved access for the removal of waste container equipment and preparation for demolition. These include the South dock and landing (100, 100B, and 200), L-South (300, 302, 302A, 303, 305, 307, and 308), and L-North (311, 311A, and 311B).
B881 A 000038 04/01/2004 1 Pages PUBLIC	YES, ROUTINE	N/A	FOSS, DYAN	KRUCHEK, DAVID	Purpose of Contact: Building 881 Opening to the Environment. In order to prepare Building 881 for demolition, asbestos flashing and the parapet needed to be removed from the roof to allow for drilling. While removing the parapet along the Annex on the northeast side of the building, several small gaps were made between the exterior wall and the metal roof
B881 A 000039 04/13/2004 98 Pages PUBLIC	YES, ROUTINE	04-DOE-00275	LEGARE, JOSEPH A.	GUNDERSON, STEVE	Forwards/submits: Please find enclosed the Facility Disposition Rocky Flats Cleanup Agreement (RFCA), Standard Operating Procedure (SOP), Notification letter for Type 2 Facilities Building 881, 881F, and 887. This notification invokes the RSOP for demolition of the facility pending completion and Lead Regulatory Agency (LRA) of the Pre-Demolition Survey Report (PDSR), for the facility and the enclosed document.

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Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000040 05/06/2004 1 Pages PUBLIC	YES, ROUTINE	00212-RF-04	GUNDERSON, STEVE	LEGARE, JOSEPH A.	The Colorado Department of Public Health and Environment (CDPHE), Hazardous Material and Waste Management Division has reviewed April 7, 2004 letter (received on April 14, 2004) notifying CDPHE, that the Facility Disposition Rocky Flats Cleanup Agreement Standard Operating Protocol (RSOP) will be utilized during the demolition of Building 881 and 887.
B881 A 000041 05/20/2004 2 Pages PUBLIC	YES, ROUTINE	N/A	FOSS, DYAN	KRUCHEK, DAVID	Purpose of Contact: Building 881 Backfilling of Room 10 and elevator, 100A. This contact record is to document the consultative process and Colorado Department of Public Health and Environment (CDPHE) approval of the predemolition survey conducted to support backfilling of Room 10 and elevator, 100A, in Building 881. The survey demonstrating these areas were at unrestricted release were provided to CDPHE during a bi-monthly B881 status meeting on May 13. In addition, follow-up information was provided on the surveys and information copies of the work packages were provided to CDPHE.
B881 A 000044 05/27/2004 1 Pages PUBLIC	YES, ROUTINE	N/A	FOSS, DYAN	KRUCHEK, DAVID	Purpose of Contact: Building 881 Backfill of Rooms 247 through 249. This contact record is to document the consultative process and Colorado Department of Public Health and Environment (CDPHE) approval of the predemolition surveys conducted to support backfilling of Rooms 247 through 249, also known as the vaults, in Building 881.
B881 A 000045 05/27/2004 1 Pages PUBLIC	YES, ROUTINE	N/A	FOSS, DYAN	KRUCHEK, DAVID	Purpose of Contact: Building 881, Room 11, Old Process Waste Line Pipe penetration. This contact record is to document the consultative process and Colorado Department of Public Health and Environment (CDPHE) approval of the disposition of a piece of old process waste line that penetrates into Room 11 in Building 881. Room 11 is the lowest level of Building 881 and is currently below grade.

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Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000046 06/03/2004 1 Pages PUBLIC	YES, ROUTINE	N/A	FOSS, DYAN	KRUCHEK, DAVID	Purpose of Contact: Building 881 exclusion dock pre-demolition survey data and demolition. This contact record is to document the consultative process and Colorado Department of Public Health and Environment (CDPHE) approval of the pre-demolition survey conducted to support the mechanical demolition of Building 881 exclusion dock.
B881 A 000047 06/03/2004 2 Pages PUBLIC	YES, ROUTINE	N/A	PARSONS, DUANE	WALLIN, BURCE	Purpose of Contact: Building 881 Pre-demolition Surveys. On May 12, 2004 a walkdown of Building 881 was conducted with US Department of Energy (DOE) and Remediation, Industrial Building D&D and Site Services Project, (RISS) to observe in process Pre-Demolition Survey (PDS) of Building 881 areas.
B881 A 000052 06/07/2004 94 Pages PUBLIC	YES, ROUTINE	04-RF-00617; DWF-036-04	FERRERA, DENNIS W.	MORGAN, GARY	The Rocky Flats Environmental Technology Site (RFETS/Site), Pre-Demolition Survey Report (PDSR) Buildings 881F Closure Project. A Pre-Demolition Survey (PDS) was preformed to enable compliant disposition and Waste Management of Building 881F. Because this Type 2 facility will be Decommissioned, the Characterization was performed in accordance with the Pre-Demolition Survey Plan (MAN-127-PDSP) to supplement the Reconnaissance Level Characterization (RLC) of these Type 2 facilities.
B881 A 000051 06/08/2004 2 Pages PUBLIC	YES, ROUTINE	04-RF-00671; DWF-036-04 [000042; 000052]	FERRERA, DENNIS W.	MORGAN, GARY	Submits: The attached [000052] copies for Building 881F Pre-Demolition Survey Report (PDSR). Provided for review and approval is the copies subject report for the 881F facility. This report characterizes the physical, chemical and radiological hazards associated with this facility, summarizes the Characterization, activities, defines the Data Quality Objective (DQO) developed for this Characterization, and presents the Data Quality Assessment (DQA), verification and validation of results.

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Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Pages	Title / Subject
B881 A 000057 06/08/2004	YES, ROUTINE	04-RF-00613; DWF-032-04	FERRERA, DENNIS W.	MORGAN, GARY	512	A Pre-Demolition Survey (PDS) was preformed to enable complaint disposition and Waste Management of Building 881. Because this Type 2 Facility will be demolished, the characterization was preformed in accordance with the Pre-Demolition Survey Report (PDSR) (MAN-127-PDSP). Building 881 Closure Project 2nd Floor, 2nd Floor Mezzanine and the 881/883 Tunnel interior floors, pits walls and ceilings. The purpose of this report is to communicate and document the results of the Building 881 2nd Floor, 2nd Floor Mezzanine and the 881 Tunnel PDS effort.
PUBLIC						
B881 A 000050 06/09/2004	YES, ROUTINE	04-RF-00615; DWF-034-04	FERRERA, DENNIS W.	MORGAN, GARY	108	The Rocky Flats Environmental Technology Site (RFETS/Site), Pre-Demolition Survey Report (PDSR) Building 881 Closure Project 881 Basement Area. A Pre-Demolition Survey (PDS) was preformed to enable compliant disposition and Waste Management of Building 881. Building Surfaces Characterization as part of this PDS included the Building 881 Basement interior floors, walls and ceilings.
PUBLIC						
B881 A 000048 06/10/2004	YES, ROUTINE	N/A	FOSS, DYAN	KRUCHEK, DAVID	2	Purpose of Contact: Approval of 881F (B881 plenum) Pre-Demolition Survey (PDS) data and clearance for removal of the appurtenance (881F) from the Building 811 roof. 881F is the plenum for Building 881 that was installed in 1986. The two stage, High-Efficiency Particulate Air (filter) (HEPA) exhaust filter was built on the roof of B881, and an exhaust chase was added to the east side bypass the original single stage exhaust filter.
PUBLIC						
B881 A 000049 06/10/2004	YES, ROUTINE	04-RF-00615; DWF-034-04 [000043; 000050]	FERRERA, DENNIS W.	MORGAN, GARY	2	Submits: The attached [000050] Building 881 Basement Pre-Demolition Survey Report (PDSR). Provided for review and approval is the report for the Building 881 Basement. This report characterization the physical, chemical and radiological hazards associated with this areas, summarizes the characterization activities, defines the Data Quality Objective (DQO) developed for this characterization, and presents the DQA, verification and validation of results.
PUBLIC						

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Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000056 06/10/2004 2 Pages PUBLIC	YES, ROUTINE	04-RF-00613; DWF-032-04; [000057]	FERRERA, DENNIS W.	MORGAN, GARY	Submits: The attached [000057] provided for review is the enclosed subject report for the Building 881 2nd Floor, 2nd Floor Mezzanine and 881/883 Tunnel. This report characterization the physical, chemical and radiological hazards associated with these areas, summarizes the characterization activities, defines the Pre-Demolition Survey Report (PDSR), and the Data Quality Objectives developed for this characterization, and presents the Data Quality Assessment, verification and validation of results.
B881 A 000054 06/17/2004 2 Pages PUBLIC	YES, ROUTINE	N/A	FOSS, DYAN	KRUCHEK, DAVID	Purpose of Contact: Approval of Pre-Demolition Survey (PDS) Data for Rooms 160, 169, 170, 170A, 171, 171A, 159B and portion of Rooms 168, 161 and Mechanical Demolition of Rooms 160, 169, 170, 170A, 171, 171A and 159B. This contact record is to document the consultative process and Colorado Department of Public Health and Environment (CDPHE) approval of the pre-demolition surveys conducted to support the mechanical demolition of portion of the North Annex of Building 881. The surveys demonstrating these areas were at unrestricted release were provided to CDPHE in phases.
B881 A 000053 06/23/2004 2 Pages PUBLIC	YES, ROUTINE	N/A	FOSS, DYAN	KRUCHEK, DAVID	Purpose of Contact: Approval of Pre-Demolition Survey (PDS) Data for the first and second floor and basement of Building 881 and continued building preparation for demolition. This contact record is to document the consultative process and Colorado Department of Public Health and Environment (CDPHE) approval of the pre-demolition surveys and mechanical demolition the Building 881 Annex and second floor hallways, continued building preparation for demolition, and basement backfill.

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Doc. No. / Date	Routine	Internal Code	Author(s)	Recipient(s)	Title / Subject
B881 A 000042 06/25/2004 1 Pages PUBLIC	YES, ROUTINE	00275-RF-04	GUNDERSON, STEVE	LEGARE, JOSEPH A.	The Colorado Department of Public Health and Environment (CDPHE) Hazardous Waste Management Division has reviewed the Pre-Demolition Survey Report (PDSR) for Building 881F, Version 0, dated June 7, 2004. Based on the information contained in this PDSR, the Division hereby approves this PDSR for Building 881F.
B881 A 000043 06/28/2004 1 Pages PUBLIC	YES, ROUTINE	00277-RF-04	GUNDERSON, STEVE	LEGARE, JOSEPH A.	The Colorado Department of Public Health and Environment (CDPHE) Hazardous Waste Management Division has reviewed the Pre-Demoliiton Survey Reports (PDSRs) for Building Second Floor, Second Floor Mezzanine, and 881/883 Tunnel, Volume I, Version 0 dated June 8, 2004, and B881 Basement Area, Volume II dated June 9, 2004. Based on the information contined in these PDSRs, the Division hearby approves these PDSRs for B881 Second Floor, Second Floor Mezzanine, 881/883 Tunnel, and Basement Area.
B881 A 000055 07/01/2004 1 Pages PUBLIC	YES, ROUTINE	N/A	PARSONS, DUANE	KRUCHEK, DAVID	Purpose of Contact: Based on review of the Building 887 Pre-Demolition Survey Report (PDSR) by Colorado Department of Public Health and Environment (CDPHE), this PDSR is approved and the 887 building demolition can proceed.
B881 A 000060 07/05/2004 1 Pages PUBLIC	YES, ROUTINE	00309-RF-04; [000055]	GUNDERSON, STEVE	LEGARE, JOSEPH A.	The Colorado Department of Public Health and Environment (CDPHE) Hazardous Materials Waste Management Division has reviewed the Pre-Demolition Survey Report (PDSR) for Building 887, Version 0 dated June 17, 2004, received on July 15, 2004. Based on the information contained in this PDSR, CDPHE hereby approving this PDSR for Building 887.
B881 A 000058 07/15/2004 220 Pages PUBLIC	YES, ROUTINE	04-DOE-00512; 00301-RF-04; DWF-033-04; DWF-035-(	LEGARE, JOSEPH A.	GUNDERSON, STEVE	Please find enclosed the Pre-Demolition Survey Reports (PDSR) for: (1) Building 881 first floor and the first floor mezzanine [DWF-033-04], and (2) Building 887 [DWF-035-04]. This is the official transmittal of those PDSRs, which were provided to the state in mid June, and in the case of 887, followed up with a contact record dated July 1, 2004

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Doc. No. / Date	Routine	Internal Code	Title / Subject
B881 A 000059	YES, ROUTINE	00308-RF-04	The Colorado Department of Public Health and Environment (CDPHE) Hazardous Materials Waste Management Division has reviewed the Pre-Demolition Survey Report (PDSR) for Building 881 First Floor and First Floor Mezzanie, Volume 3, dated June 17, 2004. Based on the information contained in this PDSR, are hereby approving this PDSR for B881 First Floor and First Floor Mezzanine.
07/15/2004	Author(s)	Recipient(s)	
1 Pages	GUNDERSON, STEVE	LEGARE, JOSEPH A.	
PUBLIC			

Appendix C. RCRA Unit Closure Summary

There were two RCRA units associated with the 881 Closure Project, Units 887.2 and 881.3B, that were closed in accordance the RSOPs. This section documents the RCRA closure summary information for those units. The closure documentation for RCRA units closed under the RCRA permit with Closure Description Documents have individual closure reports. Table C-1 summarizes the project documentation for RCRA unit closure.

Table C-1. 881 Closure Project Documentation for RCRA Closure

Document	Date	AR Document Number
CDPHE approval of Closure Description Document (CDD) for Partial Closure of Resource Conservation and Recovery Act (RCRA) Tank Storage Unit 887.2 (Hood Sink Removal) at Building 881	January 17, 2002	B881-A-000018
RFCA Standard Operating Protocol (RSOP) notification for Component Removal, Size Reduction and Decontamination Activities for Resource Conservation and Recovery (RCRA) Unit Closure of RCRA Unit 887.2 in Building 881 and 887	February 27, 2002	B881-A-000020
CDPHE conditional agreement on RCRA Unit Closure approach for RCRA Unit 887.2 in Building 881 and 887	May 28, 2002	B881-A-000023
RFCA Standard Operating Protocol (RSOP) notification for Component Removal, Size Reduction and Decontamination Activities for Resource Conservation and Recovery (RCRA) Unit Closure of RCRA Unit 881.3B in Building 881	January 16, 2003	B881-A-000027

Closure Summary Information for RCRA Unit 887.2

Pursuant to the *Rocky Flats Environmental Technology Site's (RFETS) "RCRA Part B Permit,"* Rev. 9/25/98, the *Rocky Flats Environmental Technology Site's (RFETS) "RFCA Standard Operating Protocol (RSOP) for Facility Component Removal, Size Reduction, and Decontamination Activities, Notification Letter,* March 1, 2002*"* (02-DOE-00306), this section is submitted to document the closure summary information for Unit 887.2.

This summary information pertains to RCRA closure activities for Tanks T-183, T-184, T-185, T-802A, T-802B, T-802C, and T-802D, ancillary piping, pumps, and secondary containment in B887, and all remaining process piping in Building 881 that was not previously removed under the following closure activities:

- Closure Description Document for Partial Closure of Interim Status Portion of Tank Unit 887.2 in Building 881 – Hood and Sink Removal
- Closure Description Document for Partial RCRA Closure of Tank Storage Unit 887.2 (first phase)
- Closure Description Document for Partial RCRA Closure of Tank Storage Unit 887.2 (second phase)

This summary is a requirement of Section 5, Closure of RCRA – Regulated Units, of the RSOP for Facility Component Removal, Size Reduction, and Decontamination Activities. This report contains a description of major closure activities and any deviations from those stated in the RSOP Notification Letter and other relevant information.

DESCRIPTION OF MAJOR CLOSURE ACTIVITIES

Closure activities were conducted in according to work packages prepared in accordance with the Integrated Work Control Program. Approximately 25.49 m^3 (20,600 lbs.) of LLM waste was generated from this pipe removal action. When tanks and ancillary equipment removal work was initiated, it was discovered that there was dried sludge in more than one tank. The sludge was physically removed and packaged into 11 drums (1,725 lbs. or 2.305 m^3). This LLM sludge was disposed at Envirocare, based on sampling and characterization. In addition, 12.745 m^3 (3,984 lbs.) of associated secondary waste (PPE, plastic, chemical wipes, etc) was packaged as LLM waste.

The tanks from Building 887 were packaged and disposed of as LLM waste consisting of 114.174 m^3 or 25,006 lbs. The secondary containment, in Building 887, was decontaminated using an abrasive technique, in order to meet the clean closure criteria. The containment was rinsed and sampled (RIN 04D0783), and met clean closure for all criteria but mercury. The containment was re-rinsed and sampled for mercury (RIN 04C0543), and met clean closure criteria for mercury. Since this concrete containment met the unrestricted release criteria, it was left in place after building demolition.

SUMMARY

The requirements stated in the RSOP Notification Letter for closure of RCRA Unit 887.2 has been fulfilled. The tanks, ancillary equipment, sludge, and secondary waste was packaged as LLM waste for appropriate disposal at Envirocare, Utah.

Closure Summary Information for RCRA Unit 881.3B

Pursuant to the *Rocky Flats Environmental Technology Site's (RFETS) "RCRA Part B Permit,"* Rev. 9/25/98, the *Rocky Flats Environmental Technology Site's (RFETS) "RFCA Standard Operating Protocol (RSOP) for Facility Component Removal, Size Reduction, and Decontamination Activities, Notification Letter,* October 25, 2002*"* this section is submitted to document the closure summary information for Unit 881.3B.

This summary information pertains to RCRA closure activities for unit 881.3B was in Room 267 of Building 881 and included hoods 3, 4, and 5. This unit was used to treat reactive chemicals from RFETS prior to disposal as low level waste; the authorized treatment processes were UV oxidation, hydrolysis, cementation, and organic treatment. The UV oxidation process was closed under a Closure Description Document.

This summary is a requirement of Section 5, Closure of RCRA – Regulated Units, of the RSOP for Facility Component Removal, Size Reduction, and Decontamination Activities. This report contains a description of major closure activities and any deviations from those stated in the RSOP Notification Letter and other relevant information.

DESCRIPTION OF MAJOR CLOSURE ACTIVITIES

Closure activities were conducted in according to work packages prepared in accordance with the Integrated Work Control Program. In compliance with the notification, only portions of the hood surface that had evidence of contact with treated chemicals were managed as hazardous waste. Careful inspection was made of the hoods, and the hoods were wiped down to determine if there was residue. No visual or residue evidence could be found, and the hoods were dispositioned as low level waste. The piping and sink/drains were cut out and dispositioned as low level mixed waste. The quantities were minimal, and the waste was combined with other building waste and not tracked separately.

SUMMARY

The requirements stated in the RSOP Notification Letter for closure of RCRA Unit 881.3B has been fulfilled. The portions of the unit that came into contact with treated chemicals and secondary waste was packaged as LLM waste for appropriate disposal at Envirocare, Utah.

Appendix D. Quantification of Airborne Dust Concentrations Downwind of the Building 881 Demolition

EXECUTIVE SUMMARY

On July 17, 2004, Building 881 at the Rocky Flats Environmental Technology Site (RFETS) was demolished using explosives. As expected, the demolition produced a significant but short-lived plume of airborne dust. This study was intended to quantify the airborne dust concentrations from building demolition for two purposes: 1) to improve our knowledge of the short-term atmospheric impact of building demolition using explosives, and 2) to provide information that will be used in future dispersion models of building demolitions using explosives at RFETS.

A monitoring study was implemented to capture and quantify particulate matter from Building 881 demolition. The study employed 12 total suspended particulate (TSP) samplers at fixed locations around the demolition between 216 and 320 meters (m) distance, along with three truck-mounted samplers that were positioned at similar distances "downwind" of the expected plume shortly before demolition. In addition, four optical aerosol monitors positioned on the trucks were used to determine the duration of plume passage. The demolition plume was videotaped against a known reference to allow the vertical extent of the plume to be estimated. Still photos from the demolition were used to determine plume structure and to guide the modeling study of plume dispersion. A portable meteorological data collection system was collocated with one of the TSP samplers to collect the wind parameters needed to model plume dispersion from the demolition. TSP data collected by the sampling array over approximately 30 to 90 minutes, depending on the sampler, were adjusted to estimate peak TSP concentrations during plume passage, as well as peak 15-minute concentrations during demolition, at each of the impacted sampler locations.

The results of the monitoring study showed that plume passage at each of the affected sampling locations, 200 m to 300 m downwind, occurred in less than 15-minutes, with most samplers experiencing elevated concentrations for approximately 6 minutes. A peak 15-minute concentration of approximately 7,000 micrograms per cubic meter ($\mu g/m^3$) TSP was estimated at the most impacted sampling location, with a peak 6-minute concentration of approximately 17,000 $\mu g/m^3$. This estimated peak concentration during demolition represents a 1,300-fold increase in dust concentration compared with pre-demolition levels.

For comparison, researchers at Johns Hopkins Medical Institutions have reported measurements of fine particulate matter (PM_{10}) at four locations around the explosive demolition of a 22-story building. Downwind peak PM_{10} concentrations varied with distance (54,000 to 589 $\mu g/m^3$), exceeding pre-demolition levels for sites 100 m and 1,130 m downwind by 3,000-fold and 20-fold, respectively. Peak PM_{10} concentrations were short-lived; concentrations at most sites returned to background within 15 minutes. A similar pattern was observed for the Building 881 demolition plume.

The dispersion of the demolition dust plume was modeled using the US Environmental Protection Agency Industrial Source Complex Short-Term model (ISCST3), using 15-minute meteorological data from the portable meteorological system. In addition, finer resolution meteorological data from the National Renewal Energy Laboratory wind site, located a few miles northwest of Building 881, were used to construct a hypothetical meteorological data set with more wind variability that was used for additional modeling studies. A sensitivity study of wind direction and initial source size was performed to find the model configuration that produced the best match to measured concentrations at the samplers that were downwind of the demolition. The best-fit results were used to back calculate apparent particulate matter emission rates from the demolition.

The study indicated that average particulate matter emissions during the 15-minutes encompassing demolition were probably in a range between 200 to 2,000 grams per second (g/s). When particle deposition that would have occurred between the demolition itself and the sampling locations is considered, the emission rates at the source were probably somewhat higher, by perhaps as much as 10%, depending on the actual particle size distribution of the demolition dust. It is expected that up to 85% of

the emissions may have been in the respirable range (PM_{10}).

TSP concentrations were projected to the minimum fenceline distance (1,800 m) from Building 881 using the range of emission rates estimated for the demolition. Peak 15-minute concentrations at 1,800 m downwind would likely have been in the range of approximately 50 to 1,630 $\mu g/m^3$, with maximum 1-hour concentrations between approximately 25 and 420 $\mu g/m^3$, including background particulate matter from sources other than Building 881 demolition. For a 24-hour average, the expected fenceline concentrations would have been between 13 and 29 $\mu g/m^3$, well below the National and Colorado Ambient Air Quality Standard limitation of 150 $\mu g/m^3$.

For future reference, note that the distribution of particulate matter in the initial source plume modeled was based largely on photographic data. Demolition of Building 881 took place during unstable atmospheric conditions with relatively light winds. It may be assumed that less stable conditions or higher wind speeds would have produced a somewhat different initial plume distribution. The effects that differing meteorological conditions may have on initial plume structure should be taken into account in planning for future explosive demolitions.

1.0 INTRODUCTION

On July 17, 2004, Building 881 at the Rocky Flats Environmental Technology Site (RFETS) was demolished using explosives. Building 881, located at the south-central edge of the RFETS Industrial Area (IA), was a reinforced concrete structure encompassing approximately 1.1 million total square feet of surface area (walls, floors, etc.), with most of the levels below grade. The building mass was estimated to be about 30.5 million pounds. The top two floors of the structure were "pancaked" onto the lower levels using 1,327 pounds of exgel dynamite. Most of the exterior surfaces (roof, south walls, etc.) were covered in fencing and geotextile to minimize projectiles and mitigate dust.

As expected, the demolition produced a significant but short-lived plume of airborne dust. This study was intended to quantify the airborne dust concentrations at known downwind distances that resulted from building demolition for two purposes: 1) to improve our knowledge of the short-term atmospheric impact of building demolition using explosives, and 2) to provide information that will be used in future dispersion models of building demolitions using explosives at RFETS.

1.1 Background

The Building 881 was used as an enriched uranium component manufacturing facility from 1953 to 1966, when stainless steel machining became the principle building activity. Radiological contamination within the facility was remediated prior to demolition; the structure was classified as unrestricted release (less than 200 picocuries per 100 square centimeters [pCi/100 cm^2])[1] at the time of demolition. Therefore, though radiological operations once occurred within the facility, there was no significant radiological emissions potential associated with Building 881 demolition. Building 881 is shown in Figure 1-1.

Prior to the demolition, atmospheric dispersion modeling was performed to assess the potential short-term impacts of Building 881 demolition on air quality. The demolition was modeled using the EPA Industrial Source Complex Short-Term (ISCST3) model, incorporating information from several papers published by researchers at Johns Hopkins Medical Institutions that examined air impacts from building demolitions using explosives in Baltimore, MD. Johns Hopkins researchers reported measurements of fine particulate matter (PM_{10}) at four locations around the demolition of a 22-story building (Beck, et al., 2003). Downwind peak PM_{10} concentrations varied with distance (54,000 to 589 micrograms per cubic meter [$\mu g/m^3$]), exceeding pre-demolition levels for sites 100 meters (m) and 1,130 m downwind by 3,000-fold and 20-fold, respectively. Peak PM_{10} concentrations were short-lived; concentrations at most sites returned to background within 15 minutes. A similar pattern was observed for the Building 881 demolition plume.

The original Building 881 demolition model results were thought to be overly conservative, based on several simplifying assumptions that were made. Through the study reported here, future modeling of RFETS building demolitions are expected to improve in their predictive power based on knowledge gained of the plume height, plume density (airborne dust concentration at known distances), plume structure, plume dispersion rate, and plume duration.

[1] Unrestricted release as defined in the RSOP for Facility Disposition and DOE Order 5400.5

1.2 Study Goals

The goals of the study were to:

- Measure total suspended particulate (TSP) concentrations at known distances from the source for known time intervals;
- Measure PM_{10} concentrations at known distances from the source for known time intervals;
- Estimate plume height based on visual observation against a known reference;
- Estimate plume dispersion based on resulting concentration data, plots of time-integrated aerosol monitor data, and analysis of meteorological data;
- Estimate plume duration based on observational and aerosol monitor data;
- Capture meteorological data concurrently with air sampling to facilitate modeling of the emissions source; and
- Develop plume height factors and TSP emission factors for future RFETS building demolitions using explosives, based on the resulting data.

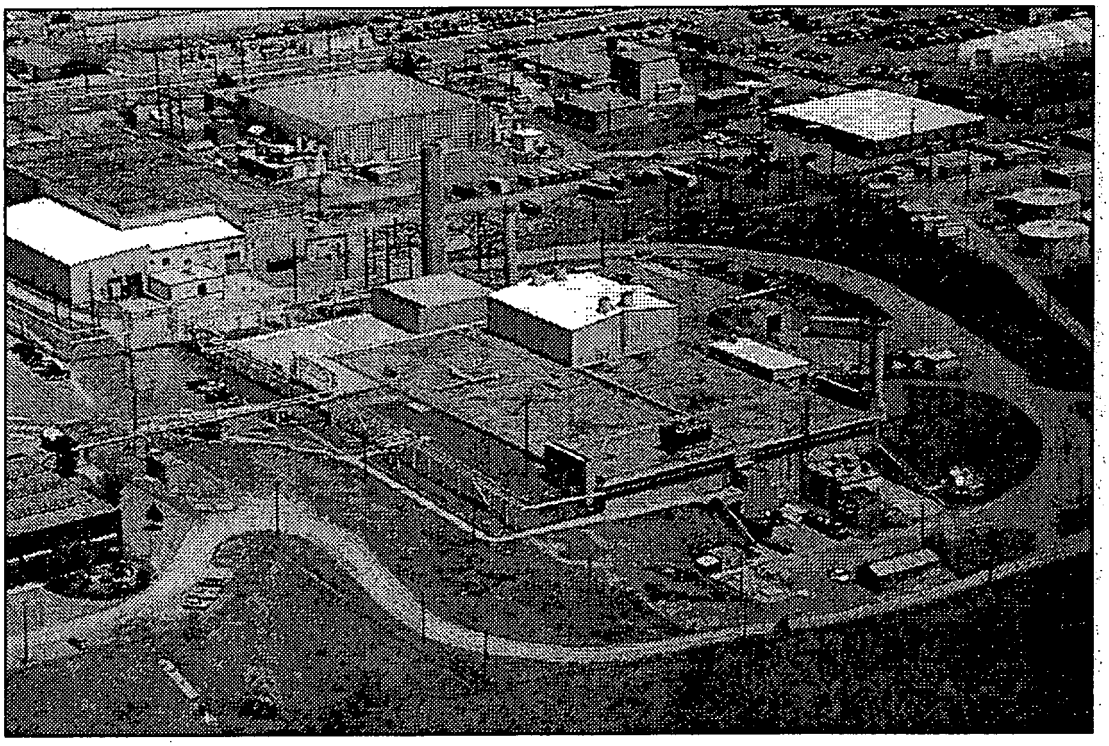

Figure 1-1. Aerial View of Building 881 from the South-Southwest.

2.0 MONITORING STUDY DESIGN AND IMPLEMENTATION

Building 881 was demolished on July 17, 2004. Explosive charges were used to weaken the upper walls of the structure, which was then collapsed onto the lower floors. Demolition commenced at approximately 10:47 am.

2.1 Monitoring Study Design

The study design is documented in more detail in the *Sampling and Analysis Plan* for this project (URS Group, 2004).

2.1.1 Boundary Definition, Spatial

To capture the plume from the demolition, 12 TSP samplers were arrayed along 30-degree radials surrounding the Building 881 demolition, subject to the limitations of topography, infrastructure, and access postings. Distances from Building 881 ranged from 216.2 m to 320.7 m, just outside the 750-foot exclusion zone established to protect personnel. Samplers were placed uniformly around Building 881 because daytime winds at RFETS in mid-July are often light and variable. As a result, wind direction for the event period was not predictable based on historical meteorological data, so attempting a predictive "downwind only" array of fixed locations could not guarantee plume capture.

In addition to the fixed sampling array, three trucks were outfitted with a TSP sampler and PM_{10} optical aerosol monitor each. One truck also contained a collocated TSP optical aerosol monitor. Shortly prior to the demolition, based on observed wind flow, the three trucks were arrayed in the southwest quadrant at distances ranging from 283.1 to 365.9 m from Building 881, as close as access would allow to the 750-m exclusion boundary. Sample collection points were between 1 and 2 m above ground.

Locations of all samplers and meteorological measurements were recorded using global positioning system (GPS) technology. Sampling locations are shown in Figure 2-1.

2.1.2 Boundary Definition, Temporal

The sampling periods for the TSP samplers ranged from 32 minutes to 89 minutes, depending on location. The shorter periods were from the truck-mounted samplers, which were switched on shortly before demolition and switched off after the plume had dispersed. The PM_{10} and TSP aerosol monitors operated continuously through the demolition period and recorded time-integrated data.

2.1.3 Description of Sampling Architecture

The TSP sample pump and a block diagram of the sample filter assembly (snorkel) are illustrated in Figures 2-2 and 2-3. The sample media is protected from weather by a bell-shaped shell. The sample media and the shell are oriented downward to prevent precipitation from impacting the samples. Sample filters were loaded into and unloaded from filter holders in the laboratory and transported in their holders to ensure filter integrity. Filters, filter holders, and sample pumps were all individually numbered to ensure traceability and chain of custody.

The R&P Dustscan Scout model 3020 aerosol monitor is illustrated in Figure 2-4. The Scout 3020 is a real-time aerosol monitor that uses forward scattering of light to quantify particle counts per unit time. Size-partitioning inlets allow for measurement of PM_{10}. Data can be downloaded to Windows-based systems to allow for processing and plotting of results.

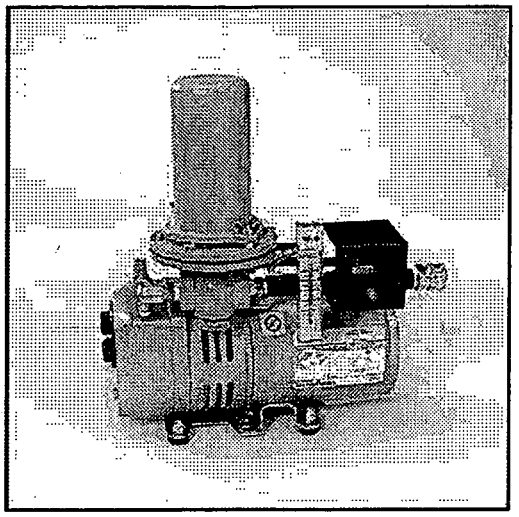

Figure 2-2. Hi-Q VS23-1023CV

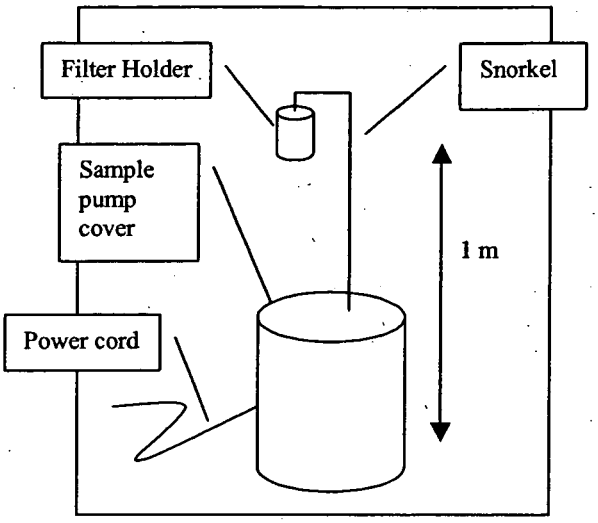

Figure 2-3. Simplified Diagram

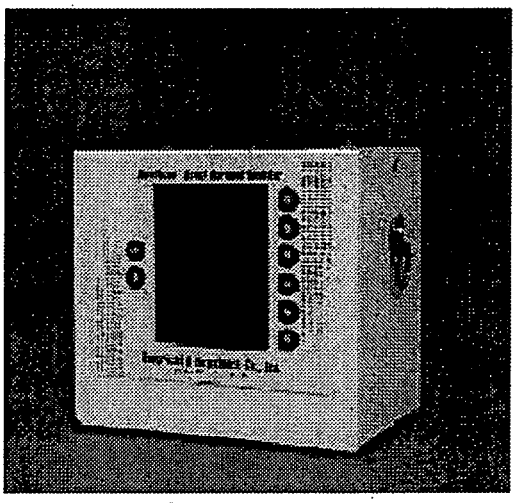

Figure 2-4. Aerosol Monitor

2.2 Implementation

2.2.1 Number of Samples and Schedule

- An array of 12 medium-volume TSP air samplers were arrayed along 30 degree radials to collect ambient air samples during the demolition (12 x 30° = 360°).
- Twelve *Hi-Q* model VS23-1023CV medium-volume sample pumps, powered by portable gasoline-fueled generators, were used for TSP sampling.
- TSP sample media consisted of tared 47 millimeter (mm) glass fiber filters.
- Four R&P Dustscan Scout model 3020 aerosol monitors were deployed to provide semi-quantitative, time-integrated plots of plume density and duration. Three units used PM_{10} inlets (one per truck) and a fourth unit sampled TSP to provide a calibration reference.
- Three trucks were outfitted with a TSP air sampler and a PM_{10} aerosol monitor each, and were deployed into the plume path to characterize downwind emissions.

2.2.2 Sample Preparation and Analysis

Sample filters were marked with unique, sequential identification numbers to correspond with sample location, sample date/time, and Report Identification Number (RIN). Filters were conditioned for a minimum of 24 hours in a desiccator at laboratory temperature in the Stoller Low Level Laboratory (LLL) of Building T130A. All gravimetric analyses were performed to a constant result, in accordance with Stoller LLL gravimetric analysis procedure. Once tared, filters were installed into filter holders and assembled into the provided sample carrier by LLL staff to await pickup by field staff.

Exposed samplers were returned to the LLL in their filter holders. Samples were recovered from their filter holders and reconditioned for a minimum of 24 hours in a desiccator at laboratory temperature. Once conditioned, final weight was determined to a constant result. Results were reported in accordance with the applicable Analytical Services Division task order requirements.

2.2.3 Meteorological Monitoring

To support the development of emission factors for use in atmospheric dispersion modeling from the data collected, meteorological monitoring was performed in the vicinity of the demolition. A portable 2-meter meteorological station was installed by the field sampling team and recorded temperature, wind direction, wind speed, and standard deviation of horizontal wind direction (sigma theta) as 15-minute averages.

2.3 Quality Assurance/Quality Control

A field QA/QC program was followed to ensure that data quality objectives are met. Sample collection errors were controlled using standard collection methods, field documentation, and chain-of-custody logs. Field log sheets were used to record sample identification, sample times, sample flow rates, sample anomalies, and sample condition. Each filter was uniquely identified on the filter itself using a sequential identification paradigm.

The project name, sample RIN, analytical method, name of sampling technician(s), sample location, and date and time of collection were recorded on sample chain of custody forms. The Site Analytical Services Division (ASD) followed established Site procedures in tracking samples to and data from the analytical laboratories and in providing data quality assurance through data validation/verification processes.

Three trip blanks were prepared and subjected to gravimetric analysis. The trip blanks accompanied samples to and from the field. Trip blank results were used to confirm the quality of the gravimetric data population. Equipment and configuration constraints precluded duplicate sampling.

All quality assurance documents generated as a result of this monitoring project are being maintained in accordance with the Site standards, as documented in the *Site Documents Requirements Manual* and *Records Management Guidance for Records Sources*.

3.0 MONITORING STUDY RESULTS

This section describes the results of the monitoring study of Building 881 demolition.

3.1 Overview

Demolition occurred at approximately 10:47 am on July 17, 2004. The detonation included a sequence of 16 sequenced shots to weaken the structure, followed by a final shot to drop the roof. Total duration was around 10 seconds.

Photographs were taken from the southwest of the building at a distance of approximately 900 m. The photographs provide a record of the evolution of the plume and its movement. In addition, a video of the event was taken from the south using a yardstick at a known distance from the camera and from Building 881 to allow calculation of the vertical extent of the plume.

Figure 3-1 shows the beginning of building collapse following detonation (note the bulging at the bottom of the geotextile fabric with which the building was wrapped). It can be seen that the explosive charges themselves caused only minor dust generation. Figure 3-2 shows the beginning of a dust cloud associated with the collapse of the building structure.

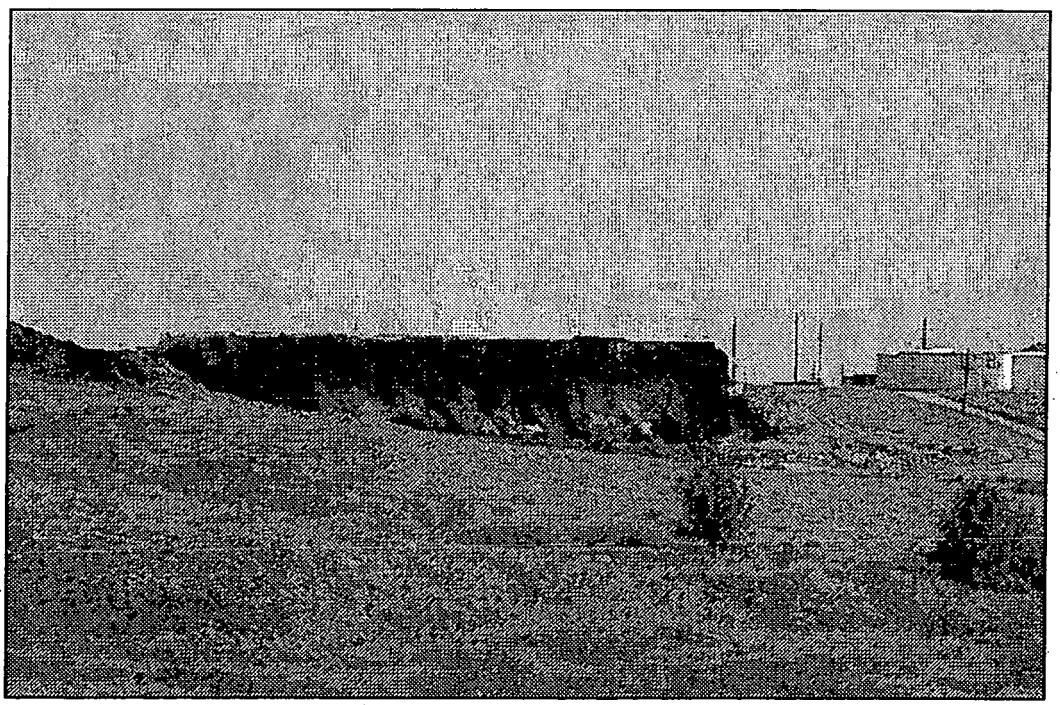

Figure 3-1. Initiation of Building 881 Collapse

Figure 3-2. Initiation of Plume

Figure 3-3 shows the dust cloud beginning to spread both out and up from the building location. The following figure, Figure 3-4, shows the growth of the dust cloud within the first few seconds following building collapse. Some dispersion is evident to the west, on the left side of the picture, as the dust cloud begins to be influenced by the wind.

Figure 3-5 shows the plume moving downwind from the Building 881 location. Some stratification of the plume is apparent in this photograph, with the lower portions of the plume showing greater dust density than the middle or upper portions. The plume structure evident in this picture was used to determine the best way to model the event (see Section 4.0). Figure 3-5 also shows the locations of two of the truck-mounted sampling units—the front portion of one truck (location 14) can be seen at the far right edge of the picture, near the bottom. The red truck at location 15/16 can be seen at the far left edge of the picture, also near the bottom. Locations 13 and 8 are just off the picture to the left along the ridgeline.

Figure 3-6 shows a later view of the plume, which has continued to disperse to the west. Trucks at locations 14 and 15/16 can also be seen in this picture. The truck-mounted sampler at location 13 is at the western edge of the plume, at the approximate location of the tree that can be seen near the top of the ridge. Note the plume movement that has occurred between Figure 3-5 and Figure 3-6; the trees evident near the center of the plume in Figure 3-6 are the same trees that can be seen at the western edge of the plume in the earlier photograph shown in Figure 3-5. Note also that the plume has largely dispersed beyond the location of Building 881 itself, located at the far right hand edge of the plume in this picture.

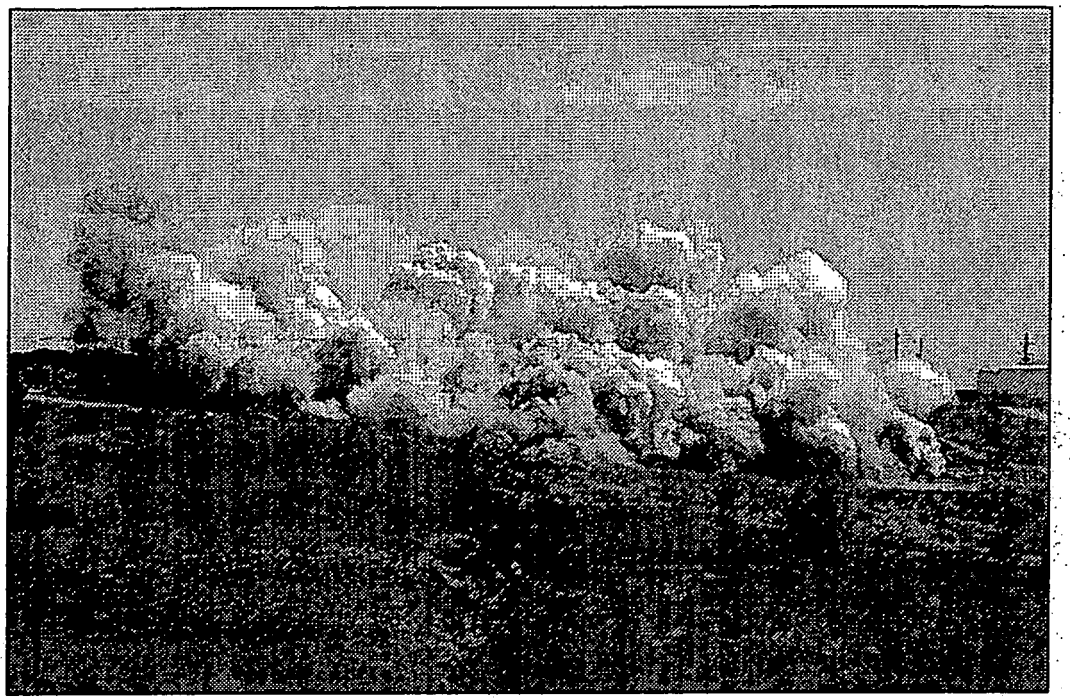

Figure 3-3. Developing Plume

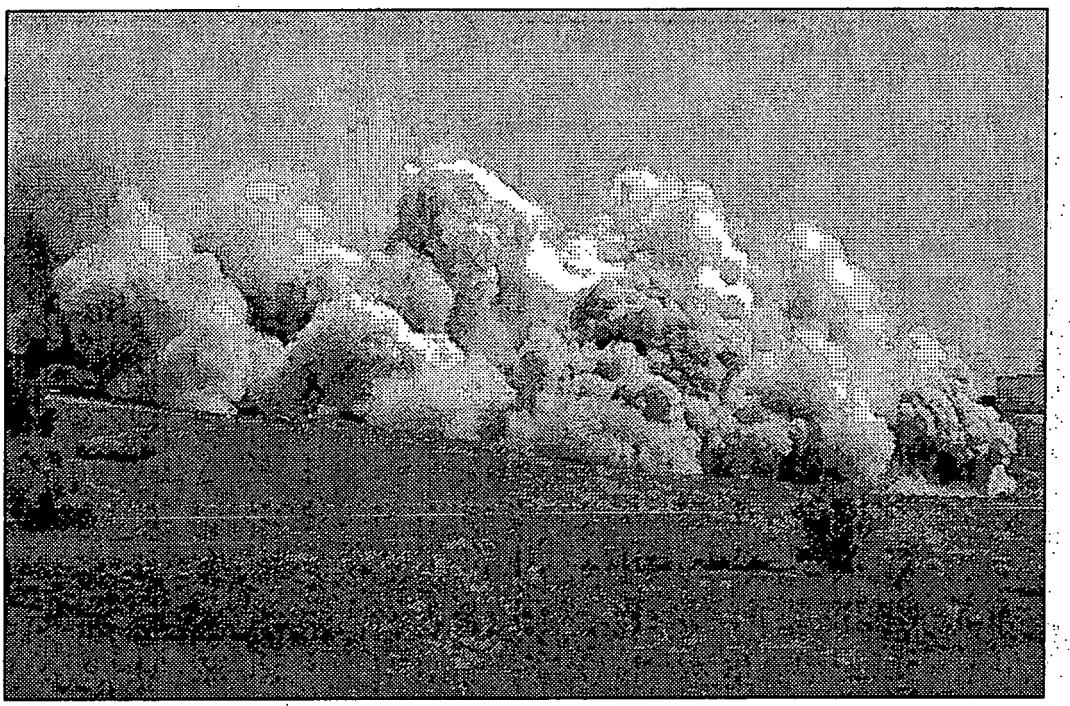

Figure 3-4. Plume Beginning to be Affected by Wind

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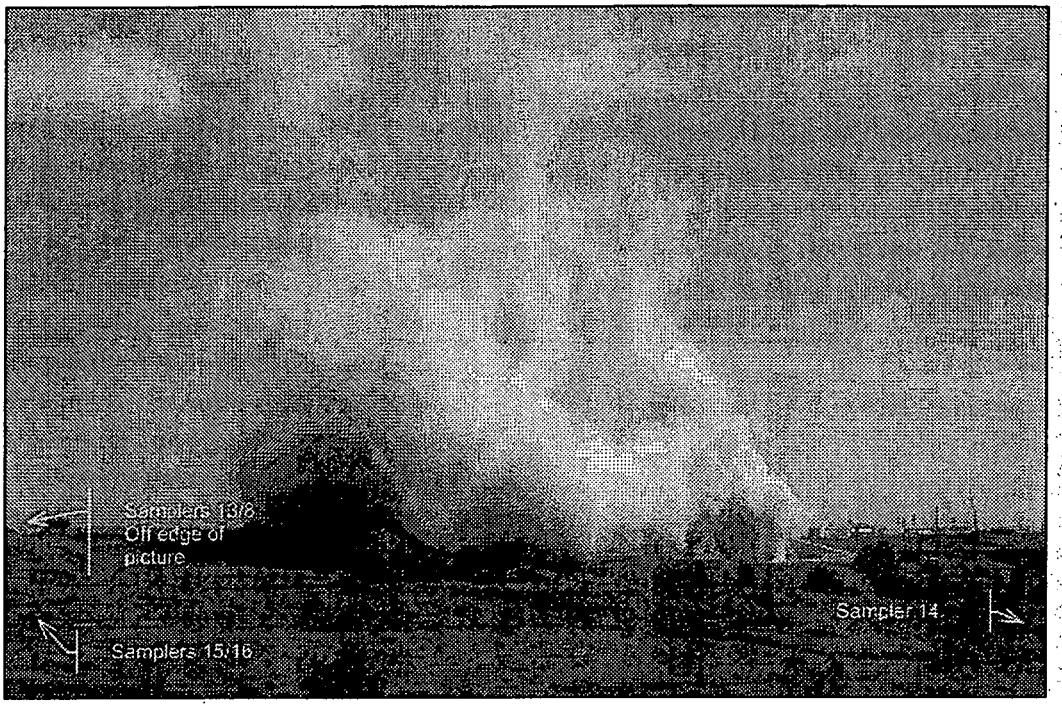

Figure 3-5. Stratified Plume Moving West

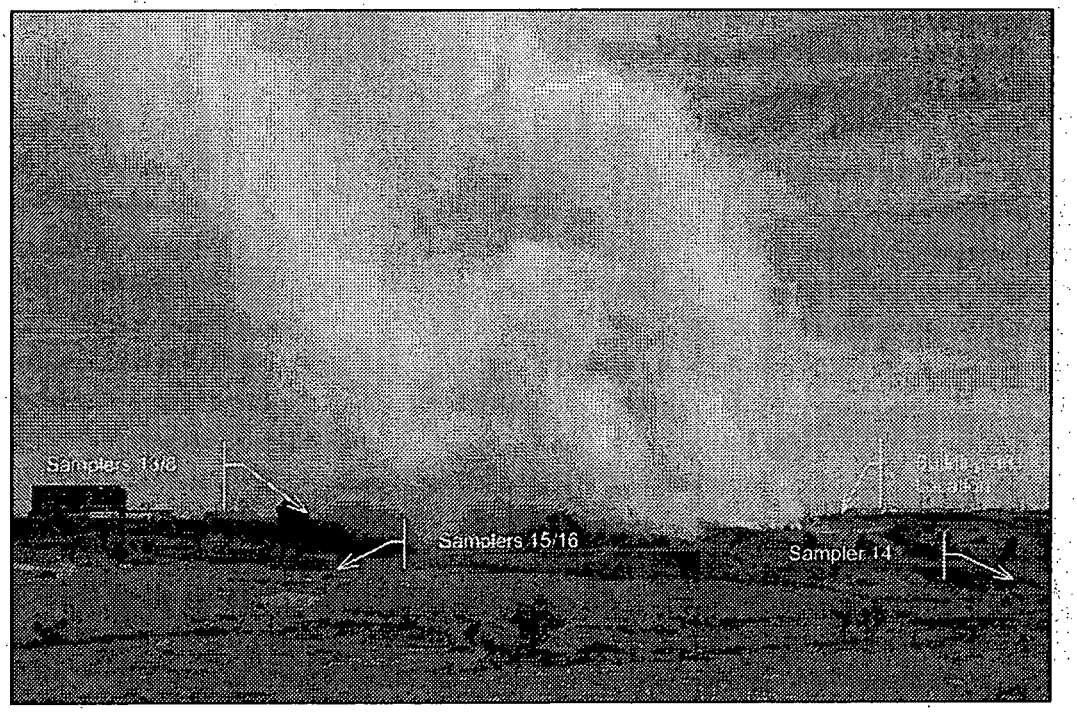

Figure 3-6. Dispersing Plume Impacting Samplers 8 and 13

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The photographic evidence shows several things that help to put the resulting measurement data in context:

- The dust cloud produced by the explosive demolition of Building 881 was largely derived from the collapse of the building structure itself, and the resulting air displacement, rather than from the explosives used for demolition. The vertical extent of the plume was thus determined more by the energy of the collapsing building mass, combined with meteorological conditions existing at the time of collapse, than by the quantity of explosives used.
- The resulting plume spread out as well as up, producing a broad, irregularly shaped "source" from which subsequent dispersion occurred.
- Stratification of mass is apparent within the plume. The video evidence allowed a calculation of 1,270 feet to the top of the plume (atmospheric conditions during demolition were unstable, which would have encouraged vertical growth of the plume). Based on that dimension and on Figure 3-5, it was estimated that approximately 60% of the mass was contained in the lower 300 feet of the plume, an additional 30% between 300 and 700 feet above ground, and the final 10% between 700 feet and the plume top. This information was later used in modeling the event to calculate the mass emission rate associated with the demolition.
- Samplers at locations 13 and 8 were well within the central portion of the plume. These locations recorded the highest concentrations of any of the sampler locations, as expected from the photographic evidence. Samplers located somewhat northeast and southeast of these locations also sampled the edges of the plume, while most other samplers were clearly upwind.
- Between the succession of photographs, the video recording, and data from the optical aerosol monitors, it was apparent that plume passage occurred quickly, with a return to background concentrations within a few minutes at most locations.

3.2 Gravimetric Analyses

Table 3-1 shows the results of the gravimetric analyses.

As can be seen, locations 8 and 13, which were located due west of the southern portions of Building 881, were the most impacted locations. The concurrent meteorological data, which were collected from a location close to sampler 8, showed an average wind direction for the 15-minute period encompassing demolition as from the east (approximately 93 degrees) at 3.14 meters per second. This provides good confirmation that samplers 8 and 13 were near the plume centerline.

Samplers at locations 7, 10, and 15 appear to have sampled portions of the plume further from the centerline. Most of the other samplers recorded only low levels of particulate matter, characteristic of background concentrations.

Sampler 9 presents something of a puzzle. Sampler 9 was located between samplers 8 and 10, both of which show evidence of having been within the plume. Sampler 9 recorded only low particulate matter concentrations, however, at concentrations similar to the upwind locations. There are several reasons why this may have occurred, including some undetected malfunction of the unit. Sampler 9 was located along a road to the west of a parking area that is frequently used to stage trucks and trailers. If the lot contained a number of trucks and trailers during demolition, they could have shielded sampler 9 from the plume, or perturbed the air flow such that the plume broke around the location. Also note the lack of homogeneity in the plume density in Figures 3-3 through 3-6; sampler 9 could also have just been in a gap in the plume.

Table 3-1. Gravimetric Results for Building 881 Demolition

Filter ID/Location	Time On/Time Off (July 17, 2004 am)	Elapsed Time	Sample Volume (m^3)	Net Weight (mg/filter)	Average TSP ($\mu g/m^3$)
1	9:56 11:14	1:18	14.27	-2.1 (no net gain)	0.00
2	10:00 11:17	1:17	15.29	0.1	6.54
3	10:04 11:22	1:18	13.86	-0.1 (no net gain)	0.00
4	10:07 11:26	1:19	15.68	0.2	12.75
5	9:56 11:11	1:15	12.64	0.4	31.64
6	9:55 11:13	1:18	15.24	0.2	13.12
7	9:53 11:15	1:22	14.58	2.2	150.92
8	9:50 11:19	1:29	15.46	18.0	1164.22
9	9:54 11:13	1:19	13.05	0.2	15.33
10	9:58 11:16	1:18	13.25	1.4	105.64[a]
11	10:01 11:19	1:18	15.09	0.3	19.88
12	10:04 11:23	1:19	15.46	0.2	12.94
13	10:13 10:58	0:45	8.56	8.9	1039.35
14	10:26 10:58	0:32	6.20	-0.1 (no net gain)	0.00
15	10:17 10:55	0:38	6.93	2.7	189.50
16	Trip blank	NA	NA	-0.1 (no net gain)	NA
17	Trip blank	NA	NA	0.0 (no net gain)	NA
18	Trip blank	NA	NA	-2.3 (no net gain)	NA

[a] Filter was black; may have been impacted by diesel smoke.

Notes:

m^3 = cubic meters
mg = milligrams
$\mu g/m^3$ = micrograms per cubic meter

The concentrations shown in Table 3-1 are average particulate matter concentrations for the duration of sampling at each location. Three of the optical aerosol monitors, a TSP sampler at location 16 (collocated with location 15) and PM_{10} samplers at locations 13 and 15, recorded plume passage. The detailed record at these locations showed that elevated concentrations occurred for approximately 6 minutes, with peak concentrations occurring for much shorter periods of time (the aerosol monitoring data are discussed further in Section 3.3). "Background" particulate matter concentrations during demolition were calculated as the median concentration from the "upwind" samplers. Assuming that each of the samplers in the plume recorded background concentrations for all but 6 minutes of the sampling period allowed an estimate of peak 6-minute concentrations and 15-minute average concentrations for the critical 15-minute period containing the demolition event. The resulting peak concentration estimates are shown in Table 3-2.

Table 3-2. Estimated Peak TSP Concentrations at Sampling Locations

Location	Peak 6-Minute TSP Concentration ($\mu g/m^3$)	Peak 15-minute Average TSP Concentration ($\mu g/m^3$)
7	1,900	768
8	17,092	6,844
10	1,219	495
13	7,712	3,092
15	2,398	967

Notes:

$\mu g/m^3$ = micrograms per cubic meter

3.3 Aerosol Monitor Data

Figure 3-7 shows the results from the optical aerosol monitors. Location 13 was due east of the southern portion of Building 881 and received the initial plume contact. The winds then shifted the plume in a somewhat more southerly direction, impacting locations 15 and 16 (collocated). (All of the optical aerosol monitors were truck mounted.)

The aerosol monitors employed for this exercise estimate particle concentrations based on forward scattering of light by the particles. Because larger particles do not scatter light as effectively as smaller particles, the actual concentrations of PM_{10} and especially TSP are likely to be underestimated. Consequently, the monitoring study was planned so that optical aerosol monitors were collocated with TSP samplers so that the concentrations recorded by the aerosol monitors could be "calibrated" against the gravimetric data.

Unfortunately, examination of Figure 3-7 shows that the tops of the concentration peaks recorded by the aerosol monitors were "clipped" due to saturation of the optical detector or because the concentrations and particle properties encountered during demolition challenged the physical limits of the signal processor. As a result, the optical aerosol monitoring data were used primarily to record the extent and duration of the plume from Building 881 demolition.

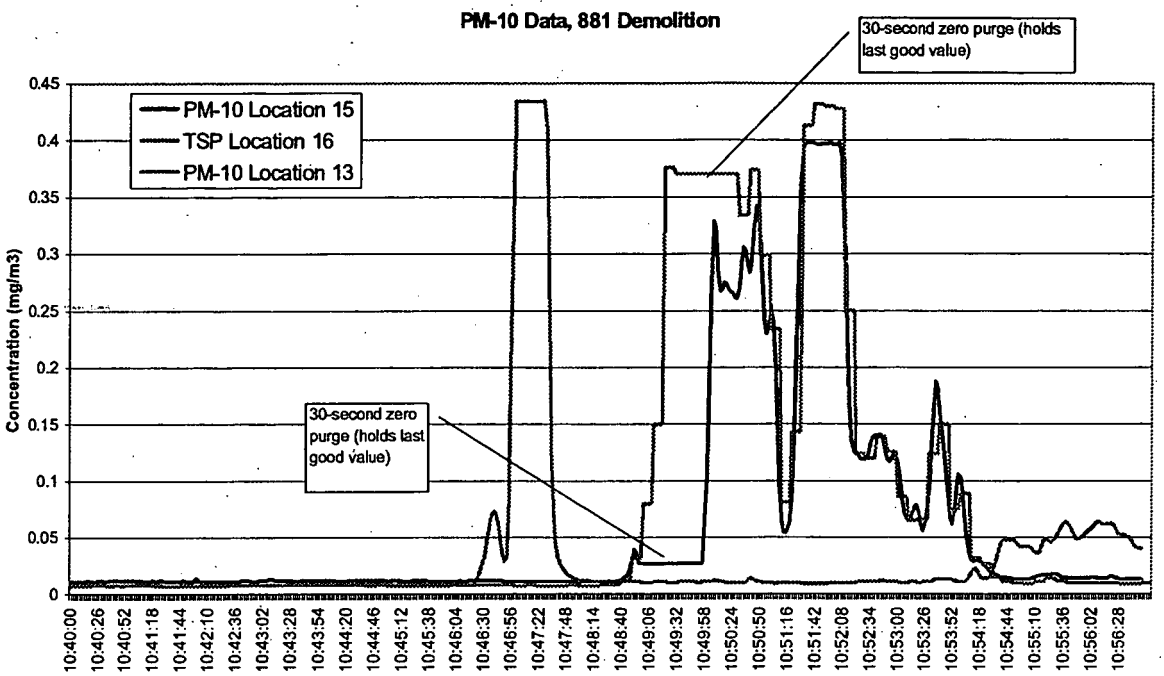

Figure 3-7. Optical Aerosol Monitoring Data

3.4 Discussion

Several studies that measured particulate matter concentrations around building demolition operations were reviewed. The most relevant studies are documented in several papers published by researchers from Johns Hopkins Medial Institutions that looked at air impacts from explosive demolition of a building in the Baltimore, MD, area. A relevant study was published in the Journal of the Air and Waste Management Association (AWMA) in October 2003 (*Impact of a Building Implosion on Airborne Particulate Matter in an Urban Community*. Beck, et al., 2003.) Researchers reported measurements of PM_{10} at four locations around the demolition of a 22-story building. Downwind peak PM_{10} concentrations varied with distance (54,000 to 589 $\mu g/m^3$), exceeding pre-demolition levels for sites 100 m and 1,130 m downwind by 3,000-fold and 20-fold, respectively. Peak PM_{10} concentrations were short-lived; most sites returned to background within 15 minutes.

These results are generally consistent with the measured impacts from Building 881 demolition. Maximum TSP concentrations at 200 m to 300 m downwind from Building 881 were estimated to be approximately 17,000 $\mu g/m^3$ for the 6-minute passage of the demolition plume, with 15-minute average concentrations at approximately 7,000 $\mu g/m^3$. PM_{10} concentrations would likely have been slightly lower. Estimated peak 6-minute TSP concentrations from Building 881 demolition represent a 1,300-fold increase over pre-demolition particulate matter concentrations at the sampler locations, 200 m to 300 m downwind. As demonstrated in the Baltimore, MD, demolition, plume passage occurred in less than 15 minutes.

4.0 MODELING STUDY

One of the objectives of the plume study was to use dispersion modeling to "back calculate" emissions from the demolition of Building 881. The modeling study is described below.

4.1 Modeling Methods

The Industrial Source Complex Short-Term (ISCT3) model was used to estimate airborne particulate matter for comparison with measured concentration data. Based on the observed shape and extent of the plume (see Figure 3-6), the demolition was modeled as three "stacked" volume sources in ISCST3. The lowest volume source extended from groundlevel to 300 feet, the second was assumed to extend from 300 feet above ground to 700 feet, and the highest volume source extended from 700 feet to the observed top of the demolition plume at 1,270 feet. Modeling assumed flat terrain, although the actual terrain surrounding Building 881 is somewhat rolling.

The sources were modeled with a "unit" emission rate—that is, a total emission rate of 1 gram per second from all three sources. Based on the observed plume, 60% of this emission rate was assigned to the lowest volume source, 30% to the middle source, and 10% to the upper level source. The release height and initial vertical extent of each of the three sources was based on guidance provided in the US Environmental Protection Agency's (EPA's) *User's Guide for the Industrial Source Complex Dispersion Models*, Volume 1, Section 3 (EPA, 1995). Results from the unit emission rate modeling were combined with measured concentrations determined from gravimetric data on a receptor-by-receptor basis and an apparent emission rate for the demolition event was calculated at each receptor. The receptors used for modeling matched the distance and bearing of each sampling location, measured from the center of Building 881.

Initial modeling was performed using the critical 15-minute average meteorological data as recorded by the portable station located near sampler location 8 (i.e., between 10:45 and 11:00 am on July 17, 2004). Although ISCST3 assumes a 1-hour time step (therefore, the shortest averaging period that can be directly modeled is 1 hour), information regarding the technical formulation of the ISCST3 dispersion equations suggests that the plume spread parameters used by ISCST3 are actually representative of 10-15 minute averaging periods. Therefore, we have modeled using ISCST3 with 15-minute meteorological data and taken the resulting "1-hour" concentrations to be characteristic of 15-minute averages as well.

Data for the critical 15-minute period encompassing demolition showed an average wind direction of 93.6 degrees (from slightly south of east) and a wind speed of 3.14 meters per second. Temperature and standard deviation of horizontal wind direction were also measured. Stability class was calculated from the measured data (wind speed and wind direction standard deviation) using an algorithm employed by EPA's Meteorological Processor for Regulatory Models (MPRM) (EPA, 1996).

Because demolition emissions and dispersion actually occurred over a period shorter than 15 minutes, based on photographic and optical aerosol monitor evidence, wind direction was varied over a small range to try to produce a better fit to the gravimetric data. Wind directions were varied between 88 and 100 degrees.

The source "footprint" was also varied to improve the correspondence between concentration predictions and the gravimetric data. One problem with using a single 15-minute period for modeling is that the plume spread is likely to be somewhat underestimated since the relatively light wind speeds that occurred during demolition would normally have been associated with somewhat variable wind directions. In this case, the "best" fit was determined by calculating the difference between the apparent emission rate calculated for each individual receptor and the ensemble average emission rate calculated for the group of receptor locations that sampled the plume (locations 7, 8, 10, 13, and 15), where the ensemble average

was represented by the median emission rate calculated for this group. The source footprint was represented by an initial lateral extent parameter, which was also calculated according to guidance in the ISCST3 User's Guide (EPA, 1995), Section 3. Initial lateral extents for the stacked volume sources varied from 20 m to 70 m. (At an initial lateral extent of 70 m, the edge of the total source area would extend slightly beyond the closest of the impacted sampling locations (to 301 m), so a larger source area was not considered credible.)

To further compensate for the "single wind direction" problem inherent in using only one meteorological period for modeling, a somewhat hypothetical meteorological data set was constructed with varying wind directions. The National Renewable Energy Laboratory (NREL) operates a meteorological tower at the northeast corner of the RFETS Buffer Zone, only a few miles from Building 881. Raw data from the 2-m level were downloaded for the critical 15-minute period (10:45 to 11:00 am, July 17, 2004); the data are 1-minute averages. Wind speeds and directions for each 1-minute interval were changed to more closely match the 15-minute average data from the portable meteorological tower employed in the Building 881 plume study by adding the same number of degrees and meters per second to each 1-minute data point until the mean wind speed and direction matched the RFETS data. Following the initial sensitivity analyses for wind direction with the 15-minute RFETS data, the NREL-based data set was readjusted to match the best-fit wind angle (approximately 89.5 degrees).

This "adjusted" data set was also used as input to ISCST3 and period averages were calculated at each receptor for the 13-minute period from 10:47 am to 11:00 am, July 17, matching the demolition and plume dispersion period. Source "footprints" were again varied between 20 m and 70 m to produce "best fit" results. Calculated emission rates were scaled up slightly to account for the difference between the 1-minute resolution of the meteorological data and the assumed 10-minute resolution of the dispersion parameters used by ISCST3.

4.2 Results

The results of the modeling exercise are shown in Table 4-1. Apparent emission rates were calculated based on estimated peak 15-minute concentrations from demolition, as shown in Table 3-2, rather than on the measured concentrations for the duration of sampling at each location.

Results are presented for modeling using only the critical 15-minute average meteorological data from the RFETS portable station and also for modeling using the NREL adjusted data. The best fit over all samplers occurred, for both meteorological data sets, at the largest initial lateral extent used (70 m). The range of predicted emission rates from individual sampling locations modeled (7, 8, 10, 13, 15), and the median and average emission rates, are shown in Table 4-1 for the 70-m initial lateral extent simulations.

Table 4-1. Modeling Study Results Building 881 Demolition

Meteorological Data Set	Minimum Calculated Emission Rate (g/s)	Maximum Calculated Emission Rate (g/s)	Average Calculated Emission Rate (g/s)	Median Calculated Emission Rate (g/s)
Average conditions from 10:45 to 11:00 am July 17, 2004	685	1,683	1,162	993
NREL-adjusted data set	214	1,927	801	448

Note: Rates shown represent demolition emissions as grams per second (g/s) for 15-minute period. Actual peak emission rates during demolition would be higher.

4.3 Discussion

The results shown in Table 4-1 indicate that particulate matter emission rates from Building 881 demolition averaged between 200 and 2,000 grams per second (g/s) for the 15-minute period during which demolition occurred. Peak emission rates from the actual demolition event would have been somewhat higher; elevated concentrations occurred for approximately 6 minutes based on optical aerosol monitor data. Previously determined demolition particle size distributions indicate that 85% of emissions or less were probably respirable (PM_{10}) although, as a conservative assumption, it may be assumed that all particles are respirable.

These calculated emission rates do not account for any particulate matter that may have fallen out of the plume and been deposited on the ground or other surfaces between the sampler locations and Building 881. The size and density of particles emitted from demolition have been previously researched for Building 776/777 demolition (conventional demolition). The bounding particle assumptions derived for Building 776/777 can be used to define the probable range of plume depletion that would be expected at various distances downwind. Modeling performed during the planning phase of Building 881 demolition indicated that concentrations at a downwind distance of 200 m (approximately the distance to the closest sampler used in this monitoring program) would be 2% to 8% less than if no deposition occurred, depending on the size and density of the actual resulting particles. This means that the emission rates shown in Table 4-1 probably underestimate actual emission rates from Building 881 demolition by up to 8% or slightly more, since the plume centerline samplers were slightly further downwind than the planning modeling assumed.

The best-fit simulations for both the RFETS 15-minute meteorological data and for the NREL-adjusted data were used to project TSP concentrations to the minimum fenceline distance (1,800 m) from Building 881 using the range of emission rates shown in Table 4-1 and considering deposition effects (fenceline distance from *Site Safety Analysis Report*). The results indicate that peak 15-minute concentrations at 1,800 m downwind would likely have been in the range of approximately 50 to 1,630 $\mu g/m^3$, with maximum 1-hour concentrations between 25 and 420 $\mu g/m^3$, including background particulate matter from sources other than Building 881 demolition. For a 24-hour average, the expected fenceline concentrations would have been between 13 and 29 $\mu g/m^3$, well below the National and Colorado Ambient Air Quality Standard limitation of 150 $\mu g/m^3$.

The distribution of particulate matter in the initial source plume was based largely on photographic data. Demolition of Building 881 took place during unstable atmospheric conditions with relatively light winds. It may be assumed that less stable conditions or higher wind speeds would have produced a somewhat different initial plume distribution. The effects that differing meteorological conditions may have on initial plume structure should be taken into account in planning for future explosive demolitions.

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