FINAL
TECHNICAL MEMORANDUM
SUBAREA HSA-7
SUBAREA HSA-3
SUBAREA NORTHERN BUFFER ZONE
HISTORICAL SITE ASSESSMENT
SANTA SUSANA FIELD LABORATORY SITE
AREA IV RADIOLOGICAL STUDY
VENTURA COUNTY, CALIFORNIA

Prepared for:

EPA Contract Number: EP-S7-05-05
Task Order Number: 0038

U.S. Environmental Protection Agency, Region 7
901 North 5th Street
Kansas City, KS 66101
and
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, CA 94105

Prepared by:

HydroGeoLogic, Inc.
Northway 10 Executive Park
313 Ushers Road
Ballston Lake, New York 12019

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HGL
HydroGeoLogic, Inc

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LIST OF ACRONYMS AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
AOC	Administrative Order on Consent
ARRA	American Recovery and Reinvestment Act
Atomics International	Atomics International Division of North American Aviation, Inc.
BPH	brake horsepower
CDPH	California Department of Public Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	Curie
cfm	cubic feet per minute
cpm	counts per minute
D&D	decontamination and decommissioning
DCGL	derived concentration guidance level
DHS	Department of Health Services
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DTSC	Department of Toxic Substances Control
EBR	Experimental Breeder Reactor
EIC	Engineer in Charge
EPA	U.S. Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center
ERDA	U.S. Energy Research and Development Administration
ETEC	Energy Technology Engineering Center
FA	fill area
HEPA	high-efficiency particulate air
HGL	HydroGeoLogic, Inc.
HMSA	hazardous material storage area
HR	House Resolution
HSA	Historical Site Assessment
ICC	International Code Council
IM	impoundment
ISF	Interim Storage Facility
Kg	kilogram
Kv	kilovolt
kW	kilowatt
LMFBR	Liquid Metal Fast Breeder Reactor
µCi/cc	micro Curie per cubic centimeter
µCi/mL	micro Curie per milliliter

μR/h	micro roentgen per hour
McLaren/Hart	McLaren/Hart Engineering Corporation
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mCi	milli Curie
mR/hr	milli roentgen per hour
mrad/hr	milli rad per hour
mrem/yr	milli rem per year
MTR	Materials Test Reactor
MWd	megawatt days
MWH	Montgomery Watson Harza
NaK	sodium potassium
NASA	National Aeronautics and Space Administration
NBZ	Northern Buffer Zone
NE	northeast
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NRC	Nuclear Regulatory Commission
NUL	Northern Undeveloped Land
NW	northwest
OMRE	Organic Moderated Reactor Experiment
ORISE	Oak Ridge Institute for Science and Education
OS	open storage
PA	processing area
pCi/g	picocuries per gram
PRG	preliminary remediation goals
R/hr	Roentgen per hour
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RHB	Radiologic Health Branch
RMDF	Radioactive Material Disposal Facility
RMHF	Radioactive Material Handling Facility
RWES	radioactive waste evaporation system
SBZ	Southern Buffer Zone
SCE	Southern California Edison
SEFOR	Southwest Experimental Fast Oxide Reactor
SHEA	Safety Health and Environmental Affairs
SNAP	Systems for Nuclear Auxiliary Power
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory
STIR	Shield Test and Irradiation Reactor
STR	Shield Test Reactor
TM	technical memorandum
TO	task order

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1.0 INTRODUCTION

This technical memorandum (TM) presents a summary of the identified environmental concerns associated with past radiological operations within a portion of Area IV at the Santa Susana Field Laboratory (SSFL) site located in eastern Ventura County, California (Figure 1.1). The SSFL site consists of four areas: Areas I, II, III, and IV; and two buffer zones: the Northern Buffer Zone (NBZ) and the Southern Buffer Zone (SBZ). The U.S. Environmental Protection Agency (EPA) is conducting a radiological characterization study of SSFL Area IV and the NBZ pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). EPA's study consists of a Radiological Historical Site Assessment (HSA), gamma scanning of accessible areas, geophysical surveys, soil and water testing. EPA's gamma scanning, geophysical, soil and water testing investigations are being developed and presented in separate work plans and data reports.

HydroGeoLogic, Inc. (HGL) has been tasked by EPA to conduct the radiological characterization study within SSFL Area IV/NBZ (hereafter called the "Area IV Study"). Figure 1.2 illustrates the location of Area IV and the NBZ. EPA has elected to subdivide the Area IV Study Area into subareas. Subarea boundaries are based on existing Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) areas for the SSFL site. EPA has further subdivided some RFI areas based on features such as roads, drainage pathways, building use, and number of buildings.

Table 1.1
Area IV Study Area
Subarea Designations

Area Designation	Number of Sites
HSA-3	1
HSA-5A	26
HSA-5B	46
HSA-5C	23
HSA-5D	21
HSA-6	38
HSA-7	18
HSA-8	8
BZ-NE	2
BZ-NW	2

The objective of the HSA component of the radiological study is to provide a comprehensive investigation that identifies, collects, organizes, and evaluates historical information relevant to nuclear research operations as it pertains to radiological contamination in the Area IV Study Area. Once these areas have been identified, potential areas where radiological contamination may exist at the site will be identified for sampling.

This work is being executed by HGL under EPA Contract EP-S7-05-05, Task Order (TO) 0038 under the technical direction and oversight of EPA Region 9. In accordance House Resolution (HR) 2764, the Department of Energy (DOE) is funding EPA's Area IV Study. DOE elected to fund EPA's study with funding allocated under the American Recovery and Reinvestment Act (ARRA) of 2009. On December 6, 2010, the DOE and the State of California Department of Toxic Substances Control (DTSC) signed an Administrative Order on Consent (AOC) for cleanup of the Area IV and the NBZ. Under this AOC, radiological contaminants will be cleaned up to background concentrations as defined by EPA's July 2011 radiological background study.

1.1 Technical Memoranda and the Radiological Historical Site Assessment

This TM presents information relating solely to sites and buildings located within Subareas HSA-7, HSA-3, and the NBZ (known collectively as HSA-7/3/NBZ). This TM is the last in a series of TMs prepared for the subareas identified in Table 1.1. Each TM has been made available in draft for review and informal comment by SSFL stakeholders and the general public. EPA is responding to each comment via draft "Response to Comment" tables, which are also made available to SSFL stakeholders. Each draft TM will be edited as described in the Response to Comment tables, and these edits along with any new information made available to EPA will be compiled into EPA's official Radiological HSA for the Area IV Study Area.

The content of each TM will be based on guidance provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM, Revision 1, August 2000). MARSSIM is used as an investigative tool to gain an understanding of the nature and extent of radiological contamination left at a site. The TMs provide preliminary recommendations for MARSSIM classifications based solely on historical information, which may be incomplete. The preliminary classifications identified in the TMs will be used to guide the subsequent gamma scanning and multimedia sampling effort. Once more complete historical environmental data has been obtained, and the results of geophysical surveys, gamma radiation scanning surveys, field observations, and the results of soil sampling and laboratory analyses are available, the preliminary classifications presented in the TMs will be revised.

1.2 Goals and Methodology of this TM

This TM is focused on radiological information within Subareas HSA-7/3/NBZ and the drainage channels that lead to and from these areas. The Subarea HSA-7/3/NBZ locations are shown on Figures 1.3a through 1.3d. A summary of the features related to potential radiological sources identified within the HSA-7/3/NBZ subareas are provided on Plate 1 figures for each subarea. Detailed information pertaining to the use of radioactive materials and the potential release of radionuclides at sites and buildings within HSA-7/3/NBZ are provided in Sections 2 and 3 of this TM. Preliminary findings specific to Subareas HSA-7/3/NBZ presented in this TM include:

- Descriptions and locations of potential, likely, or known activities that involved radioactive material, radioactive waste, or mixed waste;
- Initial MARSSIM classifications (e.g., Class 1, 2, 3) of potentially impacted areas;
- A site-by-site assessment of the likelihood or "weight of evidence" of radiologically contaminated media;
- An assessment of the likelihood of potential migration pathways; and,
- Identification of, confirmation of, and, if appropriate, addition or subtraction to, the list of the potential radiological contaminants of concern.

As specified in MARSSIM, a "site" is defined as any installation, facility, or discrete, physically separate parcel of land, or any building or structure or portion thereof, that is being considered for survey and investigation (MARSSIM, Revision 1, August, 2000). MARSSIM guidance defines all sites as either "non-impacted," or "impacted" by radiological operations. All of the sites at the Area IV Study Area are considered to have a reasonable potential for residual contamination, so none is classified as "non-impacted." Impacted areas of the Area IV Study Area are divided into one of three classifications.[1]

- *Class 1 Areas:* Areas that have, or had prior to remediation, a high potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiation investigations).
- *Class 2 Areas:* Areas that have, or had prior to remediation, a medium potential for radioactive contamination or known contamination.
- *Class 3 Areas:* Areas that have a low potential for radioactive contamination.

The information provided in this TM together with comments and recommendations provided by SSFL stakeholders and the general public will be used in the EPA's investigation strategy for sampling and analysis for residual radiological contamination in surface and subsurface soil within Subareas HSA-7/3/NBZ. As noted above, EPA will continue to obtain and receive information relating to use and possible releases of radionuclides within the Area IV Study Area. Some of the information presented in this TM may change as new information is obtained, or further evaluation of current information results in changes. In addition to the HSA, information gathered by EPA's Area IV and NBZ gamma scanning program and targeted geophysical investigation will assist EPA in fine-tuning the overall investigation strategy for the Area IV Study Area, and in making the final determination of the appropriate MARSSIM classifications.

1.3 Brief Description and History of SSFL Area IV and the NBZ

The SSFL site occupies 2,850 acres of rocky terrain with approximately 700 feet of topographic relief near the crest of the Simi Hills. The Area IV Study Area comprises approximately 465 acres. Though some of the study area is relatively flat, some portions of the area exhibit steep relief and rugged terrain. The site elevation is between 1,880 feet and 2,150 feet above sea level. The overlying soils of the Area IV Study Area consist of weathered bedrock and alluvium that

[1] *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1*, NUREG-1575, Rev. 1, EPA 402-R-97-016, Rev. 1, DOE/EH-0624, Rev. 1, August 2000, pp. 2-5.

have been eroded primarily from the surrounding Chatsworth and Santa Susana formations. Several geological faults cross this area.

The climate in the vicinity of the SSFL site is classified as Mediterranean Subtropical, corresponding to an average temperature of 50 degrees Fahrenheit in the winter and 70 degrees Fahrenheit in the summer. Rainfall averages approximately 18 inches per year.

A shallow groundwater system exists in the surface soils at small isolated locations. A regional groundwater system exists in the deeper fractured Chatsworth Formation. In some areas, groundwater from the Chatsworth Formation flows through fractures in the rock and emerges at the ground surface as seeps or springs. Groundwater underlying the SSFL site is not currently used, or anticipated to be used, as a source of drinking water for the nearby communities or at SSFL, but nearby residents may in the future consume groundwater emanating from this site

In addition to rocket and small engine testing facilities in other portions of the SSFL, North American Aviation, Inc., had facilities at Area IV for researching, developing, and constructing equipment to use nuclear energy through its Atomics International Division (AI).[1] According to a 1959 company brochure, AI maintained a nuclear field test area covering approximately 300 acres at the SSFL site.[2] Under contract to DOE and private customers, AI supported the development of civilian nuclear power, as well as the testing of non-nuclear components related to liquid metals within 90 acres of Area IV of the SSFL site. The facilities within these 90 acres would later be referred as the Energy Technology Engineering Center (ETEC).[3]

Nuclear facilities at ETEC included 10 nuclear research reactors over the period July 1956 through February 1980. These research reactors are listed in Table 1.2.

[1] North American Aviation, Inc., *The North American Story*, December 1960, p. 7
[2] Atomics International, A Division of North American Aviation, Inc., *Atomics International*, December 1959, p. 5.
[3] http://www.etec.energy.gov/History/Area-IV-History.html

Table 1.2
Research Reactors Located at the Santa Susana Field Laboratory[1]

Reactor Acronym	Building No.	Facility Name	Power Level (kW)	Period of Operation	Power Generated (MWd)	Radioactivity at End of Operation (10^3 Ci)
KEWB	4073	Kinetics Experiment Water Boiler	1	7/1956 to 11/1966	1	6
L-85/AE-6	4093	L-85 Nuclear Experimentation Reactor	3	11/1956 to 2/1980	2	18
SRE	4143	Sodium Reactor Experiment	20,000	4/1957 to 2/1964	6,700	120,000
SER	4010	Systems for Nuclear Auxiliary Power (SNAP) Experimental Reactor Facility	50	9/1959 to 12/1960	13	300
S2DR	4024	SNAP Environmental Test Facility	65	4/1961 to 12/1962	13	390
STR	4028	Shield Test Irradiation Facility	50	12/1961 to 7/1964	1	300
S8ER	4010	S8ER Test Facility	600	5/1963 to 4/1965	215	3,600
STIR	4028	Shield Test Irradiation Facility	1,000	8/1964 to /1974	28	3,714
S10FS3	4024	SNAP Environmental Test Facility	37	1/1965 to 3/1966	16	6,000
S8DR	4059	SNAP Development Reactor Facility	619	5/1968 to 12/1969	182	220

Seven criticality test facilities (i.e., facilities housing operations involving masses of fissionable material capable of sustaining a nuclear chain reaction) were also located on Area IV.[2] These are listed in Table 1.3. Other nuclear facilities within Area IV included the Radioactive Materials Disposal Facility and the Hot Laboratory, as well as the Sodium Disposal Facility, or Area IV burn pit. Each of these facilities will be addressed as a site within the appropriate TM along with supporting buildings and open areas.

According to the DOE ETEC web site, most nuclear research related programs and operations ceased in 1988 and were replaced with decontamination and decommissioning operations.[3]

[1] Oldenkamp, R.D. and Mills, J. C., *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, Rockwell International; Report No. N001ER000017, September 6, 1991, p. 23.
[2] Atomics International, A Division of North American Aviation, Inc., *Atomics International*, December 1959
[3] http://www.etec.energy.gov/History/Area-IV-History.html

Table 1.3
Criticality Test Facilities at the Santa Susana Field Laboratory[1]

Facility Name	Building No.	Period of Operation	Notes
SNAP Critical Test	4373	1957 to 1963	First SNAP-2 criticality tests
Organic Moderated Reactor	4009	1958 to 1967	Basic tests of reactor concept
Sodium Graphite Reactor	4009	1958 to 1967	Basic tests of reactor concept
SNAP Critical Equipment	4012	1961 to 1971	Later SNAP criticality tests
Fast Critical Experiment	4100	1961 to 1972	Started as Advanced Epithermal Thorium Reactor (AETR)
SNAP Flight Systems	4019	1962	SNAP flight system criticality
SNAP Transient Test	4024	1967 to 1969	SNAP transient response tests

The NBZ is a 175-acre parcel of land that abuts the SSFL property (Figure 1.2). The NBZ is a naturally vegetated area containing drainage channels that transport surface water from the SSFL downslope to surrounding populated areas.[2] The NBZ was purchased by the Rocketdyne Division of Rockwell International (Rockwell) in 1998 from the adjoining Brandeis-Bardin Institute because an environmental contractor found that the NBZ contains radioactive and chemical contamination that had migrated from the SSFL.

With the exception of 452 acres owned by the U.S. Government in Areas I and II, which are outside of the Area IV Study Area, the entire SSFL site, including the NBZ, is owned and operated by The Boeing Company.

1.4 Brief Description and History of HSA-7/3/NBZ

Subarea HSA-7 is approximately 16 acres of land that contained 18 buildings/sites over the years. It includes facilities along the west-central edge of Area IV. Drainage is generally to the northwest. Radiological operations in Subarea HSA-7 related primarily to the Shield Test Reactor (STR), which later became the Shield Test and Irradiation Reactor (STIR), and the Radioactive Material Disposal Facility (RMDF), later referred to as the Radioactive Material Handling Facility (RMHF). The Interim Storage Facility (ISF) was a below-grade structure that stored spent radioactive fuel elements. Most of the building areas Subarea HSA-7 are part of the RMHF complex and are enclosed by a fence.

Subarea HSA-3, the Southern California Edison (SCE) substation, covers 0.887 acres of land.

Subarea HSA-NBZ was purchased by Rockwell in 1998 and comprises 175 acres forming the NBZ. For this TM, the NBZ was divided into the NBZ-Northeast (NE), approximately 87.5 acres, and the NBZ-Northwest (NW), also approximately 87.5 acres.

[1] Oldenkamp, R.D. and Mills, J. C., *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, Rockwell International; Report No. N001ER000017, September 6, 1991, p. 25.
[2] Agency for Toxic Substances and Disease Registry, *Draft Preliminary Site Evaluation, Santa Susana Field Laboratory*, Atlanta, GA, December 3, 1999, pp. 2-5.

1.5 Sites in HSA-7/3/NBZ

During the peak of operations, Subarea HSA-7 comprised 18 primary sites, most of which were buildings. This TM addresses each of these 18 sites within Subarea HSA-7. Of the 18 sites, 1 was a reactor building and 13 housed operations involving radioactive materials or probable radioactive materials. One site was a drainage area that became radioactively contaminated and another site was a leach field that became radioactively contaminated. Although documented use or storage of radioactive materials was not found at all buildings in HSA-7, the proximity of those building to the buildings known to contain radioactive materials dictates that all buildings be treated as MARSSIM Class I buildings. It is important to note that EPA and HGL continue to obtain and receive information that may alter the findings of this TM. Of the 18 sites in HSA-7, only 4 buildings have been demolished.

HSA-3, the SCE substation, comprises a small rectangular building, transformers, switching equipment, protection and control equipment, and a fenced area of land surrounding these facilities.

The NBZ-NE area comprises land and drainage channels located north of Area IV extending west to east between the SRE complex and Area I. The NBZ-NW area comprises land and drainage channels located north of Area IV extending west to east between the southwest corner of HSA-8 and the SRE complex.

1.6 Site Summary Methodology

In preparing this TM, the following types of documents were reviewed:

- radiological characterization reports;
- previous radiological surveys;
- decontamination and decommissioning (D&D) reports;
- environmental monitoring reports;
- license termination reports;
- aerial photographs dating back 50 years;
- building floor plans;
- piping diagrams and construction drawings;
- RFI reports;
- unusual occurrence reports;
- incident reports;
- plant operating reports and logs;
- safety analyses reports;
- facility surveillance and maintenance reports; and
- information obtained from interviews with former workers or other persons.

Numerous documents were obtained through information requests sent to Boeing, DOE, and other parties. EPA sent formal information requests to Boeing, DOE, the Nuclear Regulatory Commission (NRC) and the California Department of Public Health (CDPH) under § 104(e) of the CERCLA. In addition, EPA directed Boeing to identify and provide pertinent documents within a number of document databases comprising approximately 1.4 million documents relating to all areas of the SSFL site, including Area IV, as well as some offsite facilities. The information acquisition process is generally complete with one exception; monthly supplemental responses are received from the DOE. If pertinent information is later acquired by EPA, it will be added to this TM and integrated into our radiological characterization study process to ensure that all available, relevant information is considered by EPA prior to the completion of our study.

EPA sent Boeing its original information request letter on June 24, 2009. Boeing provided an initial response to this request on August 31, 2009, and a supplemental response on December 10, 2009. On June 8, 2010, Boeing provided relevant site drawings and maps as identified by EPA during a review of flat files at Boeing's Safety, Health, and Environmental Affairs (SHEA) building on site. Subsequently, on June 17, 2010, EPA sent Boeing a supplemental information request letter specifically requesting all maps, diagrams, and as-built drawings for past and current buildings in Area IV. On July 15, 2010, Boeing responded and provided additional documents, including maps and drawings. On November 15, 2010, Boeing provided a third supplementary group of documents. Additional information requests have been ongoing and during the months of December 2010 and January, March, April, May, June, July, and August of 2011, Boeing provided numerous additional documents in response to both EPA original information requests and EPA queries of Boeing's document database for the SSFL.

In October 2010, EPA also sent the National Aeronautics and Space Administration (NASA) a formal information request letter. On November 22 and December 2, 2010, EPA received information responsive to this request.

EPA sent DOE its original information request letter on June 24, 2009. DOE provided an initial response to this information request on August 31, 2009. Subsequently, DOE has provided supplemental responses to this initial information request on a monthly basis. Additional information responsive to the EPA's information request has been received in September, October, November, and December 2009, as well as January through December 2010 and January, February, March, April, May, June, and July 2011. On June 17, 2010, EPA sent DOE a supplemental request for information, specifically requesting maps, diagrams, and as-built drawings for past and current buildings in Area IV. Starting in its July 2010 supplemental response to EPA, DOE is providing information that is responsive to both of the EPA information requests letters.

Other requests for information pertaining to the site have included § 104(e) information request letter sent to the NRC and CDPH. The purpose of the inquiries to both the NRC and the CDPH was to identify and obtain any nuclear materials licenses pertaining to the site that may not have been captured via the information requests sent to other parties.

In preparing the HSA-7/3/NBZ TM, 720 individual documents and photographs were reviewed. The review process was conducted by first screening over 80,000 documents amassed for the project. In addition, the documents requested from the document databases comprising approximately 1.4 million documents were reviewed. This screening effort produced 720 documents relevant to past operations at facilities within HSA-7/3/NBZ and was therefore determined to warrant in-depth evaluation. Each of these 720 relevant documents was thoroughly evaluated for information considered useful for carrying out the goals listed in Section 1.2 of this TM.

1.6.1 Contents of EPA's Site-by-Site Analyses

The subject areas considered and addressed for each site discussed in Section 2 of this TM are presented below. For each subject area, the list of criteria evaluated and the associated parameters for the evaluation are described. The most complete available information was used to evaluate the site; no known information was omitted from the description. In the event that known information did not conform to one of the listed subject areas, it was included in the most logical place.

Site Description
A physical description of the site including, at a minimum, the following data elements: building numbers of all buildings within the site; date of construction of building(s); buildings in the vicinity not associated with the site; location of site relative to street(s); site plan(s); and floor plan(s) from as-built or plan drawings, if available.

Building Features
Information related to dimensions or size of building(s), below-ground structures, vaults, pipelines, sumps, condensation lines, sewers, drains, swales, and leach fields. If none of these features were identified, the text "no information was located" was inserted.

Former Use(s)
Details of past use(s) of the site, including dates of activities.

Information from Interviewee(s)
This category includes information about the site provided by interviewee(s). If no information has been obtained for a particular site, the text "none to date" was inserted. Individuals who have been interviewed include:

- Former SSFL Employees (e.g., health physicists, electricians, mechanics, construction inspectors, nuclear technicians, etc.);
- Survivors of Former Employees;
- Former Contractors (and one survivor of a former Contractor);
- Community Stakeholders; and
- Residents in surrounding areas.

At the discretion of the Interviewee, each interview is conducted either by representatives of the EPA only, representatives of the DOE only or jointly by EPA and DOE representatives. EPA's primary objective of the interview program is to help direct the soil sampling crews to potential source areas of radiological contamination identified during the course of each interview. All information on potential source areas, corroborated or not, will be recorded in EPA's HSA process.

At the time of writing this TM, the EPA had completed forty-nine (49) interviews. Under the DOE/EPA joint interview program, eighteen (18) interviews have been conducted. Approximately 107 former employees have requested to be interviewed by DOE only and those interviews are complete. An additional eighty five (85) people were referred to EPA and DOE by interviewees during the course of the interviews, and of these, only twenty (20) could be located, which resulted in four (4) additional interviews. DOE has provided all of their interview transcripts to EPA for use in EPA TMs. For this TM, 20 interviews were relevant to the HSA-7/3/NBZ subarea.

The interview information obtained to date relevant to this TM is depicted on the relevant Plate 1 figure.

Radiological Incident Reports
Reports on any documented incidents at the site with the potential for release of radioactivity into the environment. If no incident reports were found, the text "none found" was inserted.

Current Use
Current use of the site, or date of demolition of building/structure.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s)
Previous radiological investigations such as surveys, decontamination activities, and cleanup activities were evaluated. The evaluation of previous investigations and cleanups addressed, at a minimum, the following elements:

- agency conducting the investigation;
- purpose of the investigation;
- dates of the investigation;
- details of releases inside building, to air, to soil, and to surface water, as applicable;
- decontamination/cleanup activities; and
- final survey results.

Radiological Use Authorizations
Use authorizations have been defined as issuance of a license for radioactive material(s) from an appropriate regulatory agency. All known licenses issued for the site were included; if none were found, the text "none found" was inserted.

Former Radiological Burial or Disposal Locations
A description of known burials and/or disposals of radiological materials on the site, including applicable dates, if known. If no documented burials and/or disposals were identified, the text "none found" was inserted.

Aerial Photographs
The applicable photographic analyses from the report prepared by the EPA's Environmental Photographic Interpretation Center (EPIC) in March 2010 were included for each site. These analyses include photographs from the following dates:

- December 22, 1952;
- August 19, 1957;
- August 21, 1959;
- Approximately 1960 plus or minus a year;
- March 1, 1965;
- August 13, 1967;
- April 20, 1972;
- May 16, 1978;
- October 21, 1980;
- August 21, 1983;
- October 10, 1988;
- June 19, 1995; and
- June 8, 2005.

Aerial photograph anomalies were interpreted as a trigger for assigning a higher scrutiny to a particular site than other information (such as historical documents) would indicate.

Radionuclides of Concern
Radionuclides used/generated at the site. This description includes, at a minimum, the types of radiological material(s) managed at the site; radionuclides known or suspected to have been handled or generated on the site; and how the identified radionuclides impact the list of radionuclides of concern in the background study. If no information was available, the text "none found" was inserted. It is important to note that not every radionuclide listed in this HSA will have a sample analysis. The radionuclides are listed for completeness, indicating that they have been mentioned or discussed in a cited document or report. However, many of the facility and site reports reflect the conditions at the time, thus every mention of a specific radionuclide does not mean it would be present now, due to decay. For this reason, the Radionuclides of Concern sections described for each facility or site list those found in historical records. The Radionuclides of Concern (Table 3.3) lists radionuclides that will be analyzed and does not include those that would have decayed in the years since operations ceased.

Drainage Pathways
This category includes information on the direction of surface water flow on the site and the presence of sanitary drains, storm drains, channels/ditches, septic systems, or leach fields on or near the site.

Radiological Contamination Potential
The potential for radiological contamination was evaluated for each site. Evaluations included consideration of the completeness of past cleanup and remedial operations. Many past clean-up efforts likely did not achieve the requirements of the DTSC/DOE AOC dated December 2010 that generally requires a cleanup to background levels for both radiological and chemical contaminants. Background studies for the site are nearing completion with EPA leading the radiological background study and the DTSC leading the chemical background study. The potential for radiological contamination is quantified in this TM by assigning a preliminary MARSSIM class describing the possibility for residual radiological contamination at the site based on all information collected to date. The basis for assigning the preliminary MARSSIM classification includes an examination of the following data elements:

- historical site operations;
- previous radiological investigations;
- reported incidents of releases;
- decontamination and remediation operations at the site;
- interviews with former workers;
- drainage pathways on or near the site;
- aerial photograph interpretation; and
- site reconnaissance.

Recommended Locations for Soil/Sediment Sampling

For each site, recommendations were made for possible targeted soil/sediment sampling locations. The selection of potential sampling locations was based on locations with the highest potential for radiological contamination as well as at the particular site based on all known information collected to date. The criteria evaluated for developing recommended soil/sediment sampling locations include the following:

- topography of the site;
- historical site operations;
- radiological investigations;
- reported incidents of releases;
- decontamination/cleanup operations at the site;
- interviews with former workers;
- storm drains on or near the site;
- sewer lines on or near the site;
- aerial photograph interpretation; and
- site reconnaissance.

2.0 FINDINGS

This section organizes the building areas and sites within HSA-7 by operational characteristics and geographic locations. Buildings within the Radioactive Materials Handling Facility (RMHF) perimeter fence are described first, followed by other building areas and sites in HSA-7. Additionally, areas within HSA-3 and the Northern Buffer Zone (NBZ), presented as NBZ-Northeast (NBZ-NE) and NBZ-Northwest (NBZ-NW), are included in this section. The southeastern borders of the NBZ-NE and NBZ-NW subareas adjoin the HSA-3 and HSA-6, and HSA-7 and HSA-8 subareas, respectively. Drainage features within both areas of the NBZ have their origins within their adjoining subareas, including HSA-3 and HSA-7, subjects of this TM.

Four plates depict the subareas presented in this TM: HSA-7; HSA-3; NBZ-NE; and NBZ-NW. In the interest of maintaining continuity with previously published TMs, each plate has retained its "Plate 1" prefix. Each plate should be referenced when reading Section 2 of the TM and serves as a guide for the text describing the building areas, the site photographs, and building layout drawings in each subarea.

2.1 Building 4021 Area

Site Description: The Building 4021 area comprises Building 4021 and the land surrounding it at the northern terminus of 12th Street. Building 4021 was constructed in 1959 as part of the Radioactive Materials Disposal Facility (RMDF), later known as the RMHF. The RMHF consists of seven functional buildings on approximately 3 acres of land.[1] Building 4021 is the Decontamination and Packaging Building and is a Resource Conservation Recovery Act (RCRA)-permitted facility.[2,3] Building 4021 is located within the fenced area of the RMHF, which was paved with asphalt.[4] The perimeter of the RMHF is formed by a paved drainage channel to control runoff. The paved areas of the RMHF are sloped to carry water away from the buildings to the perimeter channel, which drains west to a retention pond.[5] Figures 2.1a through 2.1z provide a recent photograph and the best available building-specific drawing(s) and photos that the research team could find.

Building Features: Building 4021 is a steel-framed structure measuring 60 feet long by 50 feet wide by 14 feet high. It measures 3,000 square feet and has a sheet steel roof and siding with a concrete floor. Building 4021 contains five rooms. Room 100 was an administration office/storage room/laundry. A 1985 letter notes Room 100 was a storage room for radioactive workers clothes and other supplies.[6] A 1993 incident report notes that the laundry room was

[1] Internal Correspondence from Horton, P.H. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Maderail [sic] and Radiation Producing Device User Authorization for RMDF Operations*, December 13, 1989.
[2] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. A-1.
[3] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[4] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385,* Rockwell International, September 15, 1982, p. 7.
[5] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[6] Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.

used over a period of years for unloading and storing low level protective clothing.[1] (See incident A0580 in Attachment A.) An interviewee states that the laundry facility did not handle radioactive laundry, but was used to wash towels. The interviewee notes that the laundry facility was not very good and was no longer used when he started at the RMHF in 1980. (see Interviewee 254 comments below). The research team has not been able to identify the time frame for laundry operations at Building 4021. Room 100 also contained the radioactive water evaporation instrumentation console. Room 102 was the cold change room and contained a shower and restroom facilities. Room 103 was the hot change room and contained a shower and sink that drained into a radioactive liquid sump tank outside and to the west of Building 4021. Room 104 was the packaging room and contained two 55-gallon drum packaging presses and a radioactive liquid solidification system. A 1978 drawing (see Figure 2.1o) also notes an evaporator system in the packaging room, although this appears to be the old gas-powered evaporator that was taken out of service after a fire in 1966. A center floor drain connected to the radioactive liquid sump tank outside and to the west of Building 4021. This sump tank automatically pumped liquid waste to the 8,000-gallon radioactive liquid storage tank in Building 4022. Material transfer into Room 104 was through an 8-foot wide by 12-foot high rollup door and an interconnecting doorway to Room 105. Room 105 was the decontamination room. The room contained two fume hoods vented to the high-efficiency particulate air (HEPA) filtering system, three dip tanks, a caustic tank, a sink with hot and cold water, and an electrically-heated liquid evaporator system with its own drain. The floor was covered with sheet steel that sloped toward a central drain opening that connected to the radioactive liquid sump tank. A 5-ton crane provided service through two north doorways on a "horseshoe" monorail that traverses the northeast quarter of the room. The main door is a 12 foot by 12 foot rollup door with an 8-foot wide by 12-foot high auxiliary door. Another 12 foot by 12 foot rollup door is located on the south exterior wall of the decontamination room. The packaging and decontamination rooms were radiologically-controlled areas requiring protective clothing.[2,3,4,5,6,7,8,9]

As noted above, Building 4021 contained two sumps. According to a 2007 Boeing report, one below ground sump was located in the decontamination room and measured 19 inches long by 19 inches wide by 32 inches deep. The second sump was located in the packaging room and

[1] Wallace, J.H., Rockwell International Internal Letter, *Subject: Radiological Safety Report RMDF T021 Laundry Room*, August 10, 1993.
[2] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007,* p. A-1.
[3] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-3.
[4] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, p. 6.
[5] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[6] Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
[7] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.
[8] Internal Correspondence from Horton, P.H. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Maderail [sic] and Radiation Producing Device User Authorization for RMDF Operations*, December 13, 1989.
[99] Rockwell International Drawing, *Santa Susana Field Laboratory B/021 & B/022 Liquid Waste Storage, 303-022-P1*, August 23, 1978.

measured 30 inches long by 30 inches wide by 15 inches deep. See Figures 2.1w and 2.1x for photographs of these sumps. These sumps were deactivated in 2004. Equipment located in the building included a cement-style mixer and drum-style mixer used to stabilize and amalgamate mixed wastes.[1,2] One small and one large floor drain were located in both the decontamination and packaging rooms. Figure 2.1k is an as-built floor plan that depicts these drains. These floor drains led to the radioactive liquid sump tank (also identified as UT-16) located outside and west of Building 4021 in an 8-foot deep concrete pit. Initially, liquids were pumped from the sump tank to a 5,000-gallon aboveground radioactive liquid waste storage tank (also referred to as T-1) west of Building 4021 pending treatment. Later, this system was replaced by an 8,000-gallon radioactive liquid storage tank (also referred to as UT-15) in Vault 2 of Building 4022.[3,4,5,6,7,8,9]

The Building 4021 drain line runs below grade along the outside and east of Building 4021 before it turns west and runs under the building to the radioactive liquid sump tank outside and west of Building 4021. This drain line is depicted in Figure 2.1l, Building 4021 Plumbing Floor Plan. A number of tee joints intersect the drain line from both inside Building 4021 and from condensation drains in the HEPA system ducting, described below, before it enters Building 4021 and continues to the Building 4021 sump. There are four cleanouts located along the pipeline indicating its extent in the area.[10]

Figure 2.1o depicts the RMHF liquid waste storage components described above as depicted in 1978, as well as the flocking tank and treated water tank located north of Building 4021. The Building 4021 radioactive liquid sump tank piping conveyed water to an evaporator north of Building 4021 and then for a period of time to a flocking tank/evaporator that was part of Building 4664. The natural gas-powered evaporator in Building 4021 was taken off line following a 1966 fire and the flocculation system was used for a period. The Building 4021 gas-powered evaporator was replaced with an electric-powered evaporator.[11] See Figures 2.1p and 2.1q. According to a Boeing employee, the flocculation system was experimental and proved unsuccessful so it was

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[1] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. A-1.
[2] Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Questions for Paul Waite Regarding RMHF Site History (Discussion took place via email during March, 2009),* March 16, 2009.
[3] The Boeing Company, *Radioactive Materials Handling Facility Current Radiological Status*, March 16, 2007.
[4] *Disposal of Radioactive Materials at Atomics International*, Unknown Author, Unknown Date, p. 6.
[5] Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
[6] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-3.
[7] *Historical Review of Underground Tanks, Area IV, No.: A4CM-AR-0005*, Unknown Corporate Author, August 10, 1994, P. 89.
[8] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, p. 11.
[9] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-2.
[10] Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Conversation with Paul Waite Regarding RHMF [sic] Site History*, February 23-24, 2009.
[11] Correspondence from Chell, M., MWH, to Waite, P., The Boeing Company, *Re: Questions for Paul Waite Regarding RHMF [sic] Site History (Discussion took place via email during March, 2009),* March 16, 2009.

replaced by the electric evaporator.[1] A 1989 report notes that the flocculation tower was built to pretreat radioactively contaminated water to make it easier to filter, but was made unnecessary by better filters and became inactive.[2] Based on drawings (see Figure 2.11d, also see Figures 2.11f and 2.11l) and reports, the flocculation system may have existed from late 1964 to early 1981, but appears not to have been used for that entire time period.[3] Atomics International site waste management plans dated in the mid-1970s note the use of the flocculation tower and January 1979 incident reports (See Section 2.11 for Building 4664 incidents A0077 and A0232) note there was an overflow of the flocculation tower.[4,5,6,7] These incident reports show that the flocculation system was being used during this time, but also suggest a time where use of the system may have been reconsidered. An underground sanitary sewage leach field, which was excavated in 1978, was located outside the fenced area of the RMHF to the north and was connected to Building 4021. It is discussed further in Section 2.14.[8]

The RMHF electric evaporator (see Figures 2.1p and 2.1q) was located in the decontamination room and operated on an automatic, self-controlling basis. The unit was a batch operation atmospheric type evaporator consisting of a stainless steel V-bottomed tank, approximately 6 feet by 30 inches by 12 inches deep. Incoming water was drawn into the evaporator by a submerged pump, which was controlled by high and low-level probes. The incoming water was filtered and preheated and the fully submerged evaporator electrical heaters were regulated to 216^{o}F. Preheated air was passed over the evaporator and drawn into the exhaust hood and passed through a water separation prefilter, a bank of four prefilters, and into the RMHF HEPA exhaust system. The exhaust stack incorporated a radiation monitor which alarmed at twice background level. Safety features included interlocks to prevent evaporator operation under conditions of over temperature, high and low water level, and low exhaust air flow. The system also incorporated a 5-minute timer, which shut off the pump and required a manual restart to prevent overflowing the evaporator. An overflow line drains back into the radioactive water holdup tank. Sludge was removed from the evaporator (as required by usage), dried in the adjacent packaging room, packaged, and disposed of as radioactive waste at approved disposal sites using approved procedures.[9]

A drum press located in the southwest corner of the packaging room (see Figure 2.1k) was used to compress dry noncombustible and combustible radioactive wastes in 55-gallon drums. The press had a protective missile shield, a shroud, a blower, and a duct to the Building 4021 exhaust

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[1] Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Conversation with Paul Waite Regarding RHMF [sic] Site History*, February 23-24, 2009.
[2] Oldenkamp, R.D. and Mills, J.C., Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective, N001ER000017, December 20, 1989, p. 29.
[3] Internal Correspondence from Tuttle, R.J. to Francis, M.A., Rockwell International, *Re: Sources of Radioactively Contaminated Water at Santa Susana*, February 17, 1981, p. 2.
[4] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.
[5] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.
[6] Gardner, F.W. Rockwell International Internal Correspondence, *Re: Release of Radioactivity from RMDF – January 1979*, February 23, 1979.
[7] Gardner, F.W., Rockwell International Internal Letter, *Subject: Radiological Safety Incident Report RMDF*, February 26, 1979.
[8] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385,* Rockwell International, September 15, 1982, p. 7.
[9] Internal Correspondence from Horton, P.H. to Gaylord, G.G., Rockwell International, *Re: Responses to Questions of RMDF Operations*, March 16, 1990.

system. The drum press operated at a negative pressure differential and exerted 52 pounds per square inch of pressure over the cross section of the drum. The shroud-drum rim interface was gasketed to create a closed system during press operation. This would prevent the spread of airborne contamination from the compressed waste.[1]

Two fume hoods (see Figure 2.1k) with a 3 foot by 6 foot work area were used in the decontamination room. The fume hood on the southeast side of the room had a stainless steel sink connected to the hot drain. Items to be decontaminated were placed in these hoods and washed with chemical agents or solvents under a controlled air flow. High air flow rates were established to insure flow of potentially contaminated air away from the operating personnel. The fume hoods had stainless steel surfaces for ease of cleaning. Electrically-heated dip tanks along the east side of the decontamination room were also available for treatment of equipment or packages that could be immersed in cleaning solutions. The tanks measured approximately 6 feet by 2 feet by 4 feet high. The dip tanks were used with the monorail crane and stainless steel baskets for handling items. Solutions used for cleaning included acids and caustics. The solutions were disposed of by neutralizing and transferring to the evaporation system or by solidification processes.[2,3]

A Malsbury steam generator was also available for steam cleaning items. It was a dolly-mounted, mobile system fitted with a hand held steam nozzle. The system included a kerosene-fired heater and an electrically-driven compressor. A large floor area was available in the decontamination room, which was served by the monorail crane and which could be covered as required by taped-down plastic sheeting. The decontamination room had a 4,700 cubic feet per minute (cfm) air flow to the exhaust system from louvered inlets and could be used when contaminated items were too large or too heavy for treatment in the fume hoods or dip tanks.[4]

Building 4021 has its own exhaust and filtration systems to control airborne radiation. Air flow for the building is provided by a 19 brake horsepower blower with a capacity of 17,680 cfm at 5 inches of water. The flow of air within Building 4021 is arranged from areas of lower contamination to areas of high contamination. Air is filtered through a bank of 14 prefilters and 14 HEPA filters before being combined in an exhaust plenum with air from Building 4022 and exhausted out the 3-foot diameter by 130-foot high stack. According to Rockwell documents, an emergency blower is not provided at Building 4021 because control of emissions during an emergency could be achieved by shutdown of operations. A separate blower unit was provided for exhaust air from the evaporator and adjacent areas. This exhaust air passed through a water separator followed by a prefilter and then a heater to prevent condensation prior to filtration by the HEPA filter exhaust system.[5,6,1]

[1] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 63.
[2] Operating Specification for the Radioactive Materials Disposal Unit, Undated, BNA00973193.
[3] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, pgs. 62-63.
[4] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, pgs. 62-63.
[5] U.S. Department of Energy Environment, Safety and Health Office of Environmental Audit, *Environmental Survey Preliminary Report, DOE Activities at Santa Susana Field Laboratories, Ventura California*, February 1989, p. 3-13.
[6] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 56.

The fenced area between Building 4021 and 4022 contains the blowers, filter banks, and compressors for both buildings as well as the shared exhaust stack. This area is often referred to as the filter/blower area. The filter/blower area also contains three utility trenches used to support the ventilation ducts. Each trench contains a floor drain to convey surface water away from the filter/blower area. The floor drains connected to a 4-inch below-grade pipeline that conveyed surface water to the RMHF northern slope, bypassing the RMHF catch basin.[2,3,4,5] See Figure 2.1y for photographs of the filter/blower area and the northern slope drainage discharge point.

A 1963 operating specification, presumed to be authored by Atomics International, for the RMHF states that automatic air monitoring systems were installed in Buildings 4021 and Building 4022 to provide continuous air sampling of the decontamination and packaging rooms in Building 4021 and the vault areas below the floor of Building 4022. No information was found concerning air sampling procedures prior to 1963. The systems were equipped with instrumentation having automatic detection, recording and alarm features. The alarm consisted of an audible signal bell and indicating lights. Equipment items of the system were located along the east wall in Room 100 of Building 4021 and along the west wall in the high bay area of Building 4022.[6]

The 1963 RMHF operating specification also notes that an automatic continuous stack effluent monitoring system was installed to sample and detect any radioactive, gaseous, or particulate releases to the atmosphere. The system instrumentation consisted of a recorder, alarm buzzer and red light in Room 101 of Building 4021, and a pump and probe assembly along the west wall of Building 4022. Figure 2.1r shows a 1970 air sampling system that was used to monitor radioactivity in Building 4021. Any abnormally high radioactive release would cause a buzzer and red light to actuate and remain in the alarm position until actions to remedy the cause and reduce the count rate were accomplished or until the alarm was manually deactivated.[7]

A May 1977 letter pertaining to a safety inspection of Building 4021, notes that the safety shower outside Building 4021 needed to be relocated further from the building to provide unobstructed access to the shower. A 1958 drawing shows the emergency shower centrally located on the north side of the building.[8,9]

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[1] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC),* June 2009, p. C.2-3.
[2] Correspondence from Seward, F.A. to Nagel, W.E., *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
[3] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC),* June 2009, p. C.2-3.
[4] Daniel, Mann, Johnson & Mendenhall, *R/A Waste and Fuel Storage Floor Plans, 303-022-M2*, September 25, 1958.
[5] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 56.
[6] Operating Specification Radioactive Materials Disposal Unit, November 7, 1963, p. 3.
[7] Operating Specification Radioactive Materials Disposal Unit, November 7, 1963, p. 4.
[8] Internal Correspondence from Grushesky, E.R. to Breese, L.S., Rockwell International, *Re: Annual Safety Inspection Department 731, Buildings 143, 003, 034, 044, 688, 665, 664, 021, and 022*, May 19, 1977.
[9] Daniel, Mann, Johnson, and Mendenhall, *R/A Waste and Fuel Storage Floor Plans, 303-022-A1*, September 25, 1958.

In December 1987, the Building 4021 radioactive water sump tank was upgraded, but remained in the same location west of Building 4021. The sump tank was identified as having a capacity of 150, 200, or 300 gallons, depending on the information source and time period. Generally, it appears that the original sump tank was 150 gallons and was replaced during the upgrade by a 200-gallon tank. Both the 150-gallon and 200-gallon sump tanks were eventually removed. Key features of the December 1987 sump tank upgrade included a new 200-gallon radioactive water tank with primary and backup pumps, a new sump liner for secondary containment and a new sensor for detecting water in the sump. An incident, described below, occurred while packaging the size reduced pieces of the old sump tank.[1,2,3,4,5]

Building 4021 was connected to a septic tank and leach field from early 1959 through late 1961 for the disposal of sanitary waste associated with Building 4021. In late 1961, a central sanitary sewer system was constructed at the Santa Susana Field Laboratory (SSFL) and Building 4021 was connected to it. RMHF sanitary waste was subsequently accepted at the Area III sewage treatment plant. The RMHF septic system was abandoned in place. Portions of the connecting sanitary sewer line were removed in 1964 because they interfered with the construction of Buildings 4664 and 4665.[6,7,8] However, according to an interviewee the septic tank itself was filled with concrete and abandoned in place. Further discussion of the RMHF Leach Field is found in Section 2.14.

According to a 1969 SSFL plot plan and 2009 RCRA Facility Investigation (RFI) report, the sewer line connected at the north side of Building 4021 and traveled west to Building 4563 before turning south and then west toward former Building 4010.[9,10] The research team was unable to locate the rationale for the particular path of the sewer line.

An electrical substation was located on the west side of Building 4021, south of the former 5,000-gallon radioactive liquid storage tank (T-1) and sump. The substation was inside a berm and had its own sump and short 2-inch diameter pipe that allowed stormwater to drain outside of

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[1] Internal Correspondence from Schrag, F.C. to McCurnin, W.R., Rockwell International, *Re: Highlights, Week Ending December 11, 1987*, December 14, 1987.
[2] Internal Correspondence from Moore, J.D. to Remley, M.E., Rockwell International, *Re: Quarterly Review of the RMDF for Radiation Safety Fourth Calendar Quarter, 1987*, March 25, 1988.
[3] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC)*, June 2009, pgs. C.2-4, C.2-12.
[4] Horton, P.H., Modification of RMDF, Building 4021 Sump, N001T1000276, Rockwell International, July 16, 1987.
[5] Eissa, E., *Compliance Evaluation Inspection Report, November 14-15, 2001*, Department of Toxic Substances Control, February 15, 2002.
[6] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 11.
[7] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-4.
[8] ICF Kaiser Engineers, *Current Conditions Report and Draft RCRA Facility Investigation Work Plan, Area IV, Santa Susana Field Laboratory, Ventura County, California, Part 1- Current Conditions Report, Volume 1*, October 1993, p. 4-40.
[9] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 11 – RFI Site Reports, Appendix G – Sewer Inspection Documentation Logs*, June 2009, p. Figure G-1.
[10] Atomics International Drawing, *Santa Susana Facility Plot Plan, 303-GEN-C40*, February 19, 1969.

the bermed area and onto the RMHF pavement, where it was directed west via sheet flow to the RMHF holdup pond.[1]

In 2004, the Building 4021 evaporator was taken offline and Building 4021 and 4022 sumps were deactivated, terminating the radioactive water conveyance and evaporation/volume reduction process. The Building 4022 liquid waste storage tank was removed in 2005.[2]

Former Use(s): The RMHF was a support facility to the Systems for Nuclear Auxiliary Power (SNAP) program, the Sodium Reactor Experiment (SRE), and the Hallam Nuclear Power Facility. It was designed to handle the storage, volume reduction, packaging, and shipping of the SNAP and SRE radioactive waste.[3] In general, radioactive wastes handled at the RMHF are residues from chemical and metallurgical laboratory operations, spent reactor fuel decladding operations, maintenance work on contaminated equipment, and decontamination and decommissioning (D&D) of facilities in which nuclear operations were previously conducted.[4] The RMHF received radioactive water from the Hot Lab, the SRE, and any other DOE facilities that generated radioactive water as a part of operations. According to Rockwell and Boeing, no nuclear fuel has been present at the RMHF since May of 1989 when the last packages of disassembled Fermi-reactor fuel were shipped to another DOE site.[5]

RMHF Radioactive Liquid Waste System and Processing

Radioactive Liquid Waste System

A 1986 Rockwell safety analysis report summarizes the RMHF radioactive liquid waste processing system. Typical operations at Building 4021 included the removal and concentration of radioactive particulate matter from liquid waste water generated by either the decontamination of equipment in Room 104 or the transfer of radioactive water from other SSFL facilities to Building 4021. A radioactive waste evaporation system (RWES) provided capabilities to process liquid radioactive waste. The RWES consisted of an atmospheric evaporator, water filters, a water preheater, an air preheater, and exhaust and process control systems. It was a batch-type operation fed from the 8,000-gallon radioactive water storage tank in Building 4022. The radioactive water was filtered and preheated prior to introduction into the evaporator. Periodically, the solid material, or sludge, was removed from the evaporator and preheater for packaging.[6]

[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.
[2] Correspondence from Chell, M., MWH, to Waite, P., Boeing, Re: *Conversation with Paul Waite Regarding RHMF Questions*, March 16, 2009.
[3] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385,* Rockwell International, September 15, 1982, p. 7.
[4] Internal Correspondence from Horton, P.H. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Maderail [sic] and Radiation Producing Device User Authorization for RMDF Operations*, December 13, 1989.
[5] Rockwell International, *Rocketdyne Division Annual Site Environmental Report Santa Susana Field Laboratory and DeSoto Sites 1992*, *RI/RD93-125, Revision A*, December 14, 1993.
[6] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report,* Rockwell International, June 16, 1986, pgs. 58-59.

The 1986 Rockwell safety analysis report notes that contaminated water from other facilities entered the Building 4021 evaporator via a portable radioactive water transfer tank, the Building 4022 radioactive liquid sump tank, or the Building 4021 floor drains. All of the above sources of water entered the radioactive water storage system before processing in the Building 4021 evaporator. The radioactive water storage system consisted of a 200-gallon radioactive liquid sump tank outside and west of Building 4021, a 50-gallon radioactive liquid sump tank located outside the southwest corner of Building 4022, and an 8,000-gallon radioactive liquid holdup tank in Vault 2 of Building 4022.[1] Figure 2.1t is a schematic diagram of the waste water processing system. The Building 4022 radioactive liquid sump pump system collected any water present in the vaults. If water collected in the sump, it was immediately pumped into the Building 4021 radioactive liquid sump tank. The Building 4021 radioactive liquid sump tank was higher than the Building 4022 radioactive liquid sump tank by 20 feet so a block valve was provided on the Building 4022 sump tank to preclude gravitational drainage back to the Building 4022 sump tank in the event of pump failures. The Building 4021 radioactive liquid sump tank was also fed by gravity from the floor drains located in the Building 4021 decontamination room. Additionally, radioactive water was brought from other SSFL facilities by a 500-gallon radioactive water transfer tank. These liquids were transferred through the Building 4021 floor drains to the Building 4021 radioactive liquid sump tank. The Building 4021 radioactive liquid sump tank was equipped with sensors to detect the water level. Upon actuation of the sump pump, water was pumped from the Building 4021 sump tank through a set of four pool filters, with 300-micron filtration capacity, to the 8,000-gallon radioactive liquid holdup tank in Building 4022. The potential for the settling of radioactive particulates to occur within the tanks was minimized by the pool filtration system and by drawing the liquid from the bottom of each tank. Radioactive water was pumped from the 8,000-gallon radioactive liquid tank in Building 4022 to the Building 4021 evaporator on demand.[2]

Prior to 1980, the radioactive liquid was stored in a 5,000-gallon aboveground holding tank (T-1) outside and west of Building 4021. Following an overflow of the 5,000-gallon holding tank in 1978 and 1980 (see radiological incident report A0070 and A0080 below), it was replaced with the 8,000-gallon underground radioactive liquid storage tank (UT-15) in Vault 2 of Building 4022.[3,4,5,6,7]

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[1] Sources differ on whether the sump tank located at the southwest corner of Building 4022 had a 50-gallon or 200-gallon capacity.

[2] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, pgs. 58-59.

[3] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I1 – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC)*, June 2009, p. C.2-4.

[4] Internal Correspondence from Tuttle, R.J. to Francis, M.A., Rockwell International, *Re: Sources of Radioactively Contaminated Water at Santa Susana*, February 17, 1981.

[5] Internal Correspondence from Tuttle, R.J. to Breese, L.S. and Walter, J.H., Rockwell International, *Re: RMDF Liquid R/A Waste Holdup Tank*, July 27, 1978.

[6] Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Conversation with Paul Waite Regarding RHMF [sic] Site History*, February 23-24, 2009.

[7] Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Questions for Paul Waite Regarding RMHF Site History (Discussion took place via email during March, 2009)*, March 16, 2009.

Radioactive Liquid Waste Processing

According to an undated Atomics International waste disposal document, incoming liquid wastes were placed in designated areas at the RMHF and separated into the following groups: "(1) concentration less than 10^{-1} uc/cc; (2) concentrations greater than 10^{-1} uc/cc but less than 200 mr/hr at surface (3) contaminated oils or solvents; and (4) SS contaminated liquid." [1]

The undated Atomics International disposal document notes that low-level radioactive liquid wastes not requiring further treatment were pumped from transport containers into holdup tanks located near the RMHF pending shipment. Low-level radioactive liquids were then pumped directly into tanker trucks operated by vendors, such as Nuclear Engineering Company, and transported to offsite disposal facilities. Intermediate-level radioactive liquids, contaminated oil and solvents, and SSFL accountable liquids were placed in International Code Council (ICC) approved transport containers and transferred to the RMHF for further treatment and solidification in drums according to operation specifications.[2]

The primary treatment for radioactive liquid waste consisted of adjusting the pH to between 7 and 9, passing the liquid through a filter system (or for a period of time to the flocculation tower) to remove suspended solids, and evaporating the liquid to reduce its volume. Wastes were solidified by placing drums under a Ross mixer and adding 8 pounds of bentonite clay and 8 pounds of cement for every 3 gallons of liquid. The mixer was turned on and left to mix the liquid, clay, and cement until a homogenous mixture was obtained. This process was repeated until the drum was filled 1 inch from the top. Wastes were also solidified by drying in a heated steel vessel located in a closed fume hood.[3,4, 5,6]

<u>RMHF Radioactive Dry Waste Processing</u>

According to an Atomics International disposal document, properly identified and monitored radioactive dry wastes were collected from generator pickup stations by RMHF personnel and transported to the RMHF. Pick-up was on a routine established schedule or when requested. The containers were re-monitored at the RMHF facility entrance gate and moved to temporary storage location west and north of Building 4021.[7]

Low-level radioactive dry waste was moved to the packaging room where separation of non-compressibles from compressibles took place. Non-compressible dry waste arriving to Building 4021 in bins or boxes was packaged in ICC 15B wooden boxes. Each box had a 2.7 curie (Ci) limit and a surface dose rate maximum of 200 millirads per hour (mrad/hr).[8] Non-compressible waste collected in drums was generally filled by the generator to volume capacity and required no further packaging. However, the drums were still checked to assure that no more non-

[1] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, p. 9.
[2] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, pgs. 9-10.
[3] Operating Specification for the Radioactive Materials Disposal Unit, Undated, BNA00973228-9.
[4] Wallace, J.H., Rockwell International Document No. N0010SP000002, *Radiation Safety Plan for the Radioactive Materials Disposal Facility (RMDF)*, March 1991, pgs. 25, 33.
[5] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.
[6] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.
[7] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, p. 8.
[8] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, p. 8.

compressible waste could be packaged in them. The drums were assigned identification numbers from the drum processing log and this identification number is painted on the drum.[1]

Packaging compressible waste involved placing drums in the press dolly for pressing by one of the two drum presses in Building 4021. Once the press plunger was raised the dolly was removed from under the press. When no more waste could be compressed in a drum it was removed from the dolly and resealed. Compressible waste was baled into 55-gallon ICC l7H single trip steel containers in the packaging room of Building 4021. The balers were fitted with protective shields, behind which the operator stood at all times during the waste compression operation. Waste was separated into three main categories "R/A, BeO, or SS Trace." Each individual drum of compressed material was to contain only one type of waste. Only ICC approved drums were used for waste packaging. As with the non-compressible waste, a log was kept of the contents of each drum. The type of package, activity of contents, and surface dose rate was recorded. The drums were color coded according to radioactive content and surface dose rate. After all packaging was completed, the outside of the drums were decontaminated with steel wool, Alconox, and water. An outside man was called to lay plastic on the packaging room pad outside Building 4021. The roll-up door was opened and the drums were moved out onto the plastic. The drums were checked for surface contamination. Drums found to be clean were moved onto pallets and stored in an unspecified holding area pending final processing. Drums found to be contaminated were sent back into the packaging room to be re-washed. [2,3]

High and intermediate-level radioactive dry wastes were placed into RMHF furnished casks, or shielded lead containers called pigs, by the generator. Pick-up was made at the generating source and transferred to the RMHF by RMHF personnel. The exteriors of the casks were monitored at the RMHF entrance gate and moved to the temporary storage area west of Building 4021. The surface dose rates of the casks were monitored individually in a low background area. Should the dose rate be greater than 200 mrad/hr, shielding was added to the cask. In the event this did not reduce the surface dose rate to less than 200 mrad/hr, the cask was removed and placed in a second and larger cask for the required shielding. If contaminated, the cask surface was decontaminated to a level less than 30 disintegrations per minute per 100 square centimeters (dpm/100 cm^2).[4] The cask was then sealed with concrete and reinforcement bar according to specification. Transfer was made to the final storage area at the west end of the RMHF to await final disposition offsite.[5]

A number of internal Rockwell letters have been identified that provide annual summaries of waste volumes processed and packaged at Building 4021. According to a November 26, 1979 letter, during fiscal year 1979, approximately 52,530 cubic feet (3,100,000 pounds) of radioactive material containing 3,558 Ci was packaged and shipped offsite to an approved land burial location. About 211 cubic feet of material had to be packed in shielded containers. In addition to the dry radioactive waste, 36,000 gallons of radioactive liquid waste was processed at

[1] Operating Specification for the Radioactive Materials Disposal Unit, Undated, BNA00973219.
[2] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, p. 8.
[3] Operating Specification for the Radioactive Materials Disposal Unit, Undated, BNA00973217-8.
[4] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, p. 9.
[5] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, p. 9.

the RMHF.[1] A December 10, 1985 letter notes that during the 1985 fiscal year, 25,179 cubic feet (792,345 pounds) of radioactive material containing 325.046 Ci was packaged and shipped offsite to an approved land burial location. In addition to the dry radioactive waste, there were 19,880 gallons of radioactive liquid waste processed at the RMHF.[2] A December 13, 1989 letter states the RMHF handled 1,314 cubic feet (32,850 pounds) of dry radioactive waste, 4,220 pounds of laundry, and 8,760 gallons of radioactive liquid waste.[3]

RMHF Decontamination Systems

According to Atomics International and Rockwell International documents, the RMHF offered decontamination service for any item that could be cleaned safely in the Building 4021 decontamination room. Decontamination operations included removal of surface contamination from reusable tools and equipment, as well as from salvageable material. Some of the available processes were: mechanically removing contaminated parts; chemically cleaning with acids, caustics, emulsifiers, or other agents; mechanically abrading using sand-blasting; or steam cleaning. In general, small items were accepted up to 25 rads per hour (rad/hr) at the surface. Most items could be decontaminated to the requested level, depending on the type of surface and radioactive material or the degree of metal removal permissible. The decontamination of packages and equipment was accomplished by means of several devices, including fume hoods and dip tanks described above, for chemical and electrolytic decontamination.[4,5,6]

RMHF Final Storage and Disposal

An undated Atomics International disposal document states that following decontamination and packaging procedures, dry and liquid radioactive wastes were transferred to a final storage area at the west end of the RMHF to await shipment to an Atomic Energy Commission (AEC)-licensed vendor, such as Nuclear Engineering Company, or AEC land burial site, such as Nevada or Idaho.[7] An Atomics International site waste management plan dated circa 1972 and an updated plan dated May 1974 note that the solidified sludge generated in Building 4021 was packaged and shipped for ultimate disposal by land burial at Beatty, Nevada.[8,9]

The RMHF waste coordinator established the shipment date of radioactive waste materials based upon surveillance of quantities on hand and those predicted at the facilities concerned. The RMHF supervisor in charge was responsible for initiating necessary shipping instructions and for

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[1] Internal Correspondence from Frazier, R.S. to Mountford, L.A., Rockwell International, *Re: Request for Radioactive Material and Radiation-Producing Device User Authorization Number 106A for RMDF Operation*, November 26, 1979.
[2] Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
[3] Internal Correspondence from Horton, P.H. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Maderail [sic] and Radiation Producing Device User Authorization for RMDF Operations*, December 13, 1989.
[4] Operating Specification for the Radioactive Materials Disposal Unit, Undated, BNA00973193.
[5] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, pgs. 62-63.
[6] Internal Correspondence from Horton, P.H. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Maderail [sic] and Radiation Producing Device User Authorization for RMDF Operations*, December 13, 1989.
[7] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, p. 9.
[8] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.
[9] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.

overseeing the entire disposal operation. The Atomics International quality control department inspected and certified the shipments. The health and safety department inspected and monitored each container. And a representative from the Atomics International traffic department inspected the loading operations to assure correct packaging and loading techniques.[1]

A 1989 letter and 2005 historical site assessment note that preparation of wastes at the RMHF for ultimate disposal consisted of inspection for conformance with U.S. Department of Transportation (DOT) specifications, which in some cases required reduction of the collected volume by selective decontamination, redisposition, and repackaging of the remaining contaminated materials. Materials of high specific activity that exceeded DOT limits in standard packaging were repackaged into shielded containers, as described above. According to Rockwell, final packaging met or exceeded DOT specifications for packaging and shipping radioactive materials as specified in Title 49 of the U.S. Code of Federal Regulations.[2,3]

Building 4021 was originally built to process low-level radioactive waste. After 1988, it was used as a processing area for wastes associated with D&D activities at the Energy Technology Engineering Center (ETEC).[4] Past activities also included radioactive sodium component cleaning and non-hazardous radioactive liquid waste processing.[5]

On March 22, 1989, the RMHF first received RCRA Interim Status authority for the storage and treatment of mixed wastes. The maximum permitted mixed waste storage at the RMHF was 200 cubic yards in a total of 200 containers. The maximum permitted treatment volume on an annual basis was 15,000 gallons or 136 cubic yards. The storage units at the RMHF consisted of Building 4021, 4022, 4621 and a paved, outdoor waste storage area. A revised RCRA Part A application was submitted on October 24, 1997 and authorized by the California Department of Toxic Substance Control in an interim status authorization letter received by Boeing in December 1997. A Closure Plan for the RMHF that reportedly met facility closure requirements for Interim Status Facilities was submitted in October 2006.[6,7]

According to a 1986 Rockwell document, the ventilation and exhaust filtration systems for Buildings 4021 and 4022 were designed to control airborne contamination. These systems directed air from the outside of Building 4021 into the decontamination and packaging rooms and from the outside of Building 4022 into the vaults. Local air pressure was successively reduced at each area of higher potential contamination. According to the 1986 Rockwell document, the operating characteristics of the system were as follows:

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[1] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, p. 10.
[2] Internal Correspondence from Horton, P.H. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Maderail [sic] and Radiation Producing Device User Authorization for RMDF Operations*, December 13, 1989.
[3] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-39.
[4] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. A-1.
[5] Kneff, D.W. and R.D. Meyer, Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008, The Boeing Company, February 4, 2004, p. 10.
[6] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, including Appendix A, October 2006.
[7] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. 1.

- Direction of air flow from areas of lower potential contamination to areas of higher potential contamination are maintained at all times.

- All facility exhaust is directed through prefilters and HEPA filters and released through the facility stack.

- Filter replacement is performed when pressure differentials across the high-efficiency filters exceed nominally 3 inches of water, with an absolute maximum of 6 inches of water, or when radiation levels at the surface of a plenum exceed 150 milliroentgens per hour (mR/h) or the flow rate is insufficient to provide proper air changes and movement. Pressure differentials across the exhaust system filters is monitored and recorded by personnel monthly.[1] Filtration efficiency of the HEPA filters is measured promptly after a change or once a year, whichever is more frequent.

- A minimum of six air changes per hour is provided in all areas posted for airborne contamination.

- Flow rates into the vaults, when any opening is made, can be maintained at nominal values by manual adjustment of dampers.

- When the potential for release of contamination exists, air flow to the areas of potentially greatest contamination is verified.[2]

According to the 1986 Rockwell document, the most recent filter test and velocity measurements performed in April 1986 indicated that the filtration system was at least 99.0 percent efficient for particles of size 0.8 microns and larger, and the flow rate out the stack is 21,933 cfm.[3]

According to a 1989 U.S. Environmental Protection Agency (EPA) report, the air emissions from Buildings 4021 and 4022 consist primarily of surface radioactive particles resulting from decontamination processing, packaging activities in Building 4021, and from storage and handling activities in Building 4022. This particulate matter contains uranium, plutonium; cesium-137 (Cs-137), strontium-90 (Sr-90), krypton-85 (Kr-85) and promethium-147 (Pm-147) as mixed fission products; and cobalt-60 (Co-60) and europium-152 (Eu-152) as activation products. The particulate matter in air was controlled through filtration by HEPA filters. The ambient air within Area IV was monitored daily by continuous collection of air particulate samples using a network of eight air samplers. The samples were counted for alpha and beta radiation following a 120 hour delay to allow for radon and thorium decay. DOE monitored the stacks serving Buildings 4021 and 4022. According to a DOE survey report in 1987, 99 percent of the ambient air alpha measurements and 64 percent of the beta measurements were below the method limit of detection at the time. The DOE survey report indicates that emissions from RMHF Buildings 4021 and 4022 were higher than the equivalent ambient air emissions shown in the Rockwell annual monitoring report data for 1981 through 1987. In 1987, the total radioactive emissions released from Buildings 4021 and 4022 was less than 1 percent (0.7

[1] The research team is not in possession of these monthly records.
[2] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, pgs. 51, 53.
[3] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 58.

percent alpha, 0.17 percent beta) of the appropriate DOE guidelines according to the DOE survey report.[1]

According to a 1990 Rockwell air emissions report, all release points at SSFL facilities with significant potential for discharge of radioactive material are controlled, by the use of HEPA filter systems, to maintain public doses far below 0.1 millirems per year (mrem/yr). Sampling was performed to permit measurement of the releases, and these measurements were used to estimate hypothetical offsite doses. Radioactive atmospheric effluents from DOE facilities were limited to a continuously operated exhaust system at the RMHF and an intermittent exhaust system at Building 4059. According to Rockwell, "minor" locations of soil contamination, including the RMHF 4614 Holdup Pond and RMHF north slope, were also monitored for airborne radioactivity. According to Rockwell, no airborne radioactivity was detected in these two locations and, therefore, they were not included in the estimate of airborne exposure. Operations at the RMHF that generate airborne radioactivity included decontamination of equipment, repackaging of radioactive waste, evaporation of radioactively contaminated water, and packaging of the resultant residue. These operations were performed inside a building, with workplace air sampling, equipped with a ventilation system that exhausted to the atmosphere through a HEPA filter system. The filters were certified for efficiency prior to installation and the system was tested after filter replacement, or at least annually. According to Rockwell, the RMHF pre-filters were noted to be 99.98 percent efficient while the HEPA filters were noted to be 99.99 percent efficient. Annual quantities of radioactive contaminates at the RMHF in 1990 are provided in the table below. The 1990 Rockwell report notes that the estimated dose to the nearest resident in 1990 is less than 1.2×10^{-6} millirems (mrem), which is below the 10 mrem standard established by 40 CFR 61.[2]

1990 Air Emissions from RMHF

Radionuclide	Quantity (Ci)
Americium-241 (Am-241)	1.0×10^{-10}
Cesium-137 (Cs-137)	3.3×10^{-7}
Cobalt-60 (Co-60)	4.9×10^{-7}
Tritium (H-3)	1.6×10^{-6}
Plutonium-239 (Pu-239)	2.5×10^{-9}
Strontium-90 (Sr-90)	2.9×10^{-8}

According to a 1991 DOE Tiger Team finding, although the radionuclide emissions from the Building 4021/4022 stack was considered to be very low, emissions from the stack had not undergone formal evaluation in accordance with established National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations. Because of this, stack monitoring according to NESHAP regulations was required. Although the samplers at the RMHF had the required continuous radiation monitors to detect sudden increases in radiation during accident situations, deficiencies in the radionuclide particulate sampling systems, which have been in use since 1970, prevented the samplers from meeting established NESHAP requirements. Examples of the noted stack sampling deficiencies included: suitability of sampling locations, number of sampling

[1] U.S. Environmental Protection Agency, Santa Susana Field Laboratory Site Report, Ventura County, California, Report for Congressman Elton Gallegly, July 31, 1989, p. 33.
[2] Correspondence from Rutherford, P.D., Rockwell International, to LeChevalier, R.R., U.S. Department of Energy, *Re: Final NESHAPs Report for 1990*, May 28, 1991.

points, and sampler design. The samplers at the RMHF were not originally designed to monitor the large range of particulates which could be present as a result of HEPA filter problems, deposition inside the stack, or corrosion buildup in the stack. Because of the design flaws, the radioactive particulate emission release rates that are supplied for modeling purposes by Rockwell were determined from air filter samples, which are collected in a manner that may not be representative of actual emissions. The Tiger Team observed that the changing and handling of the filter samples revealed that loss of particulate matter may occur and thus air emission modeling may not be accurate.[1]

A March 1993 surveillance and maintenance program plan for SSFL surplus facilities provides the following minimum requirements for surveying the RMHF.[2]

RMHF Radiation and Contamination Surveys Minimum Requirements

Area	Meter Surveys	Smear Surveys	When Conditions Change
Perimeter Fence	Quarterly	N/A	X
Building Walls	Quarterly	N/A	X
Storage Yard	Quarterly	N/A	X
Package Room	Monthly	Monthly	Spot Checks
Vault (4022)	Monthly	Monthly	X
Decon Room (4021)	Monthly	Monthly	Spot Checks
Building 4034	Quarterly	Monthly	X
Building 4044	Quarterly	Monthly	X
Building 4621	Quarterly	Monthly	X
Building 4075	Quarterly	Monthly	X
Building 4665	N/A	Quarterly	N/A
Laundry and Change Rooms	Monthly	Monthly	Spot Checks
Clean Trash	Before disposed of		
Pond Perimeter	Quarterly		
Air Samples 4021 and 4022	Changed and Counted Weekly		
Stack Sample	Changed and Counted Weekly		
Pond Water Sample	Taken monthly or every time it rains. More often when having heavy rains		
Filter Plenums	Differential Pressure Logged Monthly		

According to Boeing's 2009 site environment report, since May 2007, the decontamination and decommissioning operations at the RMHF have been suspended.[3]

Information from Interviewees: A number of former employees were interviewed about their experience at the SSFL. Fifteen remembered the RMHF. Excerpts from their interviews are included below.

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[1] U.S. Department of Energy, *Tiger Team Assessment Energy Technology Engineering Center, DOE/EH-0175,* April 1991, pgs. 3-12–3-15.
[2] Richards, C.D. et. al,, Rockwell International Document No. ER-AN-0001, *Surveillance and Maintenance Program Plan for SSFL Surplus Facilities*, March 1993.
[3] The Boeing Company, *Site Environment Report for Calendar Year 2009, DOE Operations at The Boeing Company, Santa Susana Field Laboratory, Area IV*, September 2010, p. 2-5.

Interviewee 3 was an Atomics International employee from 1963 to 1999. The interviewee started as a fork lift operator and was promoted to be in charge of five test facilities. The following excerpts were pulled from the interview.

> *"I transported waste material in 'pigs' [shielded lead containers] to Building 64, and sometimes to Buildings 21 and 22. I think an outside contractor took the waste from there to Beatty, NV. I am not sure what was ultimately done with the waste, I was just asked to move it.*
>
> *Buildings 20, 21, 22, 24, 25, 19, 59, 9, and 100 were all hot buildings.*
>
> *Those guys in Buildings 20, 21, and 22 had all the hot stuff. If anyone was going to get any exposure those buildings are where it was going to happen. I know one guy that died, I don't know if it was from cancer from working at the site, but he used to work in Building 21 and 22."*[1]

Interviewee 254 worked at the Santa Susana Field Laboratory from 1957 to 1989 and became the Engineer in Charge (EIC) at the RMDF, now known as the RMHF. The following excerpts were pulled from the interview.

> *"Waste from the Hot Lab went into casks, which were essentially lead-lined barrels that were sized based on the quantity of waste and the radiation level. Casks were sent to the RMDF, now called the RMHF. We held the casks there until we could complete all the paperwork necessary to ship the waste offsite for burial.*
>
> *I worked on the dismantling the SRE from 1975 to 1980. Then in 1980, I was sent to the RMDF as the EIC. We started getting rid of a lot of things at that point because there was stuff stored everywhere. I worked at the RMDF from 1980 to my retirement [in 1989].*
>
> *As far as spills go, I only have first-hand knowledge of one spill at the Hot Lab, but I have heard of others. A holdup tank was located in the basement of the Hot Lab (Building 20), under the operating gallery, and it had a line that came out at the north end of the building to a transfer tank. A tanker from the RMDF would pump the radioactive water from the holdup tank and take it to the RMDF where it would be put in an evaporator and reduced to sludge before being disposed. One day either the hose broke or the tank outside the Hot Lab*[2] *overflowed, I can't remember which exactly, during the transfer process and contaminated water spilled onto the asphalt. The asphalt on the north end of the building became contaminated with the radioactive water. We spent quite a bit of time cleaning that up. We had to invent a super vacuum that used HEPA filters to clean up the contamination. We also used foam to help clean up. We kept cleaning until we brought the radiation down to acceptable levels [at the time of the incident]. That is another safety issue that has changed over time – the acceptable level of*

[1] Interview No. 3 conducted by EPA on March 16, 2010.
[2] The interviewee may have been referring to the RMHF instead of the Hot Lab as this description is similar to Incident A0070 described below.

contamination. What was acceptable then may not be acceptable now. I'm sure that incident was written up in an incident report.

When I worked at the RMDF, everything that came in there was already packaged. Depending on exactly how it was packaged and what level of radiological contamination it had, we either had to repackage it, clean it further, or just complete the final necessary paperwork. Some waste at the RMDF came from DeSoto, but most of it was from SSFL. The level of radioactivity also dictated where the material was stored at the facility. There were different areas specified for each level of radioactivity. Highly radioactive fuel that came to the RMDF was stored in the RMDF Vault. The vault contained cells designed to hold fuel elements. A 50-ton crane would lower a cask that contained four or five fuel elements onto the vault floor. Another manipulator would then transfer one fuel rod and place it in one vault cell that was then topped with a plug. The cask would move to the next vault cell and lower the next fuel element in so that each fuel element was stored in its own cell. The RMDF stored waste, but it also stored items that were waiting examination in the Hot Cell. So some material was stored at RMDF until it could be examined at the Hot Lab, and then when it was done at the Hot Lab it would come back to the RMDF and await final offsite disposal.

We stored all kinds of chemicals at the RMDF and I don't think we did a good job managing the chemicals in the beginning. Eventually as safety regulations changed, they decided it wasn't a good idea to have all those chemicals sitting around so we started getting rid of the chemicals. We also started using chemicals much more sparingly. We also stored a lot of radioactive tools and equipment at the RMDF that had been used at other facilities.

At one time they washed towels at the RMDF. This was not hot laundry. The washing facility wasn't that good and by the time I got to the RMDF, they had gotten rid of it.[1] *But we still had 10-20 barrels of soap left over from the laundry facility. Eventually they asked us why we were keeping them around and we got rid of them.*

The RMDF had some spills over the years. There was a spill into the leach field that happened before my time. I only learned about it because we had a big program, with a big budget, to clean up the leach field. It was going on while I was at the RMDF, but I wasn't directly involved in the clean up at the leach field itself. The people working on the cleanup had to be fully dressed in protective clothing that was supplied by the RMDF.

There was absolutely no on-site disposal of radiological waste to my knowledge. I mentioned the spill at Building 20 from the transfer tank overflowing, the leach field spill at RMDF, and the "dip-leg tube" at SRE.

[1] This laundry facility was in Room 100 of Building 4021, which was also used as an office and administrative area. The research team has not identified a time frame for laundry operations.

> *I had a couple of jobs that involved searching through junk that was deposited in canyons. Debris, deemed to be clean at the time, had been disposed in the canyons and when we learned about the hazards of asbestos I had the job of searching through the debris piles to get the asbestos out. This occurred when I worked at RMDF when I was heading up D&D teams.*
>
> *In 1977 or 1978 we had a lot of rain and the holdup ponds were overflowing. I would get a phone call in the middle of the night that a pond alarm was going off. This meant the water level of the pond was getting too high. I would have to go up to the hill in the middle of the night and we had to catch any excess water from the holding pond. We would use whatever we had to catch and manage the excess water, including those plastic swimming pools for kids, 55-gallon drums, and pumps. We had to catch everything because the HPs had to monitor it to see if it was clean. Even though it was presumably clean, it was rain from the sky, the fact that it fell in areas where radiological or chemical material was used meant we had to monitor the water. If it was clean it could go to the Rocketdyne holdup pond.*
>
> *The RMDF had a 10,000 to 20,000 gallon holdup pond down to the west, past Building 75. That pond had alarms and radiation monitors on it. During the rains, we had to store all the excess water in 55-gallon drums so the HPs could monitor it. We had a lot of drums that had to be stored in an outdoor storage area at the RMDF complex so they could be verified as clean before being released. One whole parking lot was full of drums of rainwater."*[1]

Interviewee 419 retired from Rockwell International/Boeing as the Division Director for Environment, Health and Safety. The interviewee was a member of the Environmental Health and Safety group for 22 years. The following excerpts were pulled from the interview.

> *"The parking lot at the RMDF drained to the RMDF pond, which was also radiologically monitored. There was a cleanup on the RMDF slope between the parking lot and the end of the property. It entailed cleanup of the parking lot, slope, and an adjacent leach field. After the cleanup was completed, asphalt was put in place to seal any remaining contamination in place during the RMDF leach field clean up. The spill was the result of a large plastic carboy that failed."*[2]

Interviewee 277 started working at SSFL in May 1975 as a technician in Building 4006 for Atomic International's Sodium & Component Technology Group. The interviewee was transferred 2 to 3 years later to work at the RMHF. The following excerpts were pulled from the interview.

> *"After working for 2 or 3 years at Building 006, I was transferred to RST's department at the radioactive materials disposal facility (RMDF).*

[1] Interview No. 254 conducted by DOE/EPA on July 20, 2010.
[2] Interview No. 419 conducted by DOE in 2010.

> *There was training in radioactivity, respirators, rad handling, dosimetry, and dress out. We were trained on what we were supposed to wear as well as what we were NOT supposed to wear. To tell you the truth I was pretty impressed with KMN's department (health physics). We would wash down the cell at the RMHF and would have to wear plastic rain suits. There was a hot cell at the RMHF with an evaporator where we were sometimes required to wear a respirator. We had filters for radioactive water that was generated onsite – it could come from the SRE decontamination and decommissioning (D&D) or sometimes from DeSoto.*
>
> *Once we had a spill of water at the RMHF when a tech left the water running and the fill tank with radioactive water in it overflowed onto the asphalt. It was handled immediately like the charge of the light brigade. I was called in at night in the rain to help vacuum the water off the asphalt that drained to the pond at the bottom of the hill. The pond did overflow into the canyon in heavy rains. The pond is no longer there – it was dug out. The pond was actually built for Building 28 – there was a drainage line direct from Building 28 to the pond. Now drainage water is pumped into a Baker tank, to 17th Street and then to Silvernale Reservoir and to outfall 18, I think. There was also a septic tank and leachfield in the canyon to the north of the RMHF. In 1984, maybe 1985, they found radioactive water got into the septic system; the leachfield was dug up and never replaced. The septic tank remains but it was plugged with cement.*
>
> *(Regarding disposal of rad waste to floor drains or toilets) Unless somebody had something against the company, it would only have happened by accident or neglect; it was never done intentionally. I do know that Buildings 5 and 24, the Hot Lab, and RMHF had radioactivity in the drains.*[1] *The system could easily be breached. Also the HEPA vents were radioactive, but they would get blocked and then taken out later when we took the building down.*
>
> *I dug out a lot of DOE septic tanks – a lot of them were breached and not properly demolished."*[2]

Holding a Masters degree in Health Science with a concentration in Environmental and Occupational Health, Interviewee 269 worked at SSFL from 1992 to 2007 for Rockwell International's Rocketdyne division in the Environmental, Health, and Safety group doing permit work and performing a variety of environmental-related projects for the company. The following excerpts were pulled from the interview.

> *"At ETEC, I provided environmental support, mostly environmental regulatory interpretation and implementation, at the Radioactive Materials Handling Facility (RMHF).*
>
> *There were a number of legacy mixed and radioactive wastes at RMHF and technical assistance was needed. I was also responsible for the closure*

[1] Building 4005 was the Uranium Carbide Fuel Pilot Plan. Building 4024 was a Systems for Nuclear Auxiliary Power facility. The Hot Lab was Building 4020. The RMHF consists of Building 4021 and 4022. It is not clear from the interview which buildings contained radioactivity in the drains.
[2] Interview No. 277 conducted by DOE in 2010.

> *permitting for the HWMF (Hazardous Waste Management Facility). Off and on, that took 8 years to get an approved Closure Plan mostly because of DTSC delays. I was responsible for the permitting for the RMHF, a RCRA Part A facility which was authorized to perform treatment of mixed wastes on-site. There were quantities of mixed waste so small they were not acceptable for treatment by Envirocare, so we treated them ourselves and met the State and Federal Land Disposal Restriction treatment standards.*
>
> *My areas of responsibility were the closure of the permitted units (RMHF and HWMF), nuclear facility D&D, radioactive soils cleanup, soils and groundwater cleanup."* [1]

Interviewee 255 worked for Atomics International from 1967 to 1985 as an atomic inspector and certified x-ray technician. The following excerpt was pulled from the interview.

> *"Building 4021 and 4022 had outside drainage systems, most likely for handling rainwater. They did not expect the water to have radioactivity, but they monitored those systems just in case."* [2]

Interviewee 223 started working for Atomics International in 1965 at the RMHF. The following excerpts were pulled from the interview.

> *"The RMDF was for disposal of low-level radiological waste, which processed liquid and solid waste. There was no dumping at RMDF or in Area 4, all radiological waste was hauled for disposal at Beatty, NV. This was overseen by safety engineers. Some liquid had very low radiation so it was taken to DeSoto for disposal to the sewage system. I was there for approximately a year before being laid off, and was less than a year later was back at the RMDF but working at the SRE to revamp and modify the system, which was a three month assignment.*
>
> *We had lots of safety classes there, in fact, I was Safety Man for many years. We did weekly and monthly checks of the facilities, equipment and people, which was logged and reported. I kept logs while at RMDF when processing liquid waste, such as temperature readings, number of barrels processed, etc. The safety engineers inspected the areas."* [3]

Starting as an electrician and eventually becoming the supervisor, Interviewee 203 started working for Atomics International at SSFL in 1976. The following excerpt was pulled from that interview.

> *"Regarding radiological contamination, I knew that it was found downstream of the SRE, near the RMHF. The contaminated soil was removed and taken to Hanford for disposal. The cleanup occurred in the mid-1970s, and the soil was*

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[1] Interview No. 269 conducted by DOE in 2010.
[2] Interview No. 255 conducted by DOE and EPA on July 9, 2010.
[3] Interview No. 223 conducted by DOE in 2010.

> *tested following the remediation to ensure that it was clean. I did not do the actual clean up, but was involved in a supervisory role."* [1]

Starting as a fireman at Santa Susana, Interviewee 155 was eventually transferred to the Radiation Safety Department (Health Physics) to work as a monitor. The following excerpts were pulled from the interview.

> *"When I was the HP at the RMDF I would survey the casks and sign off on the shipper and survey the truck drivers cab. There were maybe a couple of shipments a week. There weren't a lot of accidents on Woolsey Canyon Road - if there were, we didn't hear about them."* [2]

Interviewee 117 started working at Santa Susana in 1957 as a chemical research engineer. The following excerpt was pulled from the interview.

> *"I received 14 roentgens (REM) of exposure during the early years. There was a lot of radiation waste early on, the most radioactive of which was packaged in one-gallon paint cans. Some of them required shielding. The RMDF handled the disposal."* [3]

Interviewee 107 worked for Atomics International from 1961 to 1973 as an engineer at the SNAP 2, SNAP 10/10A, S8ER, and STIR programs. The following excerpt was pulled from the interview.

> *"Radiological waste, including contaminated clothing, was disposed at the RMDU in 55-gallon drums. Initially, these drums were taken out to sea and dumped, but that practice fell out of favor and after that all waste from the RMDU was sent to Idaho for disposal*[4]*. I am not aware of any Area IV waste disposal on site. When projects were shut down, uranium and plutonium were transported to Idaho for disposal. Beatty, Nevada was also considered as a disposal location."* [5]

As manager of Atomic International's Engineering Department for System and Test, Interviewee 101 managed Buildings 4133, 4005, 4006, and 4023, as well as some inactive buildings. The following excerpts were pulled from the interview.

> *"One of the projects I worked on used molten salts, heated to 900 degrees centigrade, to convert potential hazardous waste chemicals to non-hazardous molecules, which we did effectively. We also developed a process for treating mixed wastes, which would be oil and radiological mixed waste, for which we were granted a Small Scale Feasibility Study permit by the EPA and funded by the*

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[1] Interview No. 203 conducted by DOE in 2010.
[2] Interview No. 155 conducted by DOE in 2010.
[3] Interview No. 117 conducted by DOE in 2010.
[4] The Marine Protection, Research, and Sanctuaries Act of 1972, codified in 33 U.S.C. §§ 1401 – 1445 and 16 U.S.C. §§ 1431-1445 was enacted to "prevent or strictly limit the dumping into ocean waters of any material which would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities." 33 U.S.C. §1401(b). This law effectively ended the dumping of radioactive waste into the ocean.
[5] Interview No. 107 conducted by DOE and EPA on July 6, 2010.

DOE. We were successful in demonstrating the technology, which we operated at the RMDF for approximately ten weeks. The hydrocarbons were volatilized as CO_2 and H_2O and the salt, when cooled down, was hauled away as radiological waste for disposal in a licensed facility." [1]

Interviewee 90 started working for Atomics International in April 1955 eventually becoming Supervisor of the Santa Susana Health Physics Unit. The following excerpt was pulled from the interview.

"Sodium-24 and other contaminants were hard to keep contained during movement of components into and out of the reactor, and we had contamination problems from time to time. Wastes from the SRE eventually went to the Radioactive Materials Disposal Facility that was located west of the SRE. I am not aware of any intentional disposal of radioactive waste to the environment but there were accidents." [2]

From January 1987 to March 1999, Interviewee 7 worked as a Quality Engineer for Rocketdyne/Boeing. The following excerpts were pulled from the interview.

"DOE was tearing down buildings in Area IV, clearing them out, packaging things in boxes. So I performed quality auditing of the hazardous waste packaging on the hill. I worked out of the Radioactive Material Handling Facility (RMHF) as the quality auditor of hazardous waste material. The boxes of material were big, approximately three feet square. My job was to verify that what they were taking out of the buildings and putting in the boxes was correctly stated in their documentation. The boxes had identification numbers for tracking and I made sure that the box ID and contents matched the shipping documentation and quality control records. Our office was in the RMHF, but what I think was Building 9 was an open-ended building with only a roof.[3] *That's where I was checking the boxes. There were rows of boxes piled up on top of each other. I had to go up and down the aisles, and crawl around to find the correct boxes. I didn't have to wear any protective clothing, but I did wear a film badge.*

Boxes were piled in the open-ended storage building, what I think is Building 9, west of the RMHF and the enclosed building attached to Building 9. There was also another building across the street that held boxes.[4] *I am not exactly sure of the building numbers. But when I was auditing at RMHF, I was actually working out of four buildings, the RMHF, Building 9, the building next to Building 9, and the building across the street. A little west of these RMHF buildings was a burn pit. I didn't have anything to do with the burn pit, but I could see it while I was in*

[1] Interview No. 101 conducted by DOE in 2010.
[2] Interview No. 90 conducted by DOE in 2010.
[3] The references to Building 9 appear to be Building 4075 based on the building description and location on the SSFL site map.
[4] This building appeared to be Building 4621 based on the SSFL site map.

the RMHF area. I could see smoke from the burn pit. I don't know what they were burning, but sometimes we could see smoke.[1]

Anyone who worked at Rocketdyne could get up on the hill. They had guards at the gate, but all you had to do was show your Rocketdyne badge and once you were in there you were free to go to your destination. I was in and out of a few buildings for various meetings or to check on parts, but I spent most of my time associated with the RMHF area and adjacent buildings."[2]

Interviewee 222 worked for Atomics International from 1967 to 1988 as a Subcontractor Administrator and Procurement Manager. The following excerpt was pulled from the interview.

"The radiological waste was either hauled off site by a subcontractor, (overseen by a different Subcontract Administrator), or it was taken to [sic] from the site over to the RMDF. The RMDF would seem like the most likely place where possible radiological contamination would be located."[3]

Radiological Incident Reports: There have been several incidents associated with Building 4021 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing. Summaries of only the incident reports that resulted or may have resulted in releases to the environment are provided following the table, when available. Summaries of all available incident reports are provided in Attachment A.

Building 4021 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0348	3/16/1960	Decon RM	Mixed Fission Product	A Boiling Decon Solution Foamed Over And Spread Contamination In Decon Rm.
A0336	12/21/1960	Decon RM		Glove Box And Be-Contaminated Cutoff Wheel Separation Caused Floor Contamination.
A0017	6/12/1962	RMDF Decon RM	Mixed Fission Product	SRE Sodium Pipe For Decon Exhibited High Dose Rates And Airborne Activity.
A0019	10/30/1962	Decon RM T021	Mixed Fission Product	Employee Failed To Wear Prescribed Respiratory Equipment.
A0408	6/10/1964	BLDG 21 Decon	Mixed Fission Product	R/A Sodium Covered Moderator Can Being Disassembled Exploded And Burned.
A0413	7/21/1964	BLDG 21 Decon	Mixed Fission Product	RMDF Decon RM Moderator Can Cleaning Resulted In Sodium Fire And Explosion.

[1] The research team thinks Interviewee 7 is speaking about the Sodium Burn Pit. However, the research team thinks the Sodium Burn Pit is more than "a little west" of the RMHF. The high elevation of the RMHF complex allows someone working in the area to see smoke from a distance. The research team does not think there is any other burn pit between the RMHF and the Building 4886 area known as the Sodium Burn Pit. The Sodium Burn Pit is discussed in the HSA-8 technical memorandum.
[2] Interview No. 7 conducted by EPA on August 31, 2010.
[3] Interview No. 222 conducted by DOE in 2010.

Building 4021 Incident Report Summary (concluded)

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0448	12/22/1964	North of T021	Mixed Fission Product	Heat Exchanger Bell Leaked Water Onto Ground While Being Moved.
A0297	11/11/1966	T021 Evaporator	Mixed Fission Product	Filters Plugged And Collapsed When "Water" Evaporator Pan Caught Fire.
A0387	6/26/1968	Decon Room		A Fire Started During Primary Sodium Draining From A Hallam Throttle Valve.
A0388	10/31/1974	Evaporator RM		RMDF Evaporator Fire In Bldg 21.
A0070	5/22/1978	R/A Tank Area	Mixed Fission Product	Sump Pump Failure Allowed R/A Liquid To Overflow Into Yard.
A0558	10/13/1978	RMDF Decon RM		Employee Contaminated Previous Cut.
A0559	10/10/1979	RMDF Decon RM	Mixed Fission Product	Splashed R/A Water Contaminated Employee And Subsequently His Film Badge.
A0080	1/9/1980	RMDF & Drainage	Mixed Fission Product	Water Hose Broke Overfilling R/A Waste Tank And Drained To 28 Pond.
A0243	2/29/1980	T021 Sump Pump		Employee Became Contaminated Working on R/A Sump Pump
A0566	12/4/1981	RMDF Decon RM	Mixed Fission Product	Bucket Overfilled With R/A Liquid Spilling Into Drum.
A0180	11/9/1987	Decon RM 021	Mixed Fission Product	Waste Packaging Generated High Airborne Activity When Item Was Dropped.
A0179	11/18/1987	Decon RM 021	Mixed Fission Product	Escorted Worker Entered Contaminated Area Before He Could Be Stopped.
A0208	8/9/1990	Decon RM 021	Mixed Fission Product	Contaminated Power Tool Cut Finger During Size Reducing R/A Waste.
A0211	11/15/1990	Decon RM 021	Ce-144	Exit Survey Revealed Contamination On Employee Shorts.
A0266	2/14/1991	Exhaust Fan		R/A Exhaust Blower Failure Caused Alarm.
A0580	8/6/1993	RMDF Laundry RM		Employee Worked In Controlled Area Without Permission.
A0655	10/12/1994	RMDF T021 PK RM	Cs-137	Cs-137 & Co-60 Contamination Of Personnel Shoes
A0680	10/3/1997	Lower Park Lot		State Found 4 Blocks Over The Limit 100-120 Cpm Fixed Contamination
A0671	1/10/1997	Decon Room		Fixed R/A Contamination On Individual's Personal Shoe

- On June 10, 1964, personnel were attempting to disassemble a moderator can for disposal. There was a reaction of the sodium that caused an explosion and fire. Contaminated smoke resulted in an average beta gamma contamination level of 4.5 x 10^6 dpm/100 cm^2. The incident report indicated that sodium sparks were blown approximately 25 feet searing plastic on the floor and red-line clothing worn by personnel. The fire was extinguished with calcium carbonate. Personnel received contamination in the nose (60 dpm beta gamma) as a result of opening the door of the decontamination room immediately after the explosion and inhaling the smoke. After the smoke had cleared from the room, personnel drove a fork lift into the room to push the moderator can back into the storage can. The incident report indicated that the moderator can covered with sodium had a radiation level on a section of the can of 50 rad/hr, including mixed fission products. The incident report did not provide additional information to indicate whether there were any releases of contaminated air to the atmosphere, whether the surfaces in the decontamination room became contaminated and required decontamination, or how the moderator can was handled after being placed in the storage can (A0408).[1]

- On July 21, 1964, while washing out an empty moderator storage can, a sodium reaction caused an explosion and fire. The explosion and fire were reported to have been confined to the inside of the storage can and were smothered with calcium carbonate. Continuous air monitoring reportedly indicated no increase in airborne contamination during the incident. The incident report stated that an air sample taken 75 minutes following the incident indicated airborne concentrations of 3.2×10^{-11} microcuries per cubic centimeter (µC/cc) alpha and 1.2×10^{-10} µC/cc beta gamma. Nose swipes of the personnel involved indicated no detectable contamination (A0413).[2]

- On December 22, 1964, a component from the SRE was taken to Building 4021 for decontamination.[3] According to the incident report, while transferring the component from a storage area to the decontamination room, rain water contained under plastic covering spilled on the pad and asphalt in back of the decontamination room resulting in the contamination of the pad, asphalt, forklift, and a pallet. The maximum contamination measured was 7,000 dpm/100 cm^2 with a radiation level of 6 mrad/hr from the asphalt.[4] At the time of the incident report, the asphalt and the pad were being cleaned "without significant progress." The incident report did not elaborate on how the area was being cleaned or if the area had been successfully cleaned. The forklift was cleaned to 30 dpm/100 cm^2 and the pallet was discarded as contaminated waste, although the incident report did not provide information to indicate how or to where the pallet was discarded.

  Investigation of the incident had determined that the plastic covering for the SRE component was contaminated to a level of 2,000 dpm. In addition, the single plastic covering had a number of rips and tears from which the contamination was spread by the entrance of rain water. The incident report noted that it was unknown whether or not the item was in the reported condition upon receipt to the RMHF or if it was damaged at the RMHF. It could not be determined from the incident report where the item was stored prior to decontamination as the incident report identifies the area only as a "storage area." Given that rain water had infiltrated the plastic covering of the SRE component, it is assumed this storage area was located exterior to Building 4021 (A0448).[5]

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[1] Young, L.N., Atomics International Internal Correspondence, *Re: Incident Report Building 21-Decontamination Room, June 6, 1964*, June 17, 1964.
[2] Young, L.N., Atomics International Internal Correspondence, *Re: Incident Report, Building 021, Decontamination Room, July 21, 1964*, July 22, 1964.
[3] The incident report and the Boeing incidents database identified the component as a "heat exchanger bell."
[4] A 2005 historical site assessment indicated a maximum contamination level of 2,000 dpm/100 cm^2 for this incident. It is unclear from the source document whether the level of contamination was 2,000 dpm/100 cm^2 or 7,000 dpm/100 cm^2.
[5] Young, L.N., Atomics International Internal Correspondence, *Re: Incident Report, North Side – Building 021, December 22, 1964*, January 18, 1965.

- On November 11, 1966, a water evaporator pan caught fire. Upon arrival to the building, smoke was observed to be emanating from Building 4021 though all the openings, including doors, ventilators, and stack. A portable air sample was placed in the smoke just outside Building 4021, and the Rocketdyne weather station was contacted to obtain wind direction information. This information was not available, however, because the Rocketdyne anemometer was inoperative at the time. Visual inspection observed the smoke to be moving in a southeasterly direction and it was recommended that ventilation be turned off in Buildings 4036 and 4037. Rocketdyne personnel monitored the smoke, office areas and building walls with a GM portable survey instrument and detected no radiation levels above "normal background" as reported by Rocketdyne.

  The fire was contained approximately 10 minutes following the initial alarm. A fireman entered the attic of Building 4021 to inspect the ductwork of the building and reported no unusual conditions except for residual smoke. An employee reported to the scene to perform radiation and contamination surveys of all equipment and trucks in the area.

  Investigation of the incident determined that the fire occurred in the east evaporator in the packaging room of Building 4021. The fire was caused by the "apparent ignition by radiant heaters of wax floating on the liquid undergoing evaporation." All firemen were checked for contamination and it was determined that contamination was limited to shoes at levels of up to 1 mrad/hr. These were decontaminated and returned. Some personnel had hand contamination of up to 0.54 mrad/hr, which were successfully decontaminated to less than 30 dpm/100 cm^2 beta gamma. Bioassay samples indicated no evidence of inhalation of radioactive material. Environmental sampling, including air sampling showed concentrations of 6×10^{-10} uCi/cc beta gamma. Fire trucks, "MSA equipment," fire bottles, and office areas were also surveyed and had measurements ranging from less than 50 dpm/100 cm^2 to less than 500 dpm/100 cm^2 beta gamma.

  The incident report concluded that all areas, vehicles, and equipment were successfully decontaminated to less than 30 dpm/100 cm^2 beta gamma. The report also summarized that no internal or external personnel exposure resulted and "no significant release of radioactive materials occurred" (A0297).[1]

- On June 26, 1968, a sodium fire occurred at the RMHF. According to the incident report, a Hallam reactor primary system throttle sodium valve, Valve #303, was being emptied of sodium in front of the south roll-up door of Room 105 of Building 4021, when the sodium caught fire. The heating and draining process consisted of wrapping the valve with strip heaters, heating the valve under controlled conditions, and allowing the liquid sodium to drain into a pan containing calcium carbonate.[2,3,4]
  During the course of draining Valve #303, small fires occurred as the sodium drained into the pan. Two technicians extinguished the fires with calcium carbonate; however, the

[1] Clow, H.E., Atomics International Internal Correspondence, *Subject: Fire Alarm, Bldg. 021*, November 15, 1966.
[2] Mooers, A.R., Atomics International Internal Correspondence, *Subject: Sodium Fire at the RMDF*, July 10, 1968.
[3] Tschaeche, A.N., Atomics International Internal Correspondence, *Subject: Sodium Fire at SS-021 on June 26, 1968*, July 2, 1968.
[4] Corning, F.E., Memorandum, *Sodium Fire, Building #022, Santa Susana*, June 26, 1968. The building number is incorrectly identified on this June 26, 1968 memorandum subject line. The content of the memorandum indicates the fire occurred on the south side of Building 4021.

small fires merged into one large fire in the pan and could not be controlled with calcium carbonate. The volume of the sodium that had been drained into the pan was estimated to be approximately 15 gallons. Control of the fire was achieved with an Ansul Net-L-X extinguisher and calcium carbonate. Upon receiving "HSRS" approval, staff removed the pan containing the sodium and fire-fighting chemicals to the "dangerous chemicals disposal pit for burning." [1,2,3]

The incident report indicated that two high-volume air samples were taken during the fire and included a five-minute sampled and a 30-minute sample. Both samples were placed in the path of the smoke cloud. According to Atomics International, each sample showed a concentration of approximately 2.6×10^{-10} microcurie per cubic centimeter (µCi/cc). The samples were recounted after 48 hours and were reported to have a count rate of less than background. The regulatory limit for occupational exposure in 1968 was reported to be 9×10^{-9} µCi/cc. [4,5,6]

Additionally, the ventilation systems in Buildings 4036/4037 and 4027 were shut down since the smoke cloud was moving in the direction of those buildings. Nasal smears and clothing surveys were made of all personnel involved in controlling the fire. In addition, smear and radiation surveys were made of the areas located in the path of the smoke cloud and of the general fire area. The incident report reported the measurements to be at background. The regulatory limit for insoluble sodium-22 was reported to be 3×10^{-10} µCi/cc at the time of the incident (A0387).[7,8,9]

- A fire occurred in the evaporator area of Building 4021 on October 31, 1974. The evaporator system in the building consisted of an angle iron frame, a stainless steel tank, a tank cover, and two independently controlled gas burners. Limited information is available regarding the actual fire; however, a summary of the damage indicated that the fire damaged the high voltage ignition wire on each burner and the flame detectors. In addition, the aluminum removable section of the tank cover melted, and the ignition transformer on one burner was damaged by the water that was used to hose down the area

[1] Mooers, A.R., Atomics International Internal Correspondence, *Subject: Sodium Fire at the RMDF*, July 10, 1968.
[2] Tschaeche, A.N., Atomics International Internal Correspondence, *Subject: Sodium Fire at SS-021 on June 26, 1968*, July 2, 1968.
[3] Corning, F.E., Memorandum, *Sodium Fire, Building #022, Santa Susana*, June 26, 1968. The building number is incorrectly identified on this June 26, 1968 memorandum subject line. The content of the memorandum indicates the fire occurred on the south side of Building 4021.
[4] Mooers, A.R., Atomics International Internal Correspondence, *Subject: Sodium Fire at the RMDF*, July 10, 1968.
[5] Tschaeche, A.N., Atomics International Internal Correspondence, *Subject: Sodium Fire at SS-021 on June 26, 1968*, July 2, 1968.
[6] Corning, F.E., Memorandum, *Sodium Fire, Building #022, Santa Susana*, June 26, 1968. The building number is incorrectly identified on this June 26, 1968 memorandum subject line. The content of the memorandum indicates the fire occurred on the south side of Building 4021.
[7] Mooers, A.R., Atomics International Internal Correspondence, *Subject: Sodium Fire at the RMDF*, July 10, 1968.
[8] Tschaeche, A.N., Atomics International Internal Correspondence, *Subject: Sodium Fire at SS-021 on June 26, 1968*, July 2, 1968.
[9] Corning, F.E., Memorandum, *Sodium Fire, Building #022, Santa Susana*, June 26, 1968. The building number is incorrectly identified on this June 26, 1968 memorandum subject line. The content of the memorandum indicates the fire occurred on the south side of Building 4021.

following the fire. Additional information regarding the type or cause of the fire could not be located in available documents (A0388).[1]

- On May 22, 1978, a sump pump at Building 4021 stopped working and contaminated liquid flowed out of a 5,000-gallon radioactive liquid holdup tank. Approximately 40 to 50 gallons of water contaminated with mixed fission products ran through a break in the asphalt dike contaminating asphalt and eight tires from a trailer parked on the asphalt. The contaminated water ran about 40 yards west and south of the dike and ranged from 2 feet to 10 feet in width. The wet area was covered with Pell-A-Cell absorbent, which was later picked up with shovels and put into 55-gallon drums. Foam was also applied and vacuumed up for further cleanup.

  Smear samples were taken of the foamed and vacuumed area the following day. Five smears showed contamination ranging from 108 dpm/100 cm^2 to 356 dpm/100 cm^2. These smears were all within an area of 15 feet from the holdup tank enclosure fence. This area was foamed and vacuumed again. Fifteen additional smears were taken of this area and the results were all less than 100 dpm/100 cm^2).
  As indicated above, the tires of a trailer parked in the contaminated area also became contaminated. Contamination ranged from 59 dpm/100 cm^2 to 601 dpm/100 cm^2. The tires were reported to have been cleaned to less than 50 dpm/100 cm^2 and the trailer was removed from the area. The trailer was reported to have belonged to an “outside contractor.”

  An additional survey was performed using a PUG with a shielded Eberline HP-210 probe, and direct readings observed by the instrument ranged from 20,000 counts per minute (cpm) to 45,000 cpm.[2] Background reading this area were approximately 4,000 cpm. As a result of the high readings, on May 30, 1978, the contaminated areas were foamed with “Ammoniated Turco Meteor All Purpose Water Emulsion Cleaner” and scrubbed with a stiff bristle brush and vacuumed. Reading with the PUG and HP-210 probe showed no significant change, and on June 1, 1978, the contaminated area was covered with “Midwest’s Z-40 Floor and Road Seal Emulsion” to fix any possible loose contamination. The incident report did not indicate any additional surveys and did not provide any figures to show the extent of contamination and the location of the trailer (A0070).[3]

  A follow up to the incident noted that during the “Great Rain of ‘78” there was great difficulty in handling the amounts of contaminated water generated at several facilities. The 5,000-gallon radioactive liquid storage tank was surrounded by a security fence and low berm, but was unprotected from weather. Rain poured off the Building 4021 roof and fell directly into the holdup sump and was automatically pumped to the holdup tank. To prevent rainwater from filling the holdup tank, the berm was broken to allow the water to drain out. However, because the berm and sump pit were the only protection

[1] Gutierrez, E.P., Rockwell International Internal Letter, *Subject: Evaporator Fire Incident, Bldg. 021*, November 8, 1974.
[2] A PUG is a radiation survey instrument made by Technical Associates, which has been developing radiation detection equipment since 1946.
[3] Bradbury, S.M, Rockwell International Internal Correspondence, *Re: Sump Overflow in the 5,000-Gal Holdup Tank Enclosure at the RMDF*, June 7, 1978.

against release of water from overflow and leakage, a work order to repair the berm was issued soon after the end of the rains. The work order was not completed in time to prevent the incident. The berm and sump pit, when empty, provided retention capacity for about 2,000 to 3,000 gallons of water. The 5,000-gallon holdup tank usually contained 3,000 to 5,000 gallons of water. Thus, the area did not provide enough protection against total release of the holdup contents. The radiation exposure rate at the fence around the tank averaged 50 mR/hr, but because of the large size of the tank, radiation exposure extends "significantly" beyond the enclosure. The incident follow up letter notes that these problems and potential hazards could be eliminated by construction of a concrete block wall enclosing the tank with a weather tight roof. It also states that there have been "many bad experiences with contaminated water at Santa Susana" and the facility must be upgraded to prevent future incidents.[1]

- On January 9, 1980, a water hose broke and caused the 5,000-gallon radioactive liquid storage tank to overflow at Building 4021 and drain to the RMHF 4614 Holdup Pond. The leak was discovered by RMHF personnel located outside the RMHF perimeter fence who noticed liquid running out the top of the storage tank. The source was found to be coming from the decontamination room of Building 4021 and the water was shut off. According to the incident report, the excess water was a result of an employee neglecting to turn off the water hose at the valve. The hose was used with a spray nozzle for rinsing during decontamination operations in the decontamination room of Building 4021. The incident report stated that although the nozzle was shut off, the excess pressure caused the hose to break, causing the tank to fill and overflow. This incident resulted in the release of approximately 100 gallons of liquid containing 0.01 microcuries (µCi) of mixed fission products and caused the contamination of approximately 2,500 square feet of asphalt paving and an accumulation of about 3,000 gallons of contaminated liquid with 100 gallons being released. According to the incident report, the loss occurred because the asphalt berm that should have contained the contaminated spill leaked and permitted the contaminated liquid to spread over a sizeable area. This spill is depicted on Plate 1.

  Heavy rain prior to the spill and during the cleanup operations resulted in a significant increase in the decontamination effort. Runoff from the rainfall contributed to a major increase in the amount of contaminated water that was collected first in the "RMHF radioactive pond" and then transferred to holdup tanks in the RMHF. The incident report indicated that the tank that overflowed and released the contamination liquid was taken out of service and that all future radioactive water was being stored in an underground tank with complete retention of any overflow or spill. The incident report did not provide information to indicate how the affected areas were cleaned or to what levels they were cleaned (A0080).[2]

- In 1986, during the third week of the third quarter electric power to the HEPA filtered exhaust blower for the decontamination and packaging rooms was inadvertently left off after a test and the exhaust system was inoperative for an unknown period of time. Air

[1] Internal Correspondence from Tuttle, R.J. to Breese, L.S. and Walter, J.H., Rockwell International, *Re: RMDF Liquid R/A Waste Holdup Tank*, July 27, 1978.
[2] Bradbury, S.M., Rockwell International Internal Correspondence, *Re: Radiological Safety Incident Report, RMDF, January 9, 1980*, April 9, 1980.

sampling data showed that radioactive contamination migrated across the decontamination room and into the packaging room.[1]

- On October 3, 1997, four concrete blocks in the lower RMHF parking lot were discovered to have small areas, less than 1 foot square, of fixed contamination ranging from 100 to 800 cpm. The concrete blocks were decontaminated, resurveyed, and released without radiological restrictions (A0680).[2]

Current Use: Building 4021 is standing as of 2011, but is no longer in use. According to Boeing, Building 4021 became inactive in 2007 and all equipment was removed from the building. Radioactive equipment and tools were removed, packaged and shipped for disposal. The interior surfaces were painted to fix loose contamination and the water and electrical utilities were severed. The HEPA-filtered exhaust system ducting in the attic remains intact. The permitted mixed waste treatment units are currently stored onsite until the facility undergoes closure.[3] Site visit documentation from 2009 provides a recent look at the Building 4021 rooms and appurtenances. The office/former laundry room has staining on the linoleum floor. It was not clear is the staining was laundry related. The floor was generally intact, with some degradation. The condition of the concrete underneath could not be determined. The sinks, toilets, and showers in the hot and cold change rooms were removed with concrete patches indicating their former locations. The drains were inactive and backfilled.[4]

As of July 27, 2011, Boeing notes that there is no storage of radioactive waste in Building 4021. However, the inside floor and walls are contaminated and under fixative paint, the upstream HEPA ventilation ducting in Building 4021 and between Building 4021 and Building 4022 is highly contaminated, and areas under the floor drain lines are highly contaminated.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s):

- **1981 Rockwell Environmental Survey**. In 1981, a preliminary survey was conducted to support RMHF decommissioning. Low levels of fixed and removable contamination were found in portions of the RMHF asphalt and in the soil beneath the asphalt paving. Localized areas of contamination were also discovered in the soil outside the north, west, and south fence perimeters. Thirty-seven locations were identified for sample collection with a micro-R meter. Samples were taken at the surface and at 12 inches below the surface (subsurface) to determine the extent of contamination. Surface soil sample activities ranged from 21.25 to 1,142.92 pCi/g. The soil activity at 12 inches deep ranged from 19.86 to 104.00 pCi/g. Sample results surrounding Building 4021 are described in the table below. Boeing-stated background levels ranged from 20 to 30 pCi/g gross beta activity. Soil and asphalt sampling and radiological surveys identified eight areas with elevated radiological activity at the RMHF, including an area west of Building 4021. See

[1] Internal Correspondence from Moore, J.D. to Remley, M.E., Rockwell International, *Re: Quarterly Review of the RMDF for Radiation Safety, Third Calendar Quarter, 1986*, December 15, 1986.
[2] Deschamps, R., The Boeing Company Internal Correspondence, *Re: Incident Report No. A0680*, October 20, 1997.
[3] Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Questions for Paul Waite Regarding RMHF Site History (Discussion took place via email during March 2009)*, March 16, 2009.
[4] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.

Figure 2.1u for a more specific depiction of the sampling locations and Plate 1 for the location of contaminated areas.[1,2,3]

1981 Soil Sample Analysis Results

Sample Location	Surface Activity (pCi/g)	Subsurface Activity (pCi/g)
North of Building 4021	27.25	30.90
South of Building 4021	21.85	35.16
West of Building 4021	100.86	82.94
West of Building 4021	1,142.92	93.11

- **1983 Sewer, Septic, and Drain Line Removal Procedure**. A 1983 Rockwell plan discusses procedures for the removal of the abandoned sewer lines, drain lines, and septic tank located behind the north side of Building 4021. These items were abandoned in place after Building 4021 was connected to the central sanitary sewer in late 1961, although portions of the piping had been removed in 1964 for construction of Building 4664 and 4665. The plan notes that there is an exposed aboveground terminated pipe at the northwest corner of Building 4021. From that point, one clean out plug was located 12 feet north and another clean out plug was located 8.5 feet northeast. The procedure notes that, except for the clean outs, the drain line locations could only be assumed and that it was "highly probable" that the first 6 inches of soil would be contaminated. The abandoned drain line to be removed crossed the sanitary drain line at the center of Building 4021, which was to remain in place, and then continued to a point toward the northwest corner of Building 4665 where it terminated. The drain line was paralleled by a 2 inch-overflow drain line that runs from the filter/blower area between Building 4021 and Building 4022 to the embankment north of Building 4665. The overflow drain line was to remain in place. At a point near the concrete pads to the west of Building 4665, the exit line from the septic tank connected to the abandoned drain line. The asphalt and soil was removed over the drain line. The asphalt, soil, and drain line was surveyed for radioactivity. Contamination above the limits in the table below was to be packaged and disposed as radioactive waste. Once the drain line was removed, the empty trench was also surveyed for loose contamination. The ditch was then backfilled with dirt and the areas was resurfaced with asphalt. The septic tank was to be removed only if sampling results from the septic tank were above the limits in the table below.[4,5,6,7]

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[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-3.
[2] Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, pgs. 24-29.
[3] Internal Correspondence from Peko, D. to McCurnin, W.R., Rockwell International, *Re: Radioactive Materials Disposal Facility Assessment Plan*, May 22, 1990.
[4] Poucher, G.S., *Abandoned Sewer Lines, Drain Line, and Septic Tank Removal Detailed Work Procedure, N001DWP000007*, Rockwell International, May 17, 1983.
[5] Poucher, G.S. *Abandoned Sewer Lines, Drain Line, and Septic Tank Removal Activity Requirement, N001ACR000001*, Rockwell International, Undated.
[6] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 11.
[7] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-4.

Rockwell International Acceptable Limits for Residual Radioactivity 1983

Surface Contamination	Total Average[1]	Total Maximum[2]	Removable
Beta-Gamma Emitters	2,500 dpm/100 cm^2	7,500 dpm/100 cm^2	100 dpm/100 cm^2
Alpha Emitters	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Surface Dose Rate			
At 1 cm though 7 mg/ cm^2 absorber	0.1 mrad/hr	0.5 mrad/hr	
Ambient Exposure Rate			
At 1 m from surface	5 µR/h above background		
Soil Contamination			
Alpha Emitters (above background)			
Ra-226		3 pCi/g	
Transuranic (TRU)		10 pC/g	
Thorium, Uranium		40 pCi/g	
Beta-Gamma Emitters (including background)			
Near Surface	100 pCi/g gross detectable beta activity		
Below 3 m	Average in 1 m^3 1,000 pCi/g gross detectable beta activity	Maximum 3,000 pCi/g gross detectable beta activity	
Water			
Released To Unrestricted Use	DOE Order 5480.1A, Chapter XI, Attachment XI-1		

[1] Average over a 1 square meter area
[2] Maximum value measured in 1 square meter area, averaged over 100 square centimeters
dpm/100 cm^2 - disintegrations per minute per 10 square centimeters
mrad/hr – milliard per hour
mg/cm^2 – milligram per centimeter squared
µR/h – microroentegens per hour
m – meter
pCi/g – picocuries per gram

Rockwell's 1983 table of acceptable limits is being presented only for comparison purposes with cleanup levels that are required under the December 2010 Administrative Order on Consent.

- **1987 Monthly Comprehensive Smear Surveys**. A quarterly review of the RMHF in the first quarter of 1987 detected high levels of removable contamination at the decontamination room, packaging room, and hot change room. The maximum removable contamination found in the decontamination room was 290 dpm/100 cm^2 alpha and 160,000 dpm/100 cm^2 beta. The beta contamination came from a sample of the floor near the dip tank. The maximum removable contamination found in the packaging room was 660 dpm/100 cm^2 alpha and 100,000 dpm/100 cm^2 beta. The alpha contamination came from a sample near the floor drain and the beta contamination came from a sample near the wet hood. The maximum removable contamination found in the hot change room was less than 20 dpm/100 cm^2 alpha and 600 dpm/100 cm^2 beta. The beta contamination came from a hot shower pan. All other smear surveys of the RMHF building complex showed surface contamination less than 20 dpm/100 cm^2 alpha and less than 50 dpm/100 cm^2 beta. The quarterly review notes that surveys at locations of known contamination have routinely measured beta contamination levels up to 1 million dpm/100 cm^2 beta. The review states that although these areas have undefined limits, they are typical of areas with limited accessibility, such as drains, hoods, and process equipment. Additionally, the quarterly review notes that high radiation levels measured by location film badges in the decontamination and packaging rooms continues to be notable, although gradual reductions have occurred in each of the most recent past quarters.[1] EPA is not aware of any decontamination activities to address these contaminated areas.

- **1988 DOE Environmental Survey**. A June 30, 1988 DOE status report states that although improvement had been made to reduce radiation exposure rates, because of changing operations involving radioactive materials handling at the RMHF, exposure rates may exceed the DOE guideline of 100 millirems per year for continuous exposure at the Area IV property boundary north of the RMHF. This guideline is intended to prevent members of the public from unknowingly receiving excessive exposure as a result of DOE operations. According to the report, long-term exposure to a member of the public is unlikely due to the rugged terrain along the north boundary and daily security patrols.[2]

- **1989 EPA Review Report**. In conjunction with a DOE plan to review environmental conditions at the SSFL, an EPA emergency response unit was brought to the site to collect soil and water samples for radiological analysis. A July 1989 EPA review was critical of Rocketdyne's environmental monitoring and its characterization of radioactivity in the environment. One of EPA's comments was that the northwest rainfall runoff should be monitored because rainfall water that runs off the northwest portion of the site is not periodically sampled and analyzed and could result in undetected offsite releases of contaminants. Approximately 10 percent of the surface of Area IV slopes to the northwest. Most rainfall soaks into the ground and evaporates, but heavy rains can lead to runoff. Rocketdyne's plan of action involved installing collection basins in runoff channels along the northwest boundary of the SSFL for sampling and analysis after rainstorms. Sampling of the RMHF collection basin in late 1989 and early 1990 found gross alpha ranging from 0.284 to 6.000 picocuries per liter (pCi/L), gross beta ranging from 5.49 to 163.00 pCi/L, and tritium ranging from -5.76 to 0.00 pCi/L. The high concentrations of gross beta occurred in November 1989 and may have resulted from the collection basin installation. The most restrictive limit for release of radioactivity in water to an uncontrolled area was 30 pCi/L at the time, but that did not apply to naturally occurring radioactivity, which according to the report these results represent.[3]

- **1991 Rockwell Monthly Radiation Meter Surveys**. Project progress reports located for February, March, and August 1991 note that monthly radiation meter surveys and smear surveys of the RMHF packaging, decontamination, laundry and change rooms found nothing unusual and no corrective actions were required.[4,5,1]

[1] Internal Correspondence from Moore, J.D. to Remley M.E., Rockwell International, *Re: Quarterly Review of the RMDF for Radiation Safety, First Calendar Quarter, 1987*, June 22, 1987.
[2] Weiner, L.A. and Barisas, S., *Status Report of the DOE Activities at the Santa Susana Field Laboratories Site Environmental Survey*, U.S. Department of Energy, June 30, 1988, p. 10.
[3] Tuttle, R.J., *Recent Reviews of Rocketdyne Radiological Environmental Monitoring, N001SRR140115*, Rockwell International, January 10, 1991, pgs. 5, 7, 17-19.
[4] Gaylord, G., *Energy Technology Engineering Center Project Progress Report Accounting Period for February 1991, Attachment I-3*, Engineering Technology Engineering Center, February 1991, p. 2.
[5] Gaylord, G., *Energy Technology Engineering Center Project Progress Report Accounting Period for March 1991, Attachment I-3*, Engineering Technology Engineering Center, March 1991, p. 2.

Additionally, a 1991 Rockwell report notes that radiological conditions in the RMHF are determined by periodic surveys, which are summarized for the first quarter of 1991 in the report. Results are shown in the table below.[2]

RMHF Removable Contamination Levels for First Quarter, 1991

Location	Posting Status	Limits (dpm/100 cm^2) beta-gamma	Lowest Measured Level (dpm/100 cm^2) beta-gamma	Highest Measured Level (dpm/100 cm^2) beta-gamma
Building 4021 (Laundry, Change Room, Decontamination Room, Packaging Room)	Open	< 1,000	< 50	651*
	Contaminated Area	< 1,000	< 50	3,138**
Building 4022 Vault Storage	Open	< 1,000	< 50	5,000***
Building 4034 Offices	Open	< 1,000	< 50	< 50
Building 4044 Break Area	Open	< 1,000	< 50	< 50
Building 4075 Storage Area	Open	< 1,000	< 50	< 50
Building 4621 Storage Area	Open	< 1,000	< 50	< 50

* Alpha contamination of 33 dpm/100 cm^2 was found on the sink top in the change rom. The contamination was removed and subsequent surveyed showed levels to be < 20 dpm/100cm^2.
** Isolated instances of low-level (22 – 37 dpm/100cm2) alpha contamination were found on several occasions.
*** This measurement came from aluminum sheeting awaiting packing that was discovered during a routine smear survey. The sheet was sectioned and discarded as radioactive waste. No violation of U.S. Department of Energy regulations occurred.

- **1993 RMHF Characterization Letter**. EPA finds it significant that a 1993 internal letter between Rockwell staff notes that there is suspected significant contamination beneath the asphalt-covered RMHF area. This letter states that such contamination was not included in a site characterization plan because the complex will be remediated after the RMHF ceases operation.[3]

- **2000 Boeing Survey**. In 2000, a survey of the RMHF and surrounding area was conducted. Twenty three soil samples were collected south, west, and north of the RMHF fence line and analyzed for cesium-137 (Cs-137). Thirteen samples ranged from non-detect to 1 pCi/g. Six samples ranged from 1 to 10 pCi/g. Four samples had Cs-137 concentrations between 10 and 53 pCi/g. Additionally, six samples were taken from the

[1] Gaylord, G., *Energy Technology Engineering Center Project Progress Report Accounting Period for August 1991, Attachment I-3*, Engineering Technology Engineering Center, August 1991, p. 2.
[2] Internal Correspondence from Barnes, J. to Rutherford, P., Rockwell International, *Re: First Quarter, 1991 ALARA Report*, August 8, 1991.
[3] Internal Correspondence from Author, D.W., to Hoffman, N.J., *Re: SSFL Area IV Site Characterization Plan*, June 17, 1993.

leach field area. The highest concentration of Cs-137 was 1.2 pCi/g found in one sample. The other five samples were reportedly typical of background (< 0.2 pCi/g).[1]

- **2003 RMHF South Fence Characterization**. In 2003, an extensive characterization was performed on soils outside the RMHF south fence. According to a 2003 Boeing site environmental report, this area has historically contained small amounts of Cs-137. More than 40 soil samples were taken and analyzed for man-made gamma emitters. Cs-137 was detected in most samples and averaged 27 pCi/g, ranging from nondetectable to 124 pCi/g in isolated spots. The approved soil release criteria for Cs-137 was 9.2 pCi/g.[2] Contaminated soils were excavated. According to a 2009 RFI report, three small shallow excavations were performed south of the RMHF perimeter fence to mitigate the elevated mixed fission products (primarily Cs-137) detected in soils during the south fence characterization. The excavations measured 125 feet by 13 feet, 5 feet by 7 feet, and 7 feet by 12 feet. Excavation depths were approximately 0.5 feet deep, with approximately 130 cubic yards of soil removed.[3,4] After removal of the contaminated soil, six more soil samples were taken from the area and the average Cs-137 concentration was lowered to 3.75 pCi/g, ranging from 1.65 to 7.08 pCi/g. These samples were below the release criteria of 9.2 pCi/g, applicable at that time. Since the RMHF complex is still operating, a final cleanup survey will be performed after RMHF closure.[5]

- **2004 Boeing Demolition Program Management Plan**. A January 2004 demolition program management plan states that the decontamination room, packaging room, radioactive drain system and attic area are all radioactively contaminated. General area dose rates were noted at 0.5 to 1 mR/hr in the decontamination room, 0.5 to 2 mR/hr in the packaging room, and 1 to 3 mR/hr in the attic. Contamination is also expected to have migrated into the concrete slab beneath the steel floor in the decontamination room.[6]

  The 2004 RMHF demolition program management plan also makes the following statement about the RMHF asphalt paving and perimeter soils:

  > The asphalt paving covers most of the open area within the fenced portion, of the facility. The paved area is surrounded by a berm and is sloped gradually to the west, which directs surface runoff to the drainage channel and catch basin. Low levels of fixed and removable radiological contamination are present on and in some portions of the asphalt and are expected to be in the soil beneath the paving.

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[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-3.
[2] Boeing, *Site Environmental Report for Calendar Year 2003, DOE Operations at The Boeing Company Rocketdyne Propulsion & Power, RD02-148-01*, September 2004, p. 5-13.
[3] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, June 2009, p. 3-13.
[4] The research team could not verify this information from the source cited in the 2009 Resource Conservation and Recovery Act Facility Investigation report.
[5] Boeing, *Site Environmental Report for Calendar Year 2003, DOE Operations at The Boeing Company Rocketdyne Propulsion & Power, RD02-148-01*, September 2004, p. 5-13.
[6] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, p. 10.

> Spot areas of radiological contamination may be present in the soil outside of the north, west, and south fence perimeters.[1]

These areas are found on Plate 1 and are the result of numerous spills at the RMHF complex over the years.

- **2005 Boeing Final Status Survey**. In September and October 2005, Boeing performed a characterization and final status survey of the RMHF northern and western perimeter, outside the RMHF perimeter fence. Activities included a gross gamma walkover survey, surface soil sampling, exposure rate measurements, and sample analysis. Eight survey units were surveyed and sampled. The gross gamma walkover survey found areas of elevated count rates that helped identify biased sampling locations. Four surface soil samples collected in two survey units (Units 3 and 4) were found to have Cs-137 levels above the project action level of 7.15 pCi/g. This value was the DOE and California Department of Health Services approved sitewide derived concentration guideline level (DCGL) for Cs-137 (9.2 pCi/g) modified to account for the other hard-to-detect or less abundant radionuclides of concern. Results for the four samples were 7.38 pCi/g, 9.40 pCi/g, 16.10 pCi/g, and 23.50 pCi/g. Additional biased sampling was done in these areas to further determine the lateral extent of contamination. The extent of surface contamination was found to be less than 100 square feet. Six of the eight survey units were recommended for release to unrestricted use and two units required further investigation or remediation before being released in their entirety due to high Cs-137 levels.[2]

- **2006 Boeing Post-Remedial Sampling**. In April 2006, Boeing excavated an area of 100 square feet to a depth of 6 inches from the north slope of the RMHF perimeter. Approximately 200 cubic feet of soil was removed and sent to the Nevada Test Site for low-level radioactive waste disposal. This effort was in response to the 2005 recommendation that two survey units in the RMHF perimeter required further investigation or remediation. Three samples taken in the 2005 survey contained Cs-137 levels exceeding the approved sitewide DCGL of 9.2 pCi/g, with a fourth sample above the project action level of 7.15 pCi/g. Post-remedial sampling after soil removal found six samples with Cs-137 levels below the DCGL, ranging from 0.75 to 4.40 pCi/g, and one sample still above the DCGL at 12.8 pCi/g. A second round of soil removal and sampling brought the 12.8 pCi/g result down to 2.5 pCi/g and confirmed that the survey units were brought in compliance with the Cs-137 DCGL in 2006.[3,4]

Radiological Use Authorizations: At various times, the following use authorizations were assigned to the RMHF complex:

[1] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, p. 12.
[2] Cabrera Services, *Final Final Status Survey Report: Characterization and Final Status Survey, Radioactive Materials Handling Facility, Santa Susana Field Laboratory, Ventura County, California*, March 2006, pgs. 1-2, 13-14, 29-36, 49.
[3] Internal Correspondence from Rutherford, P. and Trippeda, D. to Sujata, B., The Boeing Company, *Re: Contract DE-AC03-99SF21530 – RMHF Slop Remediation*, June 9, 2006.
[4] Internal Email from Rutherford, P. to Trippeda, D., The Boeing Company, *Re: RMHF Slope*, April 24, 2006.

- Use Authorization No. 33 was initially issued on March 17, 1971 and allowed for the use and storage of 5 millicuries (mCi) and 25 µCi cobalt-60 (Co-60) sealed sources and 40 mCi Cs-137 sealed sources at 22 locations at the SSFL. The sealed sources were used for the calibration of fixed and portable radiological alarm systems at SSFL facilities, including the RMHF. The sealed sources were stored in Building 4621. Use Authorization 33 was terminated on September 19, 2001 because the radiological alarm system was deactivated due to the "significantly reduced source term in the building." The 17 mCi cesium source used to perform functional tests was no longer needed and the source was transferred to Use Authorization 106 for storage and eventual disposal.[1,2,3,4]

- Use Authorization 106 first issued on November 19, 1976, allowed for the RMHF complex to handle radioactive waste and contaminated materials generated at other authorized facilities. The authorization was modified to deal with cleanup of specific areas. For example, a 1989 modification allowed for storage of radioactively contaminated soil from cleanup efforts at the Old Conservation Yard and Building 4064, storage of a contaminated liquid waste holdup tank from Building 4009, and a contaminated storage source thimble from Building 4029.[5] Use Authorization 106M, issued February 12, 1992, noted that operation of the RMHF included a) receiving, processing, packaging, and shipping radioactive wastes and materials generated by Rocketdyne activities, b) receiving, processing, packaging, and shipping radioactive laundry, c) receiving and processing liquid radioactive wastes, d) storing radioactive materials, and e) maintaining facilities equipment and materiel. Buildings 4021, 4022, 4044, 4075, and 4621 were listed as authorized use locations with the authorized users based out of Building 4034.[6,7] It is worth noting that as use authorizations were terminated for other buildings and operations at the Santa Susana Field Laboratory, many were transferred to Use Authorization 106 for storage and disposal at the RMHF.

- Use Authorization 124 authorized the use of sealed sources of Cs-137, Co-60, and "#3-95" for the use of calibrating radioactive instruments. The RMHF was one of a number of authorized use locations.[8] A 1989 request for amendment of Use Authorization 124 noted that it did not cover the use of a plutonium-beryllium (PuBe) neutron source that was currently being used to calibrate instruments.[9] A 1993 and 1994 issuance of Use Authorization 124 added sealed sources of Am-241, Eu-152, radium-226 (Ra-226), Sr-

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[1] *Radioactive Material Authorizations*, Rockwell International, BNA02647573.
[2] Isotope Committee Chairman, *Authorization for Use of Radioactive Materials or Radiation Producing Device*, Authorization Nos. 33E-33H, 33J, 33L-33O, 33S, April 16, 1976 through March 26, 1990.
[3] Internal Correspondence from Barnes, J.G. to Logan, A.B., Rockwell International, Re: Notification for Renewal of Authorization for Use of Radioactive Materials or Radiation Producing Devices – Second Notice, March 3, 1994.
[4] Internal Correspondence from Barnes, J. to Use Authorization File, Boeing, *Re: Termination of Use Authorization 33*, September 19, 2001.
[5] Internal Correspondence from McCurnin, W.R. to Radiation Safety Committee, Rockwell International, *Re: Modification to RMDF Use Authorization*, June 26, 1989.
[6] *Radioactive Material Authorizations*, Rockwell International, BNA02647573.
[7] Isotope Committee Chairman, *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization Nos. 106D, 106F-106M, Rockwell International, December 18, 1981 through February 12, 1992.
[8] *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization No. 124J, Issue Date: November 22, 1991, Expire Date: November 22, 1992, BNA02851152.
[9] Internal Correspondence from Moore, J.D. to Radiation Safety Committee, Rockwell International, *Re: Request for Amendment to Authorization No. 124*, April 13, 1989.

90, and thorium-230 (Th-230).[1] A 1998 version of Use Authorization 124 noted the authorized sealed source material included any radionuclide with an atomic number from 3 to 83 not to exceed 5 Ci for any one radionuclide and any radionuclide with an atomic number from 84 to 105 not to exceed 5 Ci for sealed sources or 10 mCi for any other form. Source material was not to exceed 1 pound.[2]

- Use Authorization No. 141 authorized the use of Am-241 in smoke detectors for any building at the SSFL, including Building 4021.[3,4,5]

Former Radiological Burial or Disposal Locations: None found.

Aerial Photographs: Building 4021 is first identified in a 1959 aerial photograph as part of the RMHF area. The area was active from 1959 through 2005. A smokestack and/or overhead pipeline are identified between Building 4021 and 4022 during the entire active period. An aerial photograph from approximately 1960 plus or minus a year notes a probable open storage (OS) area north of the Building 4021. In 1965, an OS area identified as OS-1, by the EPA's aerial photographic analysis is located northwest of Building 4021, along the northern fence line of the RMHF. Possible staining is noted in OS-1. In 1967, a possible stain is located on the west side of Building 4021. OS-1 has grown in size to include an area along the north and west fence line of the RMHF and staining is identified in the area. From 1967 through 1980, an aboveground pipeline extends from the north end of Building 4021 to the north end of the RMHF perimeter. In 1972, OS-1 is identified as a rectangular area in the southwest portion of the RMHF site and contains probable stains. In 1978, a possible vertical tank is identified north of Building 4021. OS-1 includes most of the western portion of the RMHF site and contains possible stains, possible crates, and probable debris. In 1980, dark-toned material is identified on the west side of Building 4021. The aboveground pipeline extending north from Building 4021 appeared to terminate in a subsurface feature identified as an area of dark-toned material. Drainage from this area is directed west along the RMHF perimeter. OS-1 is once again identified as a rectangular area in the southwestern portion of the RMHF site. In 1983, two separate areas west of Building 4021 were identified as OS-1. In 1988, OS-1 is defined as the western portion of the RMHF site and contains a stain. In 1995, multiple areas within the RMHF site were identified as OS-1 with probable stains, including areas north and west of Building 4021. By 2005, OS-1 is defined as a rectangular area in the western portion of the RMHF site. Earth moving activity is noted in a large area along the northern perimeter of the RMHF site.[6]

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[1] *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization Nos. 124K, 124K, Issue Dates: January 8, 1993 and January 8, 1994.
[2] *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization No. 124P, Issue Date: January 9, 1998, Expire Date: March 31, 1999.
[3] *Authorization for Use of Radioactive Materials or Radiation Producing Device*, Authorization No. 141H, Issue Date: February 27, 1996, Expiration Date: December 31, 1996.
[4] *Authorization for Use of Radioactive Materials or Radiation Producing Device*, Authorization No. 141I, Issue Date: December 16, 1996, Expiration Date: December 31, 1997.
[5] *Authorization for Use of Radioactive Materials or Radiation Producing Device*, Authorization No. 141K, Issue Date: December 15, 1998, Expiration Date: December 31, 1999.
[6] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.

Radionuclides of Concern: Radioactive materials handled in Building 4021 were primarily in the form of items contaminated with mixed fission products and fuels.[1] Radionuclides potentially present at the RMHF include: uranium fuel materials (U-234, U-235, U-238), transuranic isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242) and Am-241, fission products Cs-137, Sr-90, Kr-85, and Pm-147, thorium breeder material (Th-228, Th-232), and possible neutron activation products such as Co-60, europium isotopes (Eu-152, Eu-154), hydrogen-3 (H-3), iron-55 (Fe-55), nickel isotopes (Ni-59, Ni-63), managense-54 (Mn-54), potassium-40 (K-40), and sodium-22 (Na-22).[2,3,4,5] All radionuclides of concern listed with the exception of Fe-55, Kr-85, Mn-54, and Na-22 (due to relatively short half-lives) are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: A channel in the pavement around Buildings 4021 prevents water from running into the building operating areas. The same conditions are true for other buildings in the RMHF complex.[6]

The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[7] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[8] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[9] The RMHF Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[10] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any

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[1] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007,* p. A-1.
[2] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, pgs 7-8.
[3] U.S. Department of Energy Environment, Safety and Health Office of Environmental Audit, *Environmental Survey Preliminary Report, DOE Activities at Santa Susana Field Laboratories, Ventura California*, February 1989, p. 3-11.
[4] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 11 – RFI Site Reports, Appendix G – Sewer Inspection Documentation Logs*, June 2009, p. Figure G-1.
[5] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rockwell Division, Santa Susana Field Laboratory, Ventura County, California, Technical Enforcement Support at Hazardous Waste Sites, TES 11, DCN: TZ4-R09015-RN-M21460*, May 1994, p. 7-14.
[6] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 63.
[7] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[8] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[9] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[10] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.

radioactive contamination enters the pond.[1] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[2,3] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[4] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted above in a 1993 letter, Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Historically, surface water from the filter exhaust system between Building 4021 and 4022 collected in three concrete-lined trenches. Drains in these trenches discharged to the RMHF northern slope via a 4-inch below-grade pipeline that discharged to the natural drainage north of the site. At some time during the RMHF operational period, the drains were plugged, but it is not clear when or for what reason. After the drains were plugged, surface water from the filter exhaust system is now conveyed to the west to the area of the former RMHF catch basin or the stormwater aboveground storage tank.[5]

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4021 area is Class 1, due to its former use, radiological incidents, and previous radiological investigations.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the Building 4021 area. As discussed above, there were several radiological incidents at Building 4021 and documented evidence of radiological releases. Previous characterization studies for the Building 4021 area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore,

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[1] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California,* May 1994, pgs. 7-14 – 7-15.
[2] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[3] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[4] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF),* October 2006, p. 2-3.
[5] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, pgs. 2-7–2-8.

additional characterization is recommended for the Building 4021 area. This includes the following Building 4021 areas and appurtenances:

- Under the abandoned in place Building 4021 septic tank located below grade north of the asphalt swale. Documented releases to the RMHF leach field indicate the septic tank may have left residual contamination in the area.

- Under the sumps and floor drains inside Building 4021. The sumps and floor drains carried contaminated waste from the Building 4021 decontamination and packaging rooms. Residual radioactive contamination is likely in this area.

- Under the Building 4021 sump, sump tank (UT-16) and former radioactive liquid storage tank (T-1) located outside and west of the building. These features are considered to be radiologically contaminated, having received contaminated waste from the Building 4021 floor drains and Building 4022 vaults. This area is also the location of a radioactive liquid spill (A0070). Residual radioactive contamination is likely in this area.

- Under the electrical substation sump and drainage discharge point located on the western side of Building 4021. Although the sump and drainage was designed for stormwater, this water could contain airborne contamination and the discharge point may present an area where water can pool. Residual radioactive contamination could be present.

- Under the subsurface pipeline that connects the sump tanks in Building 4021 with the vaults in Building 4022 vaults with the sump tanks in Building 4021. This pipeline carried radioactive liquids. Leaks in the pipeline could have contributed to contamination and the pipeline itself could have provided a pathway for contaminant migration. Residual radioactive contamination is likely in this area.

- Filter/blower area between Building 4021 and Building 4022. This area contained the HEPA filter exhaust system, trenches to drain water from the area, and a below-grade pipeline to the RMHF northern slope. The trenches and pipeline may have also provided pathways for contaminant migration. Residual radioactive contamination is associated with some of these features and may be present in this area.

- Safety shower located on the north central side of Building 4021. The shower could have provided a drainage area for residual contamination.

- Pad and asphalt behind the decontamination room where a radiological incident (A0448) occurred and contaminated the area. Residual contamination may be present.

- Lower parking lot area where contaminated blocks were found according to a radiological incident report (A0680). The contamination was removed at the time of the incident, but residual contamination may still exist.

- Paved area from the former 5,000-gallon radioactive liquid waste storage tank (T-1) to a point 40 yards south and west of the tank and ranging between 2 and 10 feet where a spill of 40 to 50 gallons of contaminated water occurred according to a radiological incident report (A0070). Contamination from the incident was fixed in place and residual contamination may still exist.

- Possible stained area west of Building 4021 depicted in 1967 aerial photograph. If radioactive materials were spilled in this stained area, residual contamination may be present.

- Aboveground pipeline depicted in aerial photographs from 1967 through 1980 that extends from north end of Building 4021 to the northern perimeter of RMHF site. This pipeline could have leaked radioactively contaminated liquid onto the asphalt below. Residual radioactive material may be present on the ground below the pipeline.

- Area of dark-toned material west of Building 4021 identified in a 1980 aerial photograph. If radioactive materials were spilled in this dark-toned material, residual contamination may be present.

- Under the sewer lines located north and west of Building 4021. If radioactive materials were released into the sewer system, residual contamination may exist in the materials surrounding the sewer lines.

- Surface drainage areas around the Building 4021 area. Radiological incident A0080 noted that contaminated liquid flowed from Building 4021 to the RMHF 4614 Holdup Pond. Any releases of radioactive materials would have followed drainage pathways from the building and could leave residual contamination.

2.2 Building 4022 Area

Site Description: The Building 4022 area comprises Building 4022 and the land surrounding it at the northern terminus of 12th Street. Building 4022 was constructed in 1959 as part of the Radioactive Materials Disposal Facility (RMDF) site, now the Radioactive Materials Handling Facility (RMHF) site. It is the Vault Storage Building and is a Resource Conservation Recovery Act (RCRA)-permitted facility.[1,2,3] The perimeter of the RMHF is formed by a paved drainage channel to control runoff. The paved areas of the RMHF are sloped to carry water away from the buildings to the perimeter channel.[4,5] Figures 2.2a through 2.2x provide a recent photograph and the best available building-specific drawing(s) and photos that the research team could find.

[1] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-2.
[2] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[3] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 2.
[4] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[5] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.

Building 4022 was located east of Building 4021. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4022 has a steel-framed high bay that measures 70.5 feet long, 55.5 feet wide, and 48.5 feet high with sheet steel sides. The building measures 3,900 square feet and includes seven below-grade storage vaults. A 50-ton above grade bridge crane and a waste compactor were located in Building 4022.[1,2,3] The seven below-grade storage vaults were constructed with reinforced concrete and air-cooling systems. The vaults ranged in size, with a maximum depth of 20.5 feet. (See Table 2.1.) Vault walls were 30 inches thick. The vaults were used for the storage of mixed waste and low-level radioactive waste.[4,5,6,7]

Table 2.1
RMHF Vault Data

Vault	Length (feet)	Width (feet)	Depth (feet)	Volume (cubic feet)	Uses/Contents
1	25.0	15.5	11.5	4,450	Storage of Sodium Reactor Experiment (SRE) and Southwest Experimental Fast Oxide Reactor (SEFOR) fuel, Experimental Breeder Reactor –II (EBR-II) blanket subassembles, and repackaging of transuranic (TRU) waste.
2	25.0	17.5	12.5	5,450	Contains 8,000-gallon radioactive liquid waste holdup tank.
3	25.0	6.0	12.5	1,875	Former sodium melt drain system in support of SRE decommissioning, storage of plutonium in drums and SEFOR fuel.
4	25.0	7.0	20.0	3,500	Storage of processed and unprocessed SEFOR fuel and repackaging of Fermi fuel assemblies.
5	25.0	12.0	20.5	6.150	Storage of processed and unprocessed SEFOR, EBR, and Fermi fuels and high-level radioactive waste.
6	25.0	12.0	20.5	6,150	Storage of processed and unprocessed SEFOR, EBR, and Fermi fuels, high-level radioactive waste, and packaged TRU waste.
7	24.5	7.5	12.5	2,290	Received and unloaded incoming EBR-II fuel casks.

Sources: Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, pgs. 8-9.
Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, pgs. 32-34.

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1 The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-2.
2 Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
3 Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 2.
4 The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-2.
5 Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
6 Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
7 Daniel, Mann, Johnson & Mendenhall, *Calculations for R/A Waste & Fuel Storage Facility, Santa Susana, California, AEC Contract AT(11-1)-632*, August 1958.

By 1980, an 8,000-gallon radioactive liquid storage tank (UT-15) was located in Vault 2 of Building 4022 replacing the aboveground T-1 tank outside Building 4021 following overflow of the T-1 tank (See Building 4021 Radiological Incident Report). UT-15 was under static pressure and sits in a secondary open tank that provides space in the event of an overflow or catastrophic failure of the 8,000-gallon tank. UT-15, originally located in the Sodium Reactor Experiment (SRE), was connected to the Building 4021 treatment system via an aboveground pipeline. The pipeline was double-walled where it passed over the filter/blower area and into Vault 1. The pipeline entered Vault 1 and was routed to Vault 2 through a hole that was drilled between the two vaults.[1,2]

In addition to the 8,000-gallon radioactive liquid storage tank in Vault 2, two 5,000-gallon storage tanks were also located in the vault. According to discussions with Boeing personnel, these two tanks were secondary tanks brought up from the SRE to collect water, primarily rain water, during the RMHF Leach Field cleanup.[3] These tanks are illustrated in Figure 2.2p.
A 1977 drawing indicates a tank used to melt sodium out of piping units from the SRE was also located in Building 4022.[4]

Water that collected in the Building 4022 vaults flowed through vault-to-vault penetrations to a floor drain in Vault 6 and then to a 200-gallon radioactive liquid sump tank. The 200-gallon sump tank was located in a sump outside the southwest corner of Building 4022 (see Figure 2.2w).[5] This sump is a 3-foot diameter pre-cast reinforced concrete manhole pipe that extends approximately 28 feet below grade and sits on a 6-inch thick concrete slab. A submersible pump at the bottom of the sump is used to automatically pump accumulated radioactive liquids to the Building 4021 sump. A subsurface pipeline carried water from the 200-gallon radioactive liquid sump tank to the filter/blower area where it intersects with the Building 4021 drain line. Water from the Building 4022 vaults, as well as condensate from the high-efficiency particulate air (HEPA) filter system, was then conveyed to the Building 4021 decontamination room sump tank. An exit pipeline transferred the water and condensate to the Building 4021 packaging room sump tank where it was then pumped to the evaporator for treatment.[6,7,8]

The Building 4022 sump manhole cover was found to be a source of rainwater intrusion. Since the cover was sealed rainwater intrusion has been eliminated. The Building 4022 sump has had

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[1] Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Conversation with Paul Waite Regarding RHMF [sic] Site History*, February 23-24, 2009.
[2] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC),* June 2009, pgs. C.2-4, 2-11–2-12.
[3] Correspondence from Chell, M., MWH, to Waite, P., The Boeing Company, *Re: Questions for Paul Waite Regarding RHMF [sic] Site History (Discussion took place via email during March, 2009),* March 16, 2009.
[4] Rockwell International Drawing, *Santa Susana Facility B/022, NA Melt Electrical Heaters, Power & Control, 303-022-E8*, February 19, 1977.
[5] Sources differ on whether the sump tank located at the southwest corner of Building 4022 had a 50-gallon or 200-gallon capacity.
[6] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC),* June 2009, p. C.2-4.
[7] Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Conversation with Paul Waite Regarding RHMF [sic] Site History*, February 23, 2009.
[8] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, p. 11.

some groundwater intrusion; however, frequent inspections of the sump indicate that little or no groundwater is entering and the sump has not required pumping since the cover was sealed.[1,2]

The Building 4021 and 4022 radioactive liquid sump tanks were deactivated in 2004 and the Building 4022 liquid waste storage tank was removed in 2005. When the pump from the Building 4022 vault sump was removed, a gasket under the sump cover was installed and a silicone sealer was applied around the cover to minimize water infiltrating into the sump. The floor of Vault 6 is reportedly inspected weekly for moisture. According to a March 2009 discussion, the floor of Vault 6 has been dry ever since the sump cover was sealed. If water were to accumulate in the sump it would be pumped into a container for storage and eventual evaporation.[3]

A 500-gallon portable radioactive tank was stored in Building 4022. It was approved by the U.S. Department of Energy (DOE) for the onsite transport of radioactive liquids. The portable tank was used to transport material from Building 4059 and Building 4020. The tank was surveyed at each building location.[4] This tank appears to be the same or similar tank that a 2009 RCRA Facility Investigation report describes as being stored in the Building 4621 mixed waste storage yard.[5]

An historical review of underground tanks at the Santa Susana Field Laboratory (SSFL) described a 9,400-gallon steel tank for holding radioactive water. The tank was identified as UT-14 and associated with Buildings 4021 and 4022.[6] A 2008 work plan addendum associated the tank with Building 4022, but noted that the location of UT-14 could not be determined during historical document review.[7]

Building 4022 has its own exhaust and filtration systems to control airborne radiation. The ventilation for the above grade working area of Building 4022 is brought about by natural convection from the work floor to the vents on the roof. Air enters the building through louvers at grade level, or through open doors. The building has no windows. During fuel transfer operations, all of the doors are closed. The storage vaults are maintained at a negative pressure against the high bay areas and air flow within Building 4022 is arranged from areas of lower contamination to areas of higher contamination. Air flows into the vaults at a rate of 15,000 cubic feet per minute (cfm) total through two prefiltered inlets located below grade on the east

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[1] Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Conversation with Paul Waite Regarding RHMF [sic] Site History*, February 23-24, 2009.
[2] Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
[3] Chell, Meghann, *Questions for Paul Waite (Boeing) Regarding RHMF Site History*, MWH, March 16, 2009.
[4] Lavagnino, G., *ETEC Meeting and Site Visit*, U.S. Department of Energy, August 17, 1988.
[5] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1- Text, Tables and Figures and Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC)*, June 2009, pgs 3-8, C.2-4.
[6] *Historical Review of Underground Tanks, Area IV, No.: A4CM-AR-0005*, Unknown Corporate Author, August 10, 1994, P. 89.
[7] MWH, *RCRA Facility Investigation Work Plan Addendum Second Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, October 2008.

wall. The air circulation system provided temperature control and filtration for the Building 4022 vaults.[1, 2,3]

Air flow from the storage vaults is provided by two 11 brake horsepower (BPH) blowers with a capacity of 10,400 cfm each. An emergency 19-BHP blower with a capacity of 17,680 cfm was also available. In the event of a blower failure, an emergency diesel generator provides power for the emergency backup blower. Each blower, including the emergency backup blower, has a filter bank. Each filter bank has a set of 10 prefilters and 10 HEPA filters. After filtering, air from Building 4022 is combined in an exhaust plenum with air from Building 4021 and exhausted out the 3-foot diameter by 130-foot high stack connected to the western side of Building 4022. Exhaust air from the Building 4022 vaults is monitored for radioactivity in the stack.[4,5,6,7]
According to Boeing, the two large "fresh air inlets," located approximately 15-feet below grade and located on the eastern side of Building 4022, were used to provide a source of makeup air for the HEPA-filtered blowers servicing the subsurface vaults. The air was pulled through the vents by the blowers. Water collected in the inlets primarily during the wet winter months. Each inlet was equipped with a sump and sump pump to remove water that may enter the inlets. The water was discharged to the to the asphalt-covered ground surface on the east side of the building and allowed to flow on the surface of the RMHF complex, eventually draining to the RMHF 4614 Holdup Pond. In the event of a sump pump failure, water could have reached the vaults by the ducts connecting the subsurface vaults and blowers. According to Boeing, it was unlikely that water collected in the inlets could enter the vaults in the event of pump failure since the water would have had to reach over 2 feet deep to overcome the change in incline. According to Boeing, facility personnel do not recall, and there is no record of, water entering the vaults via the makeup air system. However, in the event that water entered into the vaults, it would be diverted to the radioactive water system through vault-to-vault wall penetrations leading to the Vault 6 floor drain and into the vault sump.[8,9]

The fenced area between Building 4021 and 4022 contains the blowers, filter banks, and compressors for both buildings as well as the shared exhaust stack and the diesel generator for

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[1] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, pgs. 53, 55.
[2] Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
[3] U.S. Department of Energy Environment, Safety and Health Office of Environmental Audit, *Environmental Survey Preliminary Report, DOE Activities at Santa Susana Field Laboratories, Ventura California*, February 1989, p. 3-13.
[4] Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
[5] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC),*June 2009, p. C.2-3.
[6] Daniel, Mann, Johnson & Mendenhall, *R/A Waste and Fuel Storage Floor Plans, 303-022-M2*, September 25, 1958.
[7] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 56.
[8] Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Conversation with Paul Waite Regarding RHMF [sic] Site History*, February 23-24, 2009.
[9] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, pgs. 53, 55.

the Building 4022 emergency backup blower. This area is often referred to as the filter/blower area. The filter/blower area also contained three utility trenches used to support the ventilation ducts. Each trench contained a floor drain to convey surface water away from the filter/blower area. The floor drains connected to a 4-inch below-grade pipeline that conveyed surface water to the RMHF northern slope, bypassing the RMHF catch basin.[1,2,3,4] See Figure 2.1y for photographs of the filter/blower area and the northern slope drainage discharge point.

A 1963 operating specification for the RMHF states that automatic air monitoring systems were installed in Buildings 4021 and 4022 to provide continuous air sampling of the decontamination and packaging rooms in Building 4021 and the vault areas below the floor of Building 4022. The systems were equipped with instrumentation having automatic detection, recording and alarm features. The alarm consisted of an audible signal bell and indicating lights. Equipment items of the system were located along the east wall in Room 100 of Building 4021 along the west wall in the high bay area of Building 4022.[5]

The 1963 RMHF operating specification also notes that an automatic continuous stack effluent monitoring system was installed to sample and detect any radioactive, gaseous, or particulate releases to the atmosphere. The system instrumentation consisted of a recorder, alarm buzzer and red light in Room 101 of Building 4021 and a pump and probe assembly along the west wall of Building 4022. Figure 2.2u shows a 1970 air sampling system that was used to monitor radioactivity in the stack. Any abnormally high radioactive release would cause a buzzer and red light to actuate and remain in the alarm position until actions to remedy the cause and reduce the count rate have been accomplished or until the alarm was manually deactivated.[6]

Former Use(s): The RMHF was a support facility to the Systems for Nuclear Auxiliary Power (SNAP) program, the SRE, and the Hallam Nuclear Power Facility. It was designed to handle the storage, volume reduction, packaging, and shipping of the SNAP and SRE radioactive waste.[7] Building 4022 was used for the dry storage of used and unused nuclear fuel. During the Energy Technology Engineering Center (ETEC) operations, the building vaults were used to store containerized wastes from decontamination and decommissioning activities.[8]

Storage of SRE Core I at Building 4022 began in 1959 and SRE Core II was stored beginning in 1964. Both cores were stored in 3.5-inch diameter by 166-inch long canisters with threaded

[1] Correspondence from Seward, F.A. to Nagel, W.E., *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
[2] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC),* June 2009, p. C.2-3.
[3] Daniel, Mann, Johnson & Mendenhall, *R/A Waste and Fuel Storage Floor Plans, 303-022-M2*, September 25, 1958.
[4] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 56.
[5] Operating Specification Radioactive Materials Disposal Unit, November 7, 1963, p. 3.
[6] Operating Specification Radioactive Materials Disposal Unit, November 7, 1963, p. 4.
[7] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385,* Rockwell International, September 15, 1982, p. 7.
[8] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-2.

closures. Core I fuel contained 2.8 percent uranium-235 (U-235). Core II had different assemblies with approximately 92-93 percent U-235 enrichment.[1]

A June 1985 data sheet form presents a chronology of fuel stored in the RMHF vault. This information is presented in Table 2.2 below.[2]

Table 2.2
Chronology of Fuel at RMHF Vault, 1976 through 1985

Fuel	Material Type	Quantity	Date of First Shipment	Date of Last Shipment
SRE	Europium (2.8 -12% isotope)	1,641,881 grams	*	07/23/79
	Europium (92-93% isotope)	154,952 grams	*	02/19/77
	Thorium	1,972,458 grams	*	02/19/1977
	Plutonium	610 grams	**	06/21/78
	Uranium	1,045 grams	*	02/19/77
Hallam	Europium (3.5 % isotope)	29,125,233 grams	02/08/77	08/27/79
	Plutonium	13,157 grams	02/08/77	08/27/79
Fermi	Europium (25 % isotope)	18,437 grams	07/16/79	Not provided
	Plutonium	23 grams	07/16/79	Not provided
EBR Mark III	Depleted Uranium	48 kilograms	08/06/80	10/24/80
	Plutonium	28,006 grams	08/06/80	10/24/80
SEFOR	Depleted Uranium	1,579 kilograms	05/16/82	09/16/83
	Plutonium	385,747 grams	05/16/82	09/16/83
EBR Blanket	Depleted Uranium	16,604 kilograms***	03/21/83	Not provided
	Plutonium	73,962 grams***	03/21/83	Not provided

* Quantity based on June 30, 1976 inventory.
**Quantity based on June 30, 1976 inventory plus plutonium generation booked on 8/27/76.
*** Quantity listed received as of 6/19/85

An Atomics International site waste management plan dated circa 1972 and an updated plan dated May 1974 provided information regarding the waste disposal activities at the SSFL. According to the waste management plan, which was prepared for the management of Atomic Energy Commission (AEC) contract wastes, AEC-owned waste management facilities, including treatment facilities and storage facilities, were located within the RMHF complex. These facilities included Building 4022. The waste management plan provided the following summary:

> "A small amount of high level waste resulting from hot cell operations is held in Building 022 along with irradiated scrap nuclear materials….High level materials in the form of irradiated reactor fuel elements and the high level waste resulting from dissection at the AI Hot Laboratory of irradiated fuel and reactor components are stored in the vaults in Building 022. These vaults which are located below grade in the Building 022 high-bay are constructed of magnetite concrete and are fitted with steel support racks to hold canisters containing fuel elements or other high-level waste. Access to the vaults is provided by stepped plugs which are removed by means of the building crane. The vault atmosphere is exhausted through HEPA filters and the facility stack.

[1] Correspondence from Remley, M.E., Atomics International Division of Rockwell International, to Page, R.G., U.S. Atomic Energy Commission, *Re: Physical Protection of Special Nuclear Materials Docket 70-25*, August 16, 1974.
[2] Unknown Author, Data Sheet, *Chronology of Fuel at RMDF*, June 19, 1985, BNA00972044.

> Effluent control systems are limited to HEPA filters in the radioactive exhaust systems of all facilities in which unencapsulated radioactive material is utilized. These systems consist of steel plena containing HEPA filters. . . The individual filters are tested by the Hanford Environmental Health Foundation, Richland, Washington, prior to their receipt at Atomics International. The filter plena with the filters installed are tested by Atomics International for DOP [dioctyl phthalates] penetration either annually or each time the filters are replaced." [1,2] [Note: According to a 1997 handbook on filters and filtration, DOP penetration is a common way to test the efficiency of air filters. Dioctyl phthalates are oily liquids with high boiling points. Their thermal stability made them a good chemical aerosol to use in testing, although pure corn oil is now used. A DOP penetration test examined how much of an aerosol could pass through the filter.[3]]

According to a 1986 Rockwell document, the ventilation and exhaust filtration systems for Buildings 4021 and 4022 were designed to control airborne contamination. These systems directed air from the outside of Building 4021 into the decontamination and packaging rooms and from the outside of Building 4022 into the vaults. Local air pressure was successively reduced at each area of higher potential contamination. According to the 1986 Rockwell document, the operating characteristics of the system are as follows:

- Direction of air flow from areas of lower potential contamination to areas of higher potential contamination are maintained at all times.

- All facility exhaust is directed through prefilters and HEPA filters and released through the facility stack.

- Filter replacement is performed when pressure differentials across the high-efficiency filters exceed nominally 3 inches of water, with an absolute maximum of 6 inches of water, or when radiation levels at the surface of a plenum exceed 150 milliroentgens per hour (mR/h) or the flow rate is insufficient to provide proper air changes and movement. Pressure differentials across the exhaust system filters is monitored and recorded by personnel monthly.[4] Filtration efficiency of the HEPA filters is measured promptly after a change or once a year, whichever is more frequent.

- A minimum of six air changes per hour is provided in all areas posted for airborne contamination.

- Flow rates into the vaults, when any opening is made, can be maintained at nominal values by manual adjustment of dampers.

- When the potential for release of contamination exists, air flow to the areas of potentially greatest contamination is verified.[5]

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[1] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.
[2] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.
[3] Dickenson, T.C, 1997. *Filters and Filtration Handbook*. Elsevier Advanced Technology, New York.
[4] The research team is not in possession of these monthly records.
[5] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, pgs. 51, 53.

According to the 1986 Rockwell document, the most recent filter test and velocity measurements performed in April 1986 indicated that the filtration system was at least 99.0 percent efficient for particles of size 0.8 microns and larger, and the flow rate out the stack is 21,933 cfm.[1]

According to a 1989 U.S. Environmental Protection Agency (EPA) report, the air emissions from Buildings 4021 and 4022 consisted primarily of surface radioactive particles resulting from decontamination processing, packaging activities in Building 4021, and from storage and handling activities in Building 4022. This particulate matter contained uranium, plutonium; cesium-137 (Cs-137), strontium-90 (Sr-90), krytom-85 (Kr-85) and promethium-147 (Pm-147) as mixed fission products; and cobalt-60 (Co-60) and europium-152 (Eu-152) as activation products. The particulate matter in air was controlled through filtration by HEPA filters. The ambient air within Area IV was monitored daily by continuous collection of air particulate samples using a network of eight air samplers. The samples were counted for alpha and beta radiation following a 120 hour delay to allow for radon and thorium decay. DOE monitors the stacks serving Buildings 4021 and 4022. According to a DOE survey report in 1987, 99 percent of the ambient air alpha measurements and 64 percent of the beta measurements were below the method limit of detection at the time. The DOE survey report indicates that emissions from RMHF Buildings 4021 and 4022 were higher than the equivalent ambient air emissions shown in the Rockwell annual monitoring report data for 1981 through 1987. In 1987, the total radioactive emissions released from Buildings 4021 and 4022 was less than 1 percent (0.7 percent alpha, 0.17 percent beta) of the appropriate DOE guidelines according to the DOE survey report.[2]

According to a 1990 Rockwell air emissions report, all release points at SSFL facilities with significant potential for discharge of radioactive material are controlled, by the use of HEPA filter systems, to maintain public doses far below 0.1 millirems per year (mrem/yr). Sampling was performed to permit measurement of the releases, and these measurements were used to estimate hypothetical offsite doses. Radioactive atmospheric effluents from DOE facilities were limited to a continuously operated exhaust system at the RMHF and an intermittent exhaust system at Building 4059. According to Rockwell, "minor" locations of soil contamination, including the RMHF 4614 Holdup Pond and RMHF north slope, were also monitored for airborne radioactivity. According to Rockwell, no airborne radioactivity was detected in these two locations and, therefore, they were not included in the estimate of airborne exposure. Operations at the RMHF that generate airborne radioactivity included decontamination of equipment, repackaging of radioactive waste, evaporation of radioactively contaminated water, and packaging of the resultant residue. These operations were performed inside a building, with workplace air sampling, equipped with a ventilation system that exhausted to the atmosphere through a HEPA filter system. The filters were certified for efficiency prior to installation and the system was tested after filter replacement, or at least annually. According to Rockwell, the RMHF pre-filters were noted to be 99.98 percent efficient while the HEPA filters were noted to be 99.99 percent efficient. Annual quantities of radioactive contaminates at the RMHF in 1990 are provided in the table below. The

[1] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 58.
[2] U.S. Environmental Protection Agency, Santa Susana Field Laboratory Site Report, Ventura County, California, Report for Congressman Elton Gallegly, July 31, 1989, p. 33.

1990 Rockwell report notes that the estimated dose to the nearest resident in 1990 is less than 1.2 x 10^{-6} millirems (mrem), which is below the 10 mrem standard established by 40 CFR 61.[1]

1990 Air Emissions from RMHF

Radionuclide	Quantity (Ci)
Americium-241 (Am-241)	1.0 x 10^{-10}
Cesium-137 (Cs-137)	3.3 x 10^{-7}
Cobalt-60 (Co-60)	4.9 x 10^{-7}
Tritium (H-3)	1.6 x 10^{-6}
Plutonium-239 (Pu-239)	2.5 x 10^{-9}
Strontium-90 (Sr-90)	2.9 x 10^{-8}

According to a 1991 DOE Tiger Team finding, although the radionuclide emissions from the Building 4021/4022 stack was considered to be very low, emissions from the stack had not undergone formal evaluation in accordance with established National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations. Because of this, stack monitoring according to NESHAP regulations was required. Although the samplers at the RMHF had the required continuous radiation monitors to detect sudden increases in radiation during accident situations, deficiencies in the radionuclide particulate sampling systems, which have been in use since 1970, prevented the samplers from meeting established NESHAP requirements. Examples of the noted stack sampling deficiencies included: suitability of sampling locations, number of sampling points, and sampler design. The samplers at the RMHF were not originally designed to monitor the large range of particulates, which could be present as a result of HEPA filter problems, deposition inside the stack, or corrosion buildup in the stack. Because of the design flaws, the radioactive particulate emission release rates that were supplied for modeling purposes by Rockwell were determined from air filter samples, which were collected in a manner that may not be representative of actual emissions. The Tiger Team observed that the changing and handling of the filter samples revealed that loss of particulate matter may occur and thus air emission modeling may not be accurate.[2]

A March 1993 surveillance and maintenance program plan for SSFL surplus facilities provides the following minimum requirements for surveying the RMHF.[3]

[1] Correspondence from Rutherford, P.D., Rockwell International, to LeChevalier, R.R., U.S. Department of Energy, *Re: Final NESHAPs Report for 1990*, May 28, 1991.

[2] U.S. Department of Energy, *Tiger Team Assessment Energy Technology Engineering Center, DOE/EH-0175*, April 1991, pgs. 3-12–3-15.

[3] Richards, C.D. et. al,, Rockwell International Document No. ER-AN-0001, *Surveillance and Maintenance Program Plan for SSFL Surplus Facilities*, March 1993.

RMHF Radiation and Contamination Surveys Minimum Requirements

Area	Meter Surveys	Smear Surveys	When Conditions Change
Perimeter Fence	Quarterly		X
Building Walls	Quarterly		X
Storage Yard	Quarterly		X
Package Room	Monthly	Monthly	Spot Checks
Vault (4022)	Monthly	Monthly	X
Decon Room (4021)	Monthly	Monthly	Spot Checks
Building 4034	Quarterly	Monthly	X
Building 4044	Quarterly	Monthly	X
Building 4621	Quarterly	Monthly	X
Building 4075	Quarterly	Monthly	X
Building 4665		Quarterly	
Laundry and Change Rooms	Monthly	Monthly	Spot Checks
Clean Trash	Before disposed of		
Pond Perimeter	Quarterly		
Air Samples 4021 and 4022	Changed and Counted Weekly		
Stack Sample	Changed and Counted Weekly		
Pond Water Sample	Taken monthly or every time it rains. More often when having heavy rains		
Filter Plenums	Differential Pressure Logged Monthly		

A November 14-15, 2001 compliance inspection by the California Department of Toxic Substances Control (DTSC) found that there was no activity in Vault 1 at the time of inspection, but a primary containment tent (PCT) was located in the vault. The PCT was a negative-pressure containment system equipped with dual HEPA-filtered air exhaust. It was built to provide primary containment and HEPA filtration for activities involving packaging, decontamination and sampling of the mixed transuranic waste. According to a Boeing employee, Vault 1 was last active on October 31, 2001. Vault 2 housed the 8,000-gallon radioactive liquid storage tank. The inspection notes this vault was not included in the Part A mixed waste storage permit application as a storage area. The waste analysis for the tank showed the presence of tetrachloroethene along with other halogenated solvents. The source of the tetrachloroethene could not be determined. Vault 3 was empty at the time of inspection. Vault 4 housed a 3,000-gallon cylindrical container with a small amount of mercury contaminated sludge from the decontamination and demolition of the Hot Lab. This sludge had been stored since September 9, 1994 under Site Treatment Plan (STP) No. ETW021. Vault 5 was empty. Vault 6 was divided into two areas. A total of 40 drums were stored in the vault and they appeared to be in good condition. Vault 7 housed Box B-1157 containing weirs from a water storage tank. This waste had been stored since August 24, 1993 under STP No. ETW021.[1]

Information from Interviewee(s): A number of former employees were interviewed about their experience at the SSFL. Eight remembered the RMHF. Excerpts from their interviews are included below.

Interviewee 254 worked at the Santa Susana Field Laboratory from 1957 to 1989 and became the Engineer in Charge at the RMDF, now known as the RMHF. The following excerpts were pulled from the interview.

[1] Eissa, E., *Compliance Evaluation Inspection Report, November 14-15, 2001*, Department of Toxic Substances Control, February 15, 2002.

> *"When I worked at the RMDF, everything that came in there was already packaged. Depending on exactly how it was packaged and what level of radiological contamination it had, we either had to repackage it, clean it further, or just complete the final necessary paperwork. Some waste at the RMDF came from DeSoto, but most of it was from SSFL. The level of radioactivity also dictated where the material was stored at the facility. There were different areas specified for each level of radioactivity. Highly radioactive fuel that came to the RMDF was stored in the RMDF Vault. The vault contained cells designed to hold fuel elements. A 50-ton crane would lower a cask that contained four or five fuel elements onto the vault floor. Another manipulator would then transfer one fuel rod and place it in one vault cell that was then topped with a plug. The cask would move to the next vault cell and lower the next fuel element in so that each fuel element was stored in its own cell. The RMDF stored waste, but it also stored items that were waiting examination in the Hot Cell. So some material was stored at RMDF until it could be examined at the Hot Lab, and then when it was done at the Hot Lab it would come back to the RMDF and await final offsite disposal.*
>
> *We also stored a lot of radioactive tools and equipment at the RMDF that had been used at other facilities."* [1]

Interviewee 290 worked for Atomics International for 35 years in a variety of positions as a forklift driver, shift leader, and operations engineer. The following excerpts were pulled from the interview.

> *"All my work was sodium non-nuclear, with no responsibilities relating to radiological materials or waste. I wore a film badge during my time as a forklift operator, such as when entering the RMDF. I hauled spent fuel rods from the SRE to there, as well as other radiological materials. I was aware of the SRE meltdown but had no experience with it, beyond hauling out the fuel rods.*
>
> *I was aware of no significant releases, and I never had a daily burn out from radiation exposure."* [2]

Interviewee 277 started working at SSFL in May 1975 as a technician in Building 006 for Atomic International's Sodium & Component Technology Group. The interviewee was transferred 2 to 3 years later to work at the RMHF. The following excerpts were pulled from the interview.

> *"After working for 2 or 3 years at Building 006, I was transferred to RST's department at the radioactive materials disposal facility (RMDF). We would receive casks with radioactive fuel rods inside, open them and put the fuel rod bundles into baskets and number them. Some of them were 30 feet long. The fuel rods came from places like Hallam and Savannah River. The Tri-State truck drivers would not leave their trucks until the cask was off the truck and placed in the vault. The fuel rods in the canisters were stored at the radioactive materials handling facility (RMHF) until they had cells ready at the Hot Lab (Building 020) to unclad the sodium from the fuel rods. They would open up the bundles at Building 020. We would lower the baskets into the floor vaults at the RMHF.*

[1] Interview No. 254 conducted by DOE and EPA on July 20, 2010.
[2] Interview No. 290 conducted by DOE in 2010.

> *Note that at the Hot Cell Building 020 would always clean up the cells used in each project and then paint the cells in order to keep the rad contamination down in each cell for the next project."* [1]

Interviewee 255 worked for Atomics International from 1967 to 1985 as an atomic inspector and certified x-ray technician. The following excerpts were pulled from the interview.

> *"Building 4022 was used to store radioactive material. It had a storage facility in the floor and you would take the cap off and put a fuel rod down there. They monitored that pretty close. I don't know how much fuel was stored in the building, because I only went to the building to magniflux the hooks on the cranes. I don't know anything about 4022 other than it had a fuel rod storage area. I don't know exactly what Building 4021 contained, but I suspect it had some radioactive material also.*
>
> *Building 4021 and 4022 had outside drainage systems, most likely for handling rainwater. They did not expect the water to have radioactivity, but they monitored those systems just in case."* [2]

Interviewee 195 started working at Santa Susana in 1968 at a variety of buildings. The following excerpts were pulled from the interview.

> *"Over at the RMDF, I loaded the tubes or cylinders. There were procedures and they were pretty well followed. By that time they had gotten their act together.*
>
> *We would turn the film badges in—they were mandatory to wear at the RMDF—but I don't remember how often they collected them and gave you a new one. I would leave mine on the shelf next to the door when I left the RMDF and pick it up at the same place the next day. Sometimes you wore a film badge and sometimes you also wore a dosimeter."* [3]

Transferring to Atomics International from Rocketdyne in 1974 after working on the Apollo program, Interviewee 135 was a value engineer. The following excerpt was pulled from the interview.

> *"Fuel rod storage was at the Radioactive Materials Disposal Facility. One of the buildings was used for storage of radioactive materials, maybe it was Building 59."*[4,5]

Employed by Atomics International from 1958 to 1990 to repair equipment and eventually become Manager of Remote Designs, Interviewee 18 had the following to say during the interview process.

---

[1] Interview No. 277 conducted by DOE in 2010.
[2] Interview No. 255 conducted by DOE and EPA on July 9, 2010.
[3] Interview No. 195 conducted by DOE in 2010.
[4] The RMHF building that stored fuel rods was Building 4022. Building 4059 housed the Systems for Nuclear Auxiliary Power (SNAP) 8 Development Reactor.
[5] Interview No. 135 conducted by DOE in 2010.

> *"All waste, as I remember, was stored in casks and went to Building 22 and later was shipped to Savannah for reuse. I recall CEF was an engineer that oversaw the shipping of the radiological waste to Savannah in the latter years."* [1]

Interviewee 3 was an Atomics International employee from 1963 to 1999. The interviewee started as a fork lift operator and was promoted to be in charge of five test facilities. The following excerpts were pulled from the interview.

> *"I transported waste material in 'pigs' [shielded lead containers] to Building 64, and sometimes to Buildings 21 and 22. I think an outside contractor took the waste from there to Beatty, NV. I am not sure what was ultimately done with the waste, I was just asked to move it.*
>
> *Buildings 20, 21, 22, 24, 25, 19, 59, 9, and 100 were all hot buildings.*
>
> *Those guys in Buildings 20, 21, and 22 had all the hot stuff. If anyone was going to get any exposure those buildings are where it was going to happen. I know one guy that died, I don't know if it was from cancer from working at the site, but he used to work in Building 21 and 22."*[2]

Radiological Incident Reports: There have been several incidents associated with Building 4022 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing. Summaries of only the incident reports that resulted or may have resulted in releases to the environment are provided following the table, when available. Summaries of all available incident reports are provided in Attachment A.

Building 4022 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0588	12/29/1965	RMDF Yard		Drums Of Contaminated Sodium Exploded In Rain Storm And Burned.
A0631	5/9/1969	RMDF Vault Pit		Employee Fell 12 Feet To Bottom Of Sump Pit.
A0589	5/19/1977	RMDF High Bay		SRE Piping Caught Fire In The Sodium Melt Vessel At RMDF.
A0078	4/5/1979	High Bay	Mixed Fission Product	Recovery Of Jammed Fuel Element Can In Hallam Transfer Cask.
A0314	8/14/1979	Gate to T022	Sr/Cs	Waste Truck Load Leaked R/A Liquid.
A0239	10/29/1979	Substation 783		R/A Exhaust Lost When Raccoon Shorted Out Substation and Generator Failed.
A0086	5/28/1981	High Bay	MFP	High Level R/A Liquid Ran Out of NAC Cask Onto Floor Blocks

[1] Interview No. 18 conducted by DOE in 2010.
[2] Interview No. 3 conducted by EPA on March 16, 2010.

Building 4022 Incident Report Summary (concluded)

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0567	7/23/1981	RMDF High Bay		HP Contaminated Finger While Smearing "Clean" Tools.
A0259	11/24/1981	Vault 7 Waste	Mixed Fission Product	Absorbed High Level NAC Waste Open To Atmosphere.
A0326	6/30/1982	High Bay		RAS Alarm Response Inappropriately Cancelled Because Of Known Cause.
A0115	3/24/1983	High Bay	Mixed Fission Product	RAS Alarm Caused By High Radiation During Fuel Transfer.
A0116	3/30/1983	High Bay		Response To RAS Alarm.
A0158	6/11/1986	High Bay	Mixed Fission Product	Off Scale Dosimeter During BMI Cask Work.
A0159	6/13/1986	High Bay	Mixed Fission Product	Employee Placed Unprotected Hand On Contaminated Cask.
A0161	6/25/1986	High Bay	Mixed Fission Product	Employee Contaminated Shoe During Decon Of NAC Cask.
A0166/A0167	12/22/1986	High Bay	Cs/Co	R/A Water Sprayed Employee During Fuel Cask Unloading.
	12/22/1986	High Bay		R/A Water Drained From Transfer Cask Contaminating Employee And Floor.
A0168	1/6/1987	High Bay		Employees Shoes Were Found To Be Contaminated.
A0171	1/7/1987	High Bay	Mixed Fission Product	Employee Contaminated During Routine Survey Of Tools And Equipment.
A0170	1/15/1987	All RMDF		Review of R/A Incident at RMDF.
A0172	1/16/1987	High Bay		Employee Restricted From R/A Area Observed Working In A Controlled Area.
A0209	10/2/1990	Decon Rm 021	Mixed Fission Product	Employees Became Contaminated While Unloading R/A Cable For Decon.
A0672	2/21/1997	High Bay Door Tent		Fixed R/A Contamination On Left Wrist And Personal Pants.
A0674	3/25/1997	High Bay		Discreet Particle On Employee's Right Shoe

- A health physics logbook entry for the RMHF dated December 29, 1965 describes several loud explosions thought to be sonic booms by personnel in the RMHF Office Building 4034. The explosions turned out to be coming from a sodium drum in a shipment of radioactive waste awaiting pickup. An emergency team of three firemen responded first followed by the health physics emergency team. Smoke from the fire was reported to blow away from the RMHF into an unpopulated area. The logbook entry notes that weather conditions at the time (high winds and heavy rain) made normal operating procedures, including air sampling and smearing difficult. An exclusion zone was established and equipment and personnel were monitored prior to leaving the area. One fireman's uniform was found to have contamination at 90 disintegrations per minute (dpm). All other uniforms were at background, below 0.1 millirad per hour (mrad/hr) and 30 dpm. A water sample taken from rain runoff indicated 1 x 10^{-5} microcuries per cubic centimeter (μc/cc also μCi/cc).[1] A handwritten note obtained from Boeing indicates that on December 29, 1965, drums of contaminated sodium exploded in a rain storm and "burned." The note indicated there was a fire, liquid spill, outside contamination, and airborne release to the environment. A formal incident report for this incident could not be located in available documents (A0588).[2]

- On May 19, 1977, the "Sodium Melt Vessel lid" was removed in preparation for removing the SRE piping from the vessel. Approximately 20 minutes following the removal of the lid, it was reported that smoke was detected coming from the vessel. An employee took the dry chemicals fire extinguisher and unloaded it into the vessel and the employees present evacuated the building. Two employees wearing self-contained breathing apparatus equipment entered the building to put the lid back on the melt vessel to extinguish the fire. Air samples were reported to have resulted in an immediate count of 2.3×10^{-10} μCi/cc and a 1-hour delay count of 2.0×10^{-10} μCi/cc. Nasal smears of the employees present during the incident were reported to have been negative. Following the incident, the vault area was damp mopped and allowed to dry. The incident report indicated the cause of the fire to have been either excess alcohol or deficient argon gas purge. It was also indicated that the RMDF air stack sampled was removed and analyzed and found to be "negative." On May 20, 1977, 130 smears taken in the vault area indicated four smears with a maximum count of 75 dpm. These areas were reported to have been cleaned and the building was released. The incident report did not indicate the background levels of the building (A0589).[3]

- On August 14, 1979, an outside vendor, Heavy Transport, Inc., truck-trailer was loaded with approximately 44,000 pounds of low-level radioactive waste destined for Beatty, Nevada, for burial. The shipment contained six 8-foot long boxes with the remainder of the waste in 55-gallon drums. The truck-trailer was moved outside the immediate RMHF facility area to a low-background area for a final U.S. Department of Transportation radiation survey. The trailer was parked on the left side of the facility access road and was tilted slight toward the outside edge of the roadway. Soon after moving the vehicle, liquid was observed dripping from the trailer to the asphalt apron. A shipping box leaked approximately 1 pint of radioactive liquid containing cesium-137 (Cs-137) and strontium-90 (Sr-90) on the asphalt outside the RMHF and on the trailer. An immediate survey found readings of about 85 mrad/hr on the asphalt and 125 mrad/hr on the trailer. According to the incident report, "protective measures were taken to contain and control the area and liquid escaping from that location." This included the placement of a bucket to catch what was suspected to be alcohol and a rope barrier was established to control access to the spill area.

  Alcohol splattered onto a rear tire and a mud flange, which were covered by personnel using green tape. The truck and trailer were moved back into the controlled area to unload the leaking shipping box. The incident report indicated that plastic was used to catch additional leakage and to cover the road to protect uncontaminated tires. One

[1] Lane, W., *H.P Log RMDF, A0588*, December 29, 1965.
[2] Unknown Author, *Handwritten Note: 588, 12-29-65, RMDF Yard*, Unknown Date.
[3] Bradbury, S.M., Rockwell International Internal Letter, *Subject: Fire in the Sodium Melt Vessel in Building 022*, May 23, 1977.

employee contaminated a white lab coat to about 700 counts per minute (cpm), which resulted in the lab coat being placed in a radioactive waste receptacle for disposal.

Upon removal of the shipping containers, it was determined that alcohol dripped through the wooden floor and contaminated part of the undercarriage of the trailer. Personnel were assigned to clean this radioactive material, which took approximately 3 days to reduce all detectable activity to 200 cpm or less. This included the installation of new wooden slats and the painting of all bare metal surfaces as necessary. The incident report did not indicate how the asphalt apron along the RMHF access road was decontaminated (A0314).[1]

- On October 29, 1979, alarms went off at 1:20 a.m. indicating electrical power failure at a number of Santa Susana facilities, including Building 4022. The power was off at Building 4022 and the emergency generator at the building was not operating. Electricians were called in from home to reestablish power and fix the emergency generator, which had to be shut down and restarted. Maintenance electricians found that two raccoons had entered the Southern California Edison substation and shorted out two fuses there cutting power (A0239).

- On May 28, 1981, in the Building 4022 high bay, personnel were rotating "the N.A.C. cask" 180 degrees on the longitudinal axis from the normal transport position. The cask was then lowered to the horizontal position. This was to allow the opening of a drain plug that normally faced down in transport. The incident report indicated that as the cask approached horizontal, liquid ran out the top vent line hole and the cover port located "135 degrees below top dead center." The liquid was reported to have run down the cask support member to the belly pan and through holes in the corrugated metal pan to the uncovered vault floor blocks. Personnel spread absorbent towels over the spill and placed a bucket under the belly pan to catch the liquid draining from the belly pan. The cask was elevated to stop the flow of liquid.

  The contents of the tank were reported to have been approximately 1 year old mixed fission products from a failed "PWR" power reactor fuel element that was suspended in liquid. The dose rate from the major accumulation of liquid in the bucket used to catch the liquid was 25 rads per hour (rad/hr) beta gamma at 4 inches above the bucket. One spot on the floor indicated 25 rad/h with 17 roentgens per hour (R/hr) at 2 inches. It was estimated that 50 gallons of liquid were located in the cask. The incident report did not indicate what volume spilled.

  The available incident report indicated that additional summaries were provided on the back; however, the research team only received one page of the incident report. As a result, information regarding the contamination and cleanup of the incident cannot be summarized (A086).[2]

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[1] Owens, D.E., Rockwell International Internal Correspondence, *Re: Radiological Safety Incident Report, RMDF, August 14, 1979, A0314*, August 20, 1979.
[2] Badger, F.H., Rockwell International Internal Letter, *Subject: Radiological Safety Incident Report, T022 – High Bay, May 28, 1981*, June 9, 1981.

- A 1985 second quarter radiation safety review for RMHF Building 4022 indicated that fixed-location dosimeters were placed at eight locations around the RMHF perimeter fence. Results from the initial monitoring period showed a maximum exposure of 810 mrem at the northwest perimeter fence. This result is above the annual limit of 500 mrem/yr for radiation exposure in uncontrolled areas.[1]

- A 1986 first quarter radiation safety review for the RMHF again showed a high exposure (1,140 mrem) at the northwest perimeter fence. It was noted that the possibility of exposure to any member of the general public was unlikely due to the terrain north of the RMHF fence line and the continuous remote surveillance of the area.[2]

Current Use: Building 4022 is still standing. As of July 27, 2011, Boeing notes that there is no storage of radioactive waste in Building 4022. However, the underground vaults of Building 4022 have low levels of contamination and the HEPA ventilation ducting between Building 4021 and Building 4022 is highly contaminated.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s):

- **1988 DOE Environmental Survey**. A June 30, 1988 DOE status report states that although improvement had been made to reduce radiation exposure rates, because of changing operations involving radioactive materials handling at the RMHF, exposure rates may exceed the DOE guideline of 100 mrem/yr for continuous exposure at the property boundary north of the RMHF. This guideline was intended to prevent members of the public from unknowingly receiving excessive exposure as a result of DOE operations. According to the report, long-term exposure to a member of the public was unlikely due to the rugged terrain along the north boundary and daily security patrols.[3]

- **1991 Monthly Radiation Surveys**. Project progress reports located for February, March, and August 1991 note that monthly radiation meter surveys and smear surveys of the RMHF vault found nothing unusual and no corrective actions were required.[4,5,6]

  Additionally, a 1991 Rockwell report notes that radiological conditions in the RMHF were determined by periodic surveys, which are summarized for the first quarter of 1991 in the report. Results are shown in the table below.[7]

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[1] Internal Correspondence from Moore, J.D. to Remley, M.E., Rockwell International, *Re: Quarterly Review of the RMDF (T022) for Radiation Safety, Second Calendar Quarter, 1985*, September 18, 1985.
[2] Internal Correspondence from Moore, J.D. to Remley, M.E., Rockwell International, *Re: Quarterly Review of the RMDF for Radiation Safety, First Calendar Quarter, 1986,* June 23, 1986.
[3] Weiner, L.A. and Barisas, S., *Status Report of the DOE Activities at the Santa Susana Field Laboratories Site Environmental Survey*, U.S. Department of Energy, June 30, 1988, p. 10.
[4] Gaylord, G., *Energy Technology Engineering Center Project Progress Report Accounting Period for February 1991, Attachment I-3*, Engineering Technology Engineering Center, February 1991, p. 2.
[5] Gaylord, G., *Energy Technology Engineering Center Project Progress Report Accounting Period for March 1991, Attachment I-3*, Engineering Technology Engineering Center, March 1991, p. 2.
[6] Gaylord, G., *Energy Technology Engineering Center Project Progress Report Accounting Period for August 1991, Attachment I-3*, Engineering Technology Engineering Center, August 1991, p. 2.
[7] Internal Correspondence from Barnes, J. to Rutherford, P., Rockwell International, *Re: First Quarter, 1991 ALARA Report*, August 8, 1991.

RMHF Removable Contamination Levels for First Quarter, 1991

Location	Posting Status	Limits (dpm/100 cm^2) beta-gamma	Lowest Measured Level (dpm/100 cm^2) beta-gamma	Highest Measured Level (dpm/100 cm^2) beta-gamma
Building 4021 (Laundry, Change Room, Decontamination Room, Packaging Room)	Open	< 1,000	< 50	651*
	Contaminated Area	< 1,000	< 50	3,138**
Building 4022 Vault Storage	Open	< 1,000	< 50	5,000***
Building 4034 Offices	Open	< 1,000	< 50	< 50
Building 4044 Break Area	Open	< 1,000	< 50	< 50
Building 4075 Storage Area	Open	< 1,000	< 50	< 50
Building 4621 Storage Area	Open	< 1,000	< 50	< 50

* Alpha contamination of 33 dpm/100 cm^2 was found on the sink top in the change rom. The contamination was removed and subsequent surveyed showed levels to be < 20 dpm/100cm^2.
** Isolated instances of low-level (22 – 37 dpm/100 cm^2) alpha contamination were found on several occasions.
*** This measurement came from aluminum sheeting awaiting packing that was discovered during a routine smear survey. The sheet was sectioned and discarded as radioactive waste. No violation of U.S. Department of Energy regulations occurred.

- **2006 Vault Decontamination**. In 2006, the seven below ground vaults and the inlet and outlet ventilation tunnels of Building 4022 were decontaminated to levels "appropriate for removal and disposal as low-level radioactive waste." The table below summarizes the remaining contamination in the vaults.[1]

Total Beta Contamination in the 4022 Below-Ground Vaults

Vault No.	Direct Reading Minimum Beta (dpm/100 cm^2)	Direct Reading Maximum Beta (dpm/100 cm^2)	Estimated Direct Reading Median Beta (dpm/100 cm^2)
1	< 4,170	50,000	16,667
2	< 4,170	62,500	4,170
3	< 4,170	1,666,667	416,667
4	< 4,170	833,333	62,500
5	< 4,170	333,333	25,000
6	< 4,170	1,500,000	83,333
7	< 4,170	1,458,333	125,000
Inlet Tunnel	< 4,170	750,000	< 4,170
Exhaust Tunnel	< 4,170	1,500,000	125,000

dpm/100 cm^2 – disintegrations per minute per 100 square centimeters

- **2007 Boeing Radiological Surveys**. In 2007, Boeing performed radiological surveys on Buildings within the RMHF complex, including Building 4022. The original survey for

[1] The Boeing Company, Radioactive Materials Handling Facility Current Radiological Status, March 16, 2007.

Building 4022 called for multiple survey units, but because of relatively high levels of radiation (up to 140 microroentgens per hour (μR/hr)) primarily on the west side of the building and likely due to radiation levels from Building 4021, Boeing decided that the building could not be satisfactorily surveyed as originally proposed. The full survey scope was reduced to a single unit on the east wall and limited sampling outside the survey unit. This data was used as the basis for recommendations regarding appropriate radiological controls for demolition of the building. Measurements of fixed and removable surface residual radioactivity on the east wall of Building 4022 are described in the table below and are below acceptable levels. The presence of residual radioactivity on the roof of Building 4022 was expected based on data from other RMHF buildings. Boeing recommended a radiological survey of the building roof and exhaust stack be performed prior to dismantlement and demolition of Building 4022 to determine the need for localized radiological controls. Boeing did not recommend any additional radiological controls beyond those routinely applied in an active radiologically controlled area.[1]

Measured Surface Residual Radioactivity 2007 on Building 4022 East Wall

Description	Average (dpm/100 cm^2)		Maximum (dpm/100 cm^2)		Removable (dpm/100 cm^2)		
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Tritium
DOE and NRC Allowable Limits*	100	5,000	300	15,000	20	1,000	10,000
Building 4022 East Wall Measured Values	45	1,109	101	3,850	6	93	2

dpm - disintegrations per minute per 100 square centimeters
*Most limiting value from U.S. Department of Energy (DOE) Order 5400.5 (1990) and U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86 (1974)

Radiological Use Authorizations: At various times, the following use authorizations were assigned to the RMHF complex:

- Use Authorization No. 33 was initially issued on March 17, 1971 and allowed for the use and storage of 5 millicuries (mCi) and 25 μCi cobalt-60 (Co-60) sealed sources and 40 mCi cesium-137 (Cs-137) sealed sources at 22 locations at the SSFL. The sealed sources were used for the calibration of fixed and portable radiological alarm systems at SSFL facilities, including the RMHF. The sealed sources were stored in Building 4621.[2,3,4]

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[1] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys*, October 2007, pgs. 17, 31, 40, Appendix A.
[2] *Radioactive Material Authorizations*, Rockwell International, BNA02647573.
[3] Isotope Committee Chairman, *Authorization for Use of Radioactive Materials or Radiation Producing Device*, Authorization Nos. 33E-33H, 33J, 33L-33O, 33S, April 16, 1976 through March 26, 1990.
[4] Internal Correspondence from Barnes, J.G. to Logan, A.B., Rockwell International, Re: Notification for Renewal of Authorization for Use of Radioactive Materials or Radiation Producing Devices – Second Notice, March 3, 1994.

- Use Authorization 106 pertained to radioactive waste and contaminated materials generated at other authorized facilities. Use Authorization 106M, issued February 12, 1992, noted that operation of the RMHF included a) receiving, processing, packaging, and shipping radioactive wastes and materials generated by Rocketdyne activities, b) receiving, processing, packaging, and shipping radioactive laundry, c) receiving and processing liquid radioactive wastes, d) storing radioactive materials, and e) maintaining facilities equipment and materiel. Buildings 4021, 4022, 4044, 4075, and 4621 were listed as authorized use locations with the authorized users based out of Building 4034.[1]

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: Building 4022 is first identified in a 1959 aerial photograph as part of the RMHF area. The area was active from 1959 through 2005. A smokestack and/or overhead pipeline are identified between Building 4021 and 4022 during the entire active period. In 1965, Buildings 4044 and 4688 appear east of Building 4022. In 1980, crates are identified in an area north of Building 4022 and an aboveground pipeline is identified east of Building 4022, along the east sides of Buildings 4044 and 4688. In 1988, dark-toned material is identified near the northeast corner of Building 4022. In 2005, earth moving activity is noted in a large area along the northern perimeter of the entire RMHF site.[2]

Radionuclides of Concern: Radioactive materials handled in Building 4022 were primarily in the form of items containing mixed fission products and fuels.[3] Radionuclides potentially present at the RMHF include: uranium fuel materials (U-234, U-235, U-238), transuranic isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242) and americium-241 (Am-241), fission products Cs-137 and Sr-90, thorium breeder material (Th-228, Th-232), and possible neutron activation products such as cobalt-60 (Co-60), europium isotopes (Eu-152, Eu-154), hydrogen-3 (H-3), iron-55 (Fe-55), nickel isotopes (Ni-59, Ni-63), managense-54 (Mn-54), potassium-40 (K-40), and sodium-22 (Na-22).[4] All radionuclides of concern listed with the exception of Fe-55, Mn-54, and Na-22 (due to relatively short half-lives) are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: A channel in the pavement around Buildings 4022 prevents water from running into the building operating areas. The same conditions are true for other buildings in the RMHF complex.[5] Figure 2.2x illustrates the path surface water follows around Building 4022.

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[1] Isotope Committee Chairman, *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization Nos. 106D, 106F-106M, Rockwell International, December 18, 1981 through February 12, 1992.
[2] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[3] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-2.
[4] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, pgs 7-8.
[5] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 63.

The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[1] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[2] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[3] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[4] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[5] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[6,7] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[8] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Historically, surface water from the filter exhaust system between Building 4021 and 4022 collected in three concrete-lined trenches. Drains in these trenches discharged to the RMHF northern slope via a 4-inch below-grade pipeline that discharged to the natural drainage north of the site. At some time during the RMHF operational period, the drains were plugged, but it is not clear when or for what reason. Surface water from the filter exhaust system is conveyed to

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[1] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[2] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[4] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[5] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.
[6] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[7] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[8] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

the west to the area of the former RMHF catch basin or the stormwater aboveground storage tank.[1]

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4022 area is Class 1, due to its former use as a radioactive materials storage facility, radiological incidents, and previous investigations.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the Building 4022 area. As discussed above, there were several radiological incidents at Building 4022 and documented evidence of radiological releases. Previous characterization studies for the Building 4022 area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4022 area. This includes the following Building 4022 areas and appurtenances:

- Under the Building 4022 sump and piping located at the southwest corner of the building. This sump is considered to be radiologically contaminated having received contaminated waste from the Building 4022 vaults. Radioactive contamination is likely in this area.

- Under the Building 4022 vaults. The vaults were all used for the storage of radioactive material. Vault 2 contained UT-15, the 8,000 gallon radioactive liquid storage tank, and Vault 6 contained a floor drain that collected drainage from all of the vaults. Incident A0170 also noted a radioactive spill in Vault 7. The maximum vault depth is 20. 5 feet. Residual radioactive contamination is likely in this area.

- Subsurface pipeline that connects the Building 4022 vaults with the sump tanks in Building 4021. This pipeline carried radioactive liquids. Leaks in the pipeline could have contributed to contamination and the pipeline itself could have provided a pathway for contaminant migration. Residual radioactive contamination is likely in this area.

- Filter/blower area between Building 4021 and Building 4022. This area contained the HEPA filter exhaust system, trenches to drain water from the area, and a below-grade pipeline to the RMHF northern slope. The trenches and pipeline may have also provided pathways for contaminant migration. Residual radioactive contamination is associated with some of these features and may be present in this area.

- Possible 9,400-gallon tank (UT-14) associated with Building 4022, if confirmation of its existence and location can be determined. At this time it is not clear what this tank contained or where it was located, but it could have held radioactive material and should be investigated if additional information becomes available.

[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, pgs. 2-7–2-8.

Redacted

- Area of dark-toned material at the northeast corner of Building 4022 identified in a 1988 aerial photograph. If radioactive materials were spilled in this dark-toned material, residual contamination may be present.

- Drainage areas along north and south sides of Building 4022. Although pavement near the building slopes away, stormwater runoff flows east to west around the north and south sides of Building 4022. Radioactive materials could have migrated in this manner and left residual contamination the drainage pathway north and south of Building 4022.

2.3 Building 4034 Area

Site Description: The Building 4034 area comprises Building 4034 and the land surrounding it along the east fence line of the Radioactive Material Handling Facility (RMHF) site, formerly the Radioactive Material Disposal Facility (RMDF) site. Building 4034 was constructed in 1961 as an RMHF Office Building.[1] It contains the administrative and engineering offices for the RMHF.[2] Figures 2.3a through 2.3e provide a recent photograph and the best available building-specific drawing(s) and photos that the research team could find. Building 4034 was located at the southeast corner the RMHF complex. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4034 is a small steel structure, with corrugated metal siding and an asphalt tile floor. It measures 33 feet by 21 feet and is 693 square feet in size. Building 4034 contains two main office areas and two restrooms.[3,4,5] A sewer line located along 12th Street terminates at Building 4034.[6]

Former Use(s): Building 4034 served as an office building for the RMDF and then RMHF.[7] It was also used for records storage.[8]

Information from Interviewees: None to date.

Radiological Incident Reports: None found.

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[1] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-6.
[2] *Current Conditions Report and Draft RCRA Facility Investigation Work Plan, Area IV Santa Susana Field Laboratory, Ventura Count y California, Part 1 – Current Conditions Report Volume 1*, ICF Kaiser Engineering, October 1993, p. 4-39.
[3] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-6.
[4] *Atomics International Radioactive Waste Facility Office Bldg Floor Plan & Elevations, 303-034-A2*, June 19, 1962.
[5] Unknown Author, *RMDF Fire Preplans – Structures*, Unknown Date.
[6] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 11 – RFI Site Reports, Appendix G – Sewer Inspection Documentation Logs*, June 2009, p. Figure G-1.
[7] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-6.
[8] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008,* The Boeing Company, February 4, 2004, p. 11.

Redacted

Current Use: Building 4034 is still standing. It serves as the main office and point of entry for RMHF.[1]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **1991 Monthly Building Surveys**. Project progress reports located for February, March, April, May, June, August, and October 1991 note that monthly smear surveys of Building 4034 found nothing unusual and no corrective actions were required.[2]

  Additionally, a 1991 Rockwell report notes that radiological conditions in the RMHF are determined by periodic surveys, which are summarized for the first quarter of 1991 in the report. Results are shown in the table below.[3]

RMHF Removable Contamination Levels for First Quarter, 1991

Location	Posting Status	Limits (dpm/100 cm^2) beta-gamma	Lowest Measured Level (dpm/100 cm^2) beta-gamma	Highest Measured Level (dpm/100 cm^2) beta-gamma
Building 4021 (Laundry, Change Room, Decontamination Room, Packaging Room)	Open	< 1,000	< 50	651*
	Contaminated Area	< 1,000	< 50	3,138**
Building 4022 Vault Storage	Open	< 1,000	< 50	5,000***
Building 4034 Offices	Open	< 1,000	< 50	< 50
Building 4044 Break Area	Open	< 1,000	< 50	< 50
Building 4075 Storage Area	Open	< 1,000	< 50	< 50
Building 4621 Storage Area	Open	< 1,000	< 50	< 50

* Alpha contamination of 33 dpm/100 cm^2 was found on the sink top in the change rom. The contamination was removed and subsequent surveyed showed levels to be < 20 dpm/100cm^2.
** Isolated instances of low-level (22 – 37 dpm/100cm2) alpha contamination were found on several occasions.
*** This measurement came from aluminum sheeting awaiting packing that was discovered during a routine smear survey. The sheet was sectioned and discarded as radioactive waste. No violation of U.S. Department of Energy regulations occurred.

[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-11.
[2] Gaylord, G., *Energy Technology Engineering Center Project Progress Report Accounting Period for February-June 1991, August 1991, and October 1991, Radioactive Materials Disposal Facility (RMDF) Maintenance*, Engineering Technology Engineering Center, 1991, p. 2.
[3] Internal Correspondence from Barnes, J. to Rutherford, P., Rockwell International, *Re: First Quarter, 1991 ALARA Report*, August 8, 1991.

- **1997 Rockwell Monthly Radiation Survey**. A monthly radiation survey report dated May 27, 1997 found that Building 4034 had less than the 20 disintegrations per minute per 100 square centimeters (dpm/cm^2) limit of alpha activity and less than the 100 dpm/cm^2 limit of beta activity. The maximum exposure rate was 22.0 microroentgens per hour (µR/h).[1]

- **2004 Boeing Demolition Program Management Plan**. A January 2004 demolition program management plan states that Building 4034 has no loose (smearable) radiological contamination, but may have some fixed contamination. The document states that the possibility of fixed contamination has not yet been investigated. According to the plan document, Building 4034 will be surveyed to determine the presence and extent of any radiological contamination. If no contamination is present, the building will be demolished and removed by a subcontractor. If contamination is present, the contamination will be removed to allow for subcontractor demolition or the contaminated structures will be dismantled and packaged as low-level radiological waste.[2]

- **2005 Historical Site Assessment**. According to a 2005 historical site assessment, routine quarterly radiation surveys are conducted in this office building to verify that it has not become contaminated.[3]

- **2009 Boeing Sewer/Manhole Inspection**. In March 2009, sewer lines in the HSA-7 area were assessed through manhole inspection and soil sampling. According to a 2009 Resource Conservation and Recovery Act Facility Investigation report, a soil sample was not collected at the exit point of the sewer line at Building 4034 because an interior soil sample was collected near this exit point inside the building at a restroom floor drain.[4] The soil samples were not tested for radionuclides. The Building 4034 restroom floor drain and/or the sewer line extending southeast from the building require sampling for radionuclides.

Radiological Use Authorizations: At various times, the following use authorizations were assigned to the RMHF complex:

- Use Authorization 106 pertained to radioactive waste and contaminated materials generated at other authorized facilities. Use Authorization 106M, issued February 12, 1992, noted that operation of the RMHF included a) receiving, processing, packaging, and shipping radioactive wastes and materials generated by Rocketdyne activities, b) receiving, processing, packaging, and shipping radioactive laundry, c) receiving and processing liquid radioactive wastes, d) storing radioactive materials, and e) maintaining

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[1] Darcy, K., *Radiation Survey Report – T-034*, Rockwell International, May 27, 1997, HDMSe00388913.
[2] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, pgs. 10-11, 19.
[3] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-11.
[4] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C – Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC)*, June 2009, p. C.3-5.

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facilities equipment and materiel. Buildings 4021, 4022, 4044, 4075, and 4621 were listed as authorized use locations with the authorized users based out of Building 4034.[1]

- Because use authorization applications list the location of the principle user, most use authorizations identified for the RMHF complex indicate the principle user was located at the RMHF Office Building 4034.

Former Radiological Burial or Disposal Locations: None found.

Aerial Photographs: Building 4034 is never formally identified as a building in the U.S. Environmental Protection Agency's (EPA's) aerial photograph analysis, but it is first clearly visible in 1965, at the northern terminus of 12th Street in the southeast corner of the RMHF site. Buildings 4044 and 4688 are formally identified north of Building 4034. In 1980 and 1995, an aboveground pipeline is identified along the east side of Building 4034. In 2005, earth moving activity is noted in a large area along the northern perimeter of the entire RMHF site.[2]

Radionuclides of Concern: The research team found no evidence that nuclear or radioactive materials were known to have been stored or handled in Building 4034.[3] Because Building 4034 is located southeast of the Building 4022 RMHF storage vault, contamination could have migrated from Building 4022 to Building 4044. Radionuclides associated with the potential migration from RMHF Building 4022 include: uranium fuel materials (U-234, U-235, U-238), transuranic isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242), and americium-241 (Am-241), fission products cesium-137 (Cs-137) and strontium-90 (Sr-90), thorium breeder material (Th-228, Th-232), and possible neutron activation products such as cobalt-60 (Co-60), europium isotopes (Eu-152, Eu-154), hydrogen-3 (H-3), iron-55 (Fe-55), nickel isotopes (Ni-59, Ni-63), managense-54 (Mn-54), potassium-40 (K-40), and sodium-22 (Na-22).[4] All radionuclides of concern listed with the exception of Fe-55, Mn-54, and Na-22 (due to relatively short half-lives) are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[5] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[6] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to

[1] Isotope Committee Chairman, *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization Nos. 106D, 106F-106M, Rockwell International, December 18, 1981 through February 12, 1992.
[2] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[3] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-6.
[4] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, pgs 7-8.
[5] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[6] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.

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an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[1] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[2] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[3] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[4,5] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[6] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4034 area is Class 1, due to its proximity to RMHF Building 4022 and the potential for contaminant migration.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Additional soil sampling is recommended in the Building 4034 area. As discussed above, Building 4034 was located in proximity to the Building 4022 RMHF vault, which stored radioactive materials, and previous characterization studies for the Building 4034 area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4034 area. This includes the following Building 4034 areas and appurtenances:

[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[2] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[3] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.
[4] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[5] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[6] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

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- Under the floor drain in Building 4034. A sample was previously collected, but it was not analyzed for radionuclides. If radioactive materials were released into the drain, residual contamination may still exist.

- Sewer line connected to south side of Building 4034. If radioactive materials were released into the sewer system, residual contamination may exist in the materials inside and surrounding the sewer lines.

- Aboveground pipeline identified in 1980 and 1995 aerial photographs located east of Building 4034. The contents of this pipeline are unknown based on the aerial photograph, and it could have provided pooling locations for potential contaminants around pipeline supports. Residual radioactive contamination could be present.

- Surface drainage areas around the Building 4034 area. Any releases of radioactive materials would have followed drainage pathways from the building and could leave residual contamination.

2.4 Building 4044 Area

Site Description: The Building 4044 area comprises Building 4044 and the land surrounding it in the east fence line of the Radioactive Material Handling Facility (RMHF) site, formerly the Radioactive Material Disposal Facility (RMDF) site. Building 4044 was constructed in the mid-1960s as the RMDF Clean Shop.[1,2,3] Figures 2.4a through 2.4e provide a recent photograph and the best available building-specific drawing(s) and photos that the research team could find. Building 4044 was located north of Building 4034 and south of Building 4688. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4044 has a concrete foundation and floor with a steel frame and corrugated metal exterior walls and roof. The interior walls are insulated. It measures 39 feet by 21 feet and is 819 square feet in area. A 12-foot high sliding door is located on the west side of the building.[4] The building contains a radiation safety office with health physics instrumentation and a technician support area with a break room and restroom. The building has electricity, heating, air conditioning, industrial water supply, and fire sprinklers. Radiation counters for radioactive surveillance of RMHF work were located in Building 4044.[5,6] A 2005 site

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[1] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis*, June 18, 2007, p. A-4.
[2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[3] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[4] Unknown Author, *RMDF Fire Preplans – Structures*, Unknown Date.
[5] Waite, P.H. and P.H. Horton, *Process Hazard Analysis (PHA) for RMHF Operations, EID-04446, Rev. A*, The Boeing Company, Unknown Date, p. 13.
[6] Bassat, I.B., *RMHF Familiarization Document, EID-06144*, Rev. A, The Boeing Company, May 24, 2001, pgs. 7, 13.

photograph shows a safety shower located at the north end of the building.[1] Photographs from a 2009 site visit show the storage area/utility closet adjacent to the former counting room contained an industrial sink and floor drain. The restroom sink and floor drain were connected to the sanitary sewer system.[2] A 2004 demolition program management plan states that a sump located on the north side of the building is contaminated. It is not clear if the plan is referring to the oil sump in the area (see Section 2.13 below) or another sump.[3,4,5] No other information has been found on this sump or the type of contamination it contains.

Former Use(s): Building 4044 served various roles including that of a clean shop, health physics office, and a break room. The health physics office has been used as a counting area for removable contamination measurements, storage, and use of calibration sources.[6] Figure 2.4e shows that radioactive waste was generated as part of operations at Building 4044.

Information from Interviewees: None to date.

Radiological Incident Reports: There has been one incident associated with Building 4044 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing.

Building 4044 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0082	7/24/1980	RMDF	Mixed Fission Product	Radioactive Waste Container Emptied Into Clean Waste Gondola.

- On July 24, 1980, it was discovered that a 5-gallon radioactive waste container from the counting room of Building 4044 was inadvertently emptied into a regular trash gondola on July 23, 1980. Upon discovering the error, the trash gondola was returned to the RMHF facility (Building 4022) and had the entire contents placed into a proper radioactive waste disposal container. The incident report did not indicate the location of the trash gondola prior to being transported back to the RMHF (A0082).[7]

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[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-15.
[2] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Table C.3-2A, Attachment C-4.
[4] Daniel, Mann, Johnson & Mendenhall, *R/A Waste and Fuel Storage, Plumbing Site Plan, General Notes & Legend, 303-022-M1*, September 25, 1958.
[5] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, February 4, 2004, p. 11.
[6] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis*, June 18, 2007, p. A-4.
[7] Owen, R.K., Rockwell International Internal Correspondence, *Re: Radiological Safety Incident Report, RMDF, July 24, 1980*, August 20, 1980.

Current Use: Building 4044 is still active as a break room and health physics office for the RMHF.[1,2] As of July 27, 2011, according to Boeing, there were 10 assorted micro-curie level check sources in use at the Health Physics laboratory in Building 4044. The check sources contained cesium-137 (Cs-137), strontium-90 (Sr-90), technetium-99 (Tc-99), thorium-230 (Th-230), and uranium-238 (U-238).

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **1991 Monthly Building Surveys.** Project progress reports located for February, March, April, May, June, August, and October 1991 note that monthly smear surveys of Building 4044 found nothing unusual and no corrective actions were required.[3]
  Additionally, a 1991 Rockwell report notes that radiological conditions in the RMHF are determined by periodic surveys, which are summarized for the first quarter of 1991 in the report. Results are shown in the table below.[4]

RMHF Removable Contamination Levels for First Quarter, 1991

Location	Posting Status	Limits (dpm/100 cm^2) beta-gamma	Lowest Measured Level (dpm/100 cm^2) beta-gamma	Highest Measured Level (dpm/100 cm^2) beta-gamma
Building 4021 (Laundry, Change Room, Decontamination Room, Packaging Room)	Open	< 1,000	< 50	651*
	Contaminated Area	< 1,000	< 50	3,138**
Building 4022 Vault Storage	Open	< 1,000	< 50	5,000***
Building 4034 Offices	Open	< 1,000	< 50	< 50
Building 4044 Break Area	Open	< 1,000	< 50	< 50
Building 4075 Storage Area	Open	< 1,000	< 50	< 50
Building 4621 Storage Area	Open	< 1,000	< 50	< 50

* Alpha contamination of 33 dpm/100 cm^2 was found on the sink top in the change rom. The contamination was removed and subsequent surveyed showed levels to be < 20 dpm/100cm^2.
** Isolated instances of low -level (22 – 37 dpm/100cm2) alpha contamination were found on several occasions.

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[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries,* May 2005, p. I-13.
[2] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008.
[3] Gaylord, G., *Energy Technology Engineering Center Project Progress Report Accounting Period for February-June 1991, August 1991, and October 1991, Radioactive Materials Disposal Facility (RMDF) Maintenance*, Engineering Technology Engineering Center, 1991, p. 2.
[4] Internal Correspondence from Barnes, J. to Rutherford, P., Rockwell International, *Re: First Quarter, 1991 ALARA Report*, August 8, 1991.

*** This measurement came from aluminum sheeting awaiting packing that was discovered during a routine smear survey. The sheet was sectioned and discarded as radioactive waste. No violation of U.S. DOE regulations occurred.

- **2004 Boeing Demolition Program Management Plan**. A January 2004 demolition program management plan states that Building 4044 has no loose (smearable) radiological contamination, but may have some fixed contamination. The document states that the possibility of fixed contamination has not yet been investigated. According to the plan document, facility dismantlement for Building 4044 will consist of removing remaining building contents and inspecting for hazardous materials. If any hazardous materials are present, they will be removed by qualified personnel. A radiological survey will be conducted. If no contamination is found, the building will be demolished and removed by a subcontractor. If contamination is found, the contamination will be removed to allow subcontractor demolition or the contaminated structure(s) will be dismantled and packaged as low-level radiological waste.[1]

- **2005 Historical Site Assessment**. According to a 2005 historical site assessment, routine daily and monthly radiological surveys are conducted in Building 4044 to verify it has not been contaminated.[2]

Radiological Use Authorizations: At various times, the following use authorizations were assigned to the RMHF complex:

- Use Authorization 106 pertained to radioactive waste and contaminated materials generated at other authorized facilities. Use Authorization 106M, issued February 12, 1992, noted that operation of the RMHF included a) receiving, processing, packaging, and shipping radioactive wastes and materials generated by Rocketdyne activities, b) receiving, processing, packaging, and shipping radioactive laundry, c) receiving and processing liquid radioactive wastes, d) storing radioactive materials, and e) maintaining facilities equipment and materiel. Buildings 4021, 4022, 4044, 4075, and 4621 were listed as authorized use locations with the authorized users based out of Building 4034.[3]

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: Building 4044 is first identified in a 1965 aerial photograph. It is located along the east border of the RMHF site. In 1980, a north-south running aboveground pipeline is identified along the east side of Building 4044, with an east-west running pipeline terminating near Building 4044. In 1983 and 1988, the east-west running pipeline terminating near Building 4044 is still identified. In 1995, both the east-west aboveground pipeline and the north-south aboveground pipeline are identified on the east side of Building 4044. In 2005, the east-west

[1] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, pgs. 11, 19.
[2] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California*, *Volume 2 – Area IV Site Summaries*, May 2005, p. I-13.
[3] Isotope Committee Chairman, *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization Nos. 106D, 106F-106M, Rockwell International, December 18, 1981 through February 12, 1992.

aboveground pipeline is shown terminating near Building 4044 and earth moving activity is noted in a large area along the northern perimeter of the entire RMHF site.[1]

Radionuclides of Concern: As the health physics office, Building 4044 was used to count removable contamination measurements and store calibration sources.[2] A 1989 quarterly radioisotope inventory for Building 4044 found sources containing the following radionuclides: bismuth-210 (Bi-210), lead-210 (Pb-210), plutonium-239 (Pu-239), Sr-90, Tc-99, and Th-230.[3] An historical photo, circa 1990, shows two small containers labeled "Radioactive Material" and "Radioactive Material - Contaminated Waste" under a desk in Building 4044.[4] See Figure 2.4e for this historical photograph. The incident described above notes that mixed fission products were handled in Building 4044.

Because Building 4044 is located just east of the Building 4022 RMHF storage vault, contamination could have migrated from Building 4022 to Building 4044. Radionuclides associated with potential contaminant migration from RMHF Building 4022 include: uranium fuel materials (U-234, U-235, U-238), transuranic isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242), and americium-241 (Am-241), fission products Cs-137 and Sr-90, thorium breeder material (Th-228, Th-232), and possible neutron activation products such as cobalt-60 (Co-60), europium isotopes (Eu-152, Eu-154), hydrogen-3 (H-3), iron-55 (Fe-55), nickel isotopes (Ni-59, Ni-63), managense-54 (Mn-54), potassium-40 (K-40), and sodium-22 (Na-22).[5] All radionuclides of concern listed with the exception of Fe-55, Mn-54, and Na-22 (due to relatively short half-lives) are included in the U.S. Environmental Protection Agency (EPA) October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[6] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[7] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[8] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons

[1] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2,* U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.

[2] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis*, June 18, 2007, p. A-4.

[3] Internal Correspondence from McGinnis, E.R. to Rowles, J.A., Rockwell International, *Re: Quarterly Radioisotope Inventory Verification*, February 22, 1989.

[4] Rockwell International, *Photograph of SSFL Building 44 RMDF Clean Shop*, circa 1990, HDMSP00048945.

[5] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, pgs 7-8.

[6] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.

[7] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.

[8] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.

and was used to contain stormwater runoff and any accidental releases.[1] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[2] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[3,4] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[5] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4044 area is Class 1, due to its use as a health physics counting office and proximity to Building 4044, the RMHF storage vault.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Additional soil sampling is recommended in the Building 4044 area. As discussed above, Building 4044 generated radioactive waste from health physics counting activities and was located near the Building 4022 RMHF storage vault, which stored radioactive materials. Additionally, previous characterization studies for the Building 4044 area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4044 area. This includes the following Building 4044 areas and appurtenances:

- Under the counting room, restroom, and utility closet with industrial sink and drain in Building 4044. The counting room was used to count radioactive samples and store

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[1] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[2] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[4] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[5] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

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calibration sources. Radioactive waste was temporarily contained here. The restroom and utility closet areas in Building 4044 could have received contaminated waste either through inadvertent personal contamination or deliberate disposal. If radioactive materials were released into the drain system, residual contamination may exist in the materials inside and surrounding the drain lines.

- Under the contaminated sump on the north side of Building 4044. It is not clear what this sump is contaminated with so further investigation is required. If radioactive materials were released into the sump, residual contamination may exist in or around the sump.

- Safety shower located at the north end of Building 4044. If the safety shower was used to remove radiological contamination it could be an area of residual contamination.

- Aboveground pipeline identified in 1980 and 1995 aerial photographs located east of Building 4044. The contents of this pipeline are unknown based on the aerial photograph, and it could have provided pooling locations for potential contaminants around pipeline supports. Residual radioactive contamination could be present.

- Surface drainage areas around the Building 4044 area. Any releases of radioactive materials would have followed drainage pathways from the building and could leave residual contamination.

2.5 Building 4075 Area

Site Description: The Building 4075 area comprises Building 4075 and the land surrounding it in the northwest portion of the Radioactive Material Handling Facility (RMHF) site, formerly the Radioactive Material Disposal Facility (RMDF) site. Building 4075 was constructed in 1971 as the Contaminated Equipment Storage Building. It was a storage building for low specific activity packaged waste and was primarily used for staging of waste shipments. Building 4075 is adjacent to Building 4563, a covered storage area.[1,2] Figures 2.5a through 2.5f provide a recent photograph and the best available building-specific drawing(s) and photos that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4075 has a concrete floor and a steel frame, with corrugated metal walls and roof. It measures 73 feet by 31 feet and is 2,263 square feet in area. Two 12-foot high sliding doors are located on the south side of the building.[3,4] Building 4075 does not have any air conditioning, water supply, or natural gas connection.[5] A 2009 site visit identifies a floor drain in the southwest corner of the building. The site visit documentation notes that Building 4075 was "designed so that the floor drain was located in the topographic low point of the building, so any spilled chemicals would flow to the drain." The drain was controlled by a valve located on the

[1] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis*, June 18, 2007, p. A-3.
[2] Correspondence from Seward, F.A. to Nagel, W.E., *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.
[3] Unknown Author, *RMDF Fire Preplans – Structures*, Unknown Date.
[4] Francis, J., *Contaminated Equipment Storage Bldg. 075, 303-075-S1*, May 1971.
[5] Bassat, I.B., *RMHF Familiarization Document, EID-06144*, The Boeing Company, May 24, 2001, p. 13.

western face of Building 4075, and drained via subsurface pipeline into the stormwater culvert located on the western RMHF slope.[1] See Figure 2.5f.

Former Use(s): Building 4075 is a Resource Conservation and Recovery Act (RCRA)-permitted building for the support and storage of radioactive wastes (low-level, mixed, and transuranic wastes) pending shipment to offsite disposal.[2,3,4]

An Atomics International site waste management plan dated circa 1972 and an updated plan dated May 1974 provided information regarding the waste disposal activities at the Santa Susana Field Laboratory (SSFL). According to the waste management plan, which was prepared for the management of Atomic Energy Commission (AEC) contract wastes, AEC-owned waste management facilities, including treatment facilities and storage facilities, were located within the RMHF complex. These facilities included Building 4075. The waste management plan provided the following summary:

> "Temporary storage of low-level radioactive waste is performed in Buildings 621, 663, and 075. Low-level waste and contaminated equipment are temporarily stored in Buildings 075, 621, and 663, and in the fenced storage area surrounding Building 621. These buildings are steel buildings, which are designed to provide protection from the elements and security for the stored items. Contamination control is provided by stringent packaging requirements, so exhaust filter systems and additional contamination control safeguards are unnecessary."[5,6]

A November 1975 Rockwell letter notes that at the time Building 4075 contained stored Systems for Nuclear Auxiliary Power (SNAP) equipment and packaged material awaiting shipment for burial. Also stored in the building were pallets of contaminated materials from the Kinetics Experiment Water Boiler Reactor, Engineering Test Building, and the SNAP Environmental Test Facility waiting to be moved to Building 4021 for decontamination.[7]

A 1986 Rockwell job improvement request notes that radiation levels at the RMHF perimeter fence and property line exceed U.S. Department of Energy (DOE) limits because of waste stored in Building 4075. The request states that while the waste was inside the building awaiting transport to a DOE disposal site, steel billet stored at the RMHF complex could be used to form a bay inside Building 4075 and lead shielding currently stored at the RMHF could be hung on the

[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report*, *Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.
[2] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, p. 11.
[3] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis*, June 18, 2007, p. A-3.
[4] Science Applications International Corporation, Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California, Technical Enforcement Support and Hazardous Waste Sites, May 1994, p. 7-14.
[5] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.
[6] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.
[7] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.

walls to provide more adequate shielding. This additional shielding was requested expeditiously to bring radiation levels into acceptable DOE limits at the time.[1]

An August 15, 1988 site visit report notes that solid radioactive materials are stored inside Building 4075 in drums or large metal containers or are "temporarily" stored in the RMHF yard during staging procedures. The report states that liquid waste was not stored outside any of the RMHF buildings, only solid waste, reducing the possibility of contamination in the yard. During the site visit, there was discussion about the possibility of drums "sweating," although the topic did not seem to be one that had been considered before. Interestingly, the report notes that "ETEC [Energy Technology Engineering Center] still does not consider adding berms and roofing in the RMDF Yard to be necessary." On the day of the visit, the area south of Building 4075 and the interior of Building 4075 contained portions of approximately 300 drums of cobalt-60 (Co-60)-contaminated sand from the Building 4059 remediation. The remainder of the drums was stored in the Building 4663 area. Additionally, the interior of Building 4075 also housed large metal containers of dry waste such as chem wipes and booties. The site visit report notes that the drums of contaminated sand had concrete added to the top and bottom of each drum and were stored on 3-drum pallets with the center drum "having the highest rad. level." Drums were reportedly stored outside during repalletizing or just prior to shipment. The drums were to be transported to Hanford, Washington for disposal. It was estimated that five to six truck loads would be required to handle the 300 drum total.[2]

Information from Interviewees: A number of former employees were interviewed about their experience at the SSFL. Two remembered what was likely Building 4075. Excerpts from these interviews are included below.

From January 1987 to March 1999, Interviewee 7 worked as a Quality Engineer for Rocketdyne/Boeing. The following excerpts were pulled from the interview.

> *"DOE was tearing down buildings in Area IV, clearing them out, packaging things in boxes. So I performed quality auditing of the hazardous waste packaging on the hill. I worked out of the Radioactive Material Handling Facility (RMHF) as the quality auditor of hazardous waste material. The boxes of material were big, approximately three feet square. My job was to verify that what they were taking out of the buildings and putting in the boxes was correctly stated in their documentation. The boxes had identification numbers for tracking and I made sure that the box ID and contents matched the shipping documentation and quality control records. Our office was in the RMHF, but what I think was Building 9 was an open-ended building with only a roof.*[3] *That's where I was checking the boxes. There were rows of boxes piled up on top of each other. I had to go up and down the aisles, and crawl around to find the correct boxes. I didn't have to wear any protective clothing, but I did wear a film badge.*

[1] Schrag, F., *Job Improvement Request*, Rockwell International, June 3, 1986.
[2] Lavagnino, G., *ETEC Meeting and Site Visit*, U.S. Department of Energy, August 17, 1988.
[3] The references to Building 9 appear to be Building 4075 based on the building description and location on the SSFL site map.

> *Boxes were piled in the open-ended storage building, what I think is Building 9, west of the RMHF and the enclosed building attached to Building 9. There was also another building across the street that held boxes.*[1] *I am not exactly sure of the building numbers. But when I was auditing at RMHF, I was actually working out of four buildings, the RMHF, Building 9, the building next to Building 9, and the building across the street. A little west of these RMHF buildings was a burn pit. I didn't have anything to do with the burn pit, but I could see it while I was in the RMHF area. I could see smoke from the burn pit. I don't know what they were burning, but sometimes we could see smoke.*[2].
>
> *Anyone who worked at Rocketdyne could get up on the hill. They had guards at the gate, but all you had to do was show your Rocketdyne badge and once you were in there you were free to go to your destination. I was in and out of a few buildings for various meetings or to check on parts, but I spent most of my time associated with the RMHF area and adjacent buildings."*[3]

Interviewee 15 worked at the Santa Susana Field Laboratory for 7 years beginning in1958 as a laboratory technician and then becoming a radiation disposal facility supervisor. The following excerpt was pulled from the interview.

> *"I had a supervisor that heated uranium carbide in a cement mixer in a shed at the radioactive disposal facility to dispose of it."*[4]

Radiological Incident Reports: There has been one documented incident associated with Building 4075 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing.

Building 4075 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0188	8/15/1988	Radioactive Storage 075	Co/Eu	Fork Truck Operator Punctured 55 Gal Drum Of R/A Waste.

- On August 15, 1988, a forklift driver punctured two drums containing radioactive sand that originated from Building 4059. Approximately 40 grams of sand spilled onto a 200 square centimeter area of the drum pallet and floor. One-half gram of the sand had a beta-gamma reading of 24,000 disintegrations per minute (dpm). The spilt sand was

[1] This building appeared to be Building 4621 based on the SSFL site map.
[2] The research team thinks Interviewee 7 is speaking about the Sodium Burn Pit. However, the research team thinks the Sodium Burn Pit is more than "a little west" of the RMHF. The high elevation of the RMHF complex allows someone working in the area to see smoke from a distance. The research team does not think there is any other burn pit between the RMHF and the Building 4886 area known as the Sodium Burn Pit. The Sodium Burn Pit is discussed in the HSA-8 technical memorandum.
[3] Interview No. 3 conducted by EPA on March 16, 2010.
[4] Interview No. 15 conducted by EPA on November 10, 2009.

vacuumed up into a radioactive vacuum cleaner, and the punctures were sealed with duct tape. The drums were transported to the Building 4021 decontamination room and the remaining sand was transferred to new drums. Post cleanup surveys found no detectable contamination (A0188).[1,2]

Current Use: In 2001, Building 4075 ceased to be a storage area and has remained unused since that time.[3] Building 4075 is still standing. A 2009 site visit found nothing stored in Building 4075, but there was a low point in the concrete floor that appeared cracked with some water stains.[4]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **1981 Rockwell Environmental Survey**. In 1981, a preliminary survey was conducted to support RMHF decommissioning. Low levels of fixed and removable contamination were found in portions of the RMHF asphalt and in the soil beneath the asphalt paving. Localized areas of contamination were also discovered in the soil outside the north, west, and south fence perimeters. Thirty-seven locations were identified for sample collection with a micro-R meter. Samples were taken at the surface and at 12 inches below the surface (subsurface) to determine the extent of contamination. Surface soil sample activities ranged from 21.25 to 1,142.92 picocuries per gram (pCi/g). The soil activity at 12 inches deep ranged from 19.86 to 104.00 pCi/g. Sample results surrounding Building 4075 are described in the table below. Boeing-stated background levels ranged from 20 to 30 pCi/g gross beta activity. Soil and asphalt sampling and radiological surveys identified eight areas with elevated radiological activity at the RMHF, including an area northwest of Building 4075. See Figure 2.1u for a more specific depiction of the sampling locations and Plate 1 for the location of contaminated areas.[5,6,7]

[1] McGinnis, E.R., Rockwell International Internal Correspondence, *Re: Radiological Safety Incident Report, RMDF-T075, August 15, 1988*, August 23, 1988.
[2] Moore, J.D., Rockwell International Internal Correspondence, *Re: Quarterly Review of the Radioactive Materials Disposal Facility (RMDF) for Radiation Safety, Third Calendar Quarter, 1988*, December 22, 1988.
[3] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis*, June 18, 2007, p. A-3.
[4] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.
[5] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-3.
[6] Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, pgs. 24-29.
[7] Internal Correspondence from Peko, D. to McCurnin, W.R., Rockwell International, *Re: Radioactive Materials Disposal Facility Assessment Plan*, May 22, 1990.

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1981 Soil Sample Analysis Results

Sample Location	Surface Activity (pCi/g)	Subsurface Activity (pCi/g)
Northern RMHF Drainage Outside RMHF Perimeter Fence	35.41	38.00
Northwest RMHF Drainage Outside RMHF Perimeter	306.22	60.11
Southwest Corner of Building 4075	100.30	35.92
South of Building 4075	69.45	90.26
South of Building 4075	97.00	35.92
South of Building 4075	36.53	35.54

- **1991 Rockwell Monthly Smear Surveys**. Project progress reports located for February, March, April, May, June, August, and October 1991 note that monthly smear surveys of Building 4075 found nothing unusual and no corrective actions were required.[1]

  Additionally, a 1991 Rockwell report notes that radiological conditions in the RMHF are determined by periodic surveys, which are summarized for the first quarter of 1991 in the report. Results are shown in the table below.[2]

RMHF Removable Contamination Levels for First Quarter, 1991

Location	Posting Status	Limits (dpm/100 cm^2) beta-gamma	Lowest Measured Level (dpm/100 cm^2) beta-gamma	Highest Measured Level (dpm/100 cm^2) beta-gamma
Building 4021 (Laundry, Change Room, Decontamination Room, Packaging Room)	Open	< 1,000	< 50	651*
	Contaminated Area	< 1,000	< 50	3,138**
Building 4022 Vault Storage	Open	< 1,000	< 50	5,000***
Building 4034 Offices	Open	< 1,000	< 50	< 50
Building 4044 Break Area	Open	< 1,000	< 50	< 50
Building 4075 Storage Area	Open	< 1,000	< 50	< 50
Building 4621 Storage Area	Open	< 1,000	< 50	< 50

* Alpha contamination of 33 dpm/100 cm^2 was found on the sink top in the change rom. The contamination was removed and subsequent surveyed showed levels to be < 20 dpm/100cm^2.

[1] Gaylord, G., *Energy Technology Engineering Center Project Progress Report Accounting Period for February-June 1991, August 1991, and October 1991, Radioactive Materials Disposal Facility (RMDF) Maintenance*, Engineering Technology Engineering Center, 1991, p. 2.
[2] Internal Correspondence from Barnes, J. to Rutherford, P., Rockwell International, *Re: First Quarter, 1991 ALARA Report*, August 8, 1991.

** Isolated instances of low-level (22 – 37 dpm/100cm2) alpha contamination were found on several occasions.
*** This measurement came from aluminum sheeting awaiting packing that was discovered during a routine smear survey. The sheet was sectioned and discarded as radioactive waste. No violation of U.S. DOE regulations occurred.

- **1997 Rockwell Monthly Radiation Survey**. A monthly radiation survey report dated May 27, 1997 found that Building 4075 had less than the 20 disintegrations per minute per 100 square centimeters (dpm/cm^2) limit of alpha activity and less than the 100 dpm/cm^2 limit of beta activity. The maximum exposure rate was 9.0 milliroentgens per hour (mR/hr).[1]

- **2007 Boeing Radiological Survey**. In 2007, Boeing performed radiological surveys on Buildings within the RMHF complex, including Building 4075. Building 4075 was divided into five survey units. The ceiling, north wall, south wall, east wall, and west wall each composed a single survey unit. Data was also collected from exterior doors, vents, and roof surfaces. The concrete foundation was outside of the scope of this survey. Measurements of fixed and removable surface residual radioactivity on the walls and ceiling of Building 4075 are described in the table below and are within Boeing-stated acceptable levels. However, limited investigation of building roofs concluded that additional survey data would be needed to determine suitability for release.[2]

Measured Surface Residual Radioactivity 2007 on Building 4075 Walls and Ceiling

Description	Average (dpm/100 cm^2)		Maximum (dpm/100 cm^2)		Removable (dpm/100 cm^2)		
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Tritium
DOE and NRC Allowable Limits*	100	5,000	300	15,000	20	1,000	10,000
Building 4075 North Wall Measured Values	29	73	84	517	5	28	4
Building 4075 East Wall Measured Values	33	-270	101	207	2	55	4
Building 4075 South Wall Measured Values	20	-80	65	287	2	60	4
Building 4075 West Wall Measured Values	-12	144	17	506	2	50	4
Building 4075 Ceiling Measured Values	17	-282	51	34	2	33	4

*Most limiting value from U.S. Department of Energy (DOE) Order 5400.5 (1990) and U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86 (1974)

[1] Darcy, K., *Radiation Survey Report – T-075*, Rockwell International, May 27, 1997, HDMSe00388909.
[2] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys*, October 2007, pgs. 17, 31, 39.

Radiological Use Authorizations: At various times, the following use authorizations were assigned to the RMHF complex:

- Use Authorization 106 pertained to radioactive waste and contaminated materials generated at other authorized facilities. Use Authorization 106M, issued February 12, 1992, noted that operation of the RMHF included a) receiving, processing, packaging, and shipping radioactive wastes and materials generated by Rocketdyne activities, b) receiving, processing, packaging, and shipping radioactive laundry, c) receiving and processing liquid radioactive wastes, d) storing radioactive materials, and e) maintaining facilities equipment and materiel. Buildings 4021, 4022, 4044, 4075, and 4621 were listed as authorized use locations with the authorized users based out of Building 4034.[1]

Former Radiological Burial or Disposal Locations: Historical photographs taken in 1976 depict a disturbed area on the hillside north of Building 4075.[2,3]
A 2008 waste debris survey found two waste debris areas down slope from Building 4075. Both debris areas were less than 100 square feet. One debris area contained large concrete blocks and smaller broken pieces of concrete. The other debris area contained asphalt and metal wire.[4]

Aerial Photographs: Building 4075 is first identified in a 1972 aerial photograph. It is located in the northwest portion of the RMHF site. A drainage channel is identified southwest of Building 4075, with drainage running to the west. An open storage (OS) area, identified as OS-1 by the U.S. Environmental Protection Agency's (EPA's) aerial photographic analysis, is located south of Building 4075. OS-1 contains probable stains. In 1978, OS-1 expanded to include most of the western portion of the RMHF site. It abuts Building 4075 on the east and south sides. OS-1 contains possible stains, possible crates, and probable debris. Drainage is still to the west. In 1980, drainage from an area of dark-toned material at the north perimeter of the RMHF is shown to drain west along the north and west sides of Building 4075. An access road connects Building 4075 to a partially-vegetated area with a ground scar. This road runs in an east-west direction along the north side of an impoundment (IM) identified as IM-4 by the EPA's aerial photographic analysis. In 1983, two separate areas are identified as OS-1, one area east of Building 4075 and one area south of Building 4075. In 1988, OS-1 is defined as the western portion of the RMHF site and contains stains. OS-1 abuts Building 4075 on its east and south sides. In 1995, multiple areas within the RMHF site are identified as OS-1 with probable stains, including areas south of Building 4075. A large stained area is noted south of Building 4075.

[1] Isotope Committee Chairman, *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization Nos. 106D, 106F-106M, Rockwell International, December 18, 1981 through February 12, 1992.
[2] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-4.
[3] MWH, *RCRA Facility Investigation Work Plan Addendum Second Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, October 2008, p. HDMSP00015875.
[4] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Appendix F: Group 7 2008 Waste Debris Survey Results, June 2009.*

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By 2005, OS-1 is defined as a rectangular area south of Building 4075. Earth moving activity is noted in a large area along the northern perimeter of the RMHF site.[1]

Radionuclides of Concern: Possible radionuclides of concern include uranium, plutonium, thorium, and mixed fission products.[2] The incident database described isotopes of cobalt and europium as being part of the radioactive waste that was released. These radionuclides of concern are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: A 2009 site visit identifies a floor drain in the southwest corner of the building that drains via subsurface pipeline to a stormwater culvert at the western edge of the RMHF complex.[3]

A channel in the pavement around Buildings 4075 prevents water from running into the building area. The same conditions are true for other buildings in the RMHF complex.[4]

The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[5] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[6] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[7] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[8] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[9] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the

[1] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2,* U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[2] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 3.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.
[4] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 63.
[5] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[6] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[7] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[8] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[9] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.

water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[1,2] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[3] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4075 area is Class 1, due to its former use and a documented release of radiological material.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the Building 4075 area. As discussed above, there was a radiological incident at Building 4075 and documented evidence of a radiological release. Previous characterization studies for the Building 4075 area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4075 area. This includes the following Building 4075 areas and appurtenances:

- Under the concrete foundation of Building 4075. The concrete foundation received only limited investigation. Because this area served as a storage location for radioactive materials and a radioactive spill did occur in the building, residual contamination may exist.

- Floor drain in the southwest corner of Building 4075 and the subsurface pipeline leading to the stormwater culvert at the west end of the RMHF complex. This drain could have provided a pathway for contaminant migration when a release occurred in the building, and at least one radiological release was documented. Residual contamination may exist along this drainage pathway.

[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[2] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[3] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

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- Subsurface piping and stormwater culvert west of Building 4075. The piping and culvert collected drainage from Building 4075. Any leaks or spills of contaminated waste in the building would likely follow this pathway. The stormwater culvert also received drainage from the entire RMHF complex. Residual contamination may be present.

- Asphalt-lined swale located north of Building 4075 that drained to the stormwater culvert at the west end of the RMHF complex. This drainage provides a possible pathway for contaminate migration and could result in residual contamination.

- Open storage area (OS-1) identified in aerial photographs with stains. The south and east side of the Building 4075 area was an open paved area that was often used for storage. Aerial photographs note stains in OS-1. This area requires further investigation for contamination.

- Disturbed area north of Building 4075 identified in a 1976 historical photo. Because the nature of this disturbance is unknown, the area requires further investigation for contamination.

- Two debris areas downslope of Building 4075 identified in a 2008 waste debris survey. The debris areas could have contaminated items and require further investigation.

- Surface drainage areas around the Building 4075 area. The area surrounding Building 4075 was used for storage. Any releases of radioactive materials would have followed drainage pathways from the building and could leave residual contamination.

2.6 Building 4563 Area

Site Description: The Building 4563 area comprised Building 4563 and the land surrounding it in the central portion of the Radioactive Material Handling Facility (RMHF) site, formerly the Radioactive Material Disposal Facility (RMDF) site. Building 4563 was constructed in 1958, but at that time it was an uncovered, asphalt and concrete paved storage yard.[1] It was converted from an open storage area to an awning covered storage area in the late 1990s.[2] Figures 2.6a through 2.6c provide a recent photograph and the best available building-specific drawing(s) and photos that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4563 was a 1,130 square-foot paved, covered storage area adjacent and east of Building 4075. The building has a steel frame and metal roof.[3] A sewer line that

[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-21.
[2] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 11 – RFI Site Reports, Appendix C – Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC)*, June 2009, p. Table C.2-1.
[3] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007,* pgs. A-3 – A-4.

connected at Building 4021 ran west to the southeast corner of Building 4563, where a manhole existed, and then turned south and continued off the RMHF site.[1]

Former Use(s): Building 4563 was identified as the Building 4633 Storage Yard on some industrial planning maps and as Building 4075A, Storage Yard/Storage Shed, and Covered Storage Area Neighboring Building 4075 in other documents.[2,3,4,5,6] Building 4563 served as a storage area for containerized radioactive waste pending shipment to a disposal facility.[7,8] On average, fewer than 40 waste containers were stored in this yard pending shipment.[9]

Information from Interviewees: None to date.

Radiological Incident Reports: None found.
Current Use: The Building 4563 area still exists, but is no longer active.[10] A 2009 site visit found nothing stored under the Building 4563 canopy.[11]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **1981 Rockwell Environmental Survey**. In 1981, a preliminary survey was conducted to support RMHF decommissioning. Low levels of fixed and removable contamination were found in portions of the RMHF asphalt and in the soil beneath the asphalt paving. Localized areas of contamination were also discovered in the soil outside the north, west, and south fence perimeters. Thirty-seven locations were identified for sample collection with a micro-R meter. Samples were taken at the surface and at 12 inches below the surface (subsurface) to determine the extent of contamination. Surface soil sample activities ranged from 21.25 to 1,142.92 pCi/g. The soil activity at 12 inches deep ranged from 19.86 to 104.00 pCi/g. One sample was taken in the northern drainage north of the

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[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 11 – RFI Site Reports, Appendix G – Sewer Inspection Documentation Logs*, June 2009.
[2] Atomics International Drawing, *Santa Susana Facility Plot Plan, 303-GEN-C40*, June 5, 1967.
[3] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[4] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008,* The Boeing Company, January 30, 2004, pgs. 12-13.
[5] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries,* May 2005, p. I-21.
[6] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. A-3.
[7] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007,* p. A-4.
[8] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 4
[9] Waite, P.H. and P.H. Horton, *Process Hazard Analysis (PHA) for RMHF Operations, EID-04446*, The Boeing Company, Unknown Date, p. 23.
[10] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California,* March 2008.
[11] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.

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Building 4563 area. Sample results showed 244.64 pCi/g surface activity and 41.80 pCi/g subsurface activity. Boeing-stated background levels ranged from 20 to 30 pCi/g gross beta activity. Soil and asphalt sampling and radiological surveys identified eight areas with elevated radiological activity at the RMHF. See Figure 2.1u for a more specific depiction of the sampling locations and Plate 1 for the location of contaminated areas.[1,2,3]

- **2007 Boeing Radiological Survey**. In 2007, Boeing performed radiological surveys on Buildings within the RMHF complex, including Building 4563. Building 4563 was divided into two survey units: the structural steel posts and beams supporting the roof, and the ceiling or underside of the roof. Data was also collected from roof surfaces. The concrete foundation was outside of the scope of this survey. Measurements of fixed and removable surface residual radioactivity on the posts/beams and ceiling of Building 4563 are described in the table below and are within Boeing-stated acceptable levels. However, limited investigation of building roofs concluded that additional survey data would be needed to determine suitability for release.[4]

Measured Surface Residual Radioactivity 2007 on Building 4563 Beams and Ceiling

Description	Average (dpm/100 cm^2)		Maximum (dpm/100 cm^2)		Removable (dpm/100 cm^2)		
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Tritium
DOE and NRC Allowable Limits*	100	5,000	300	15,000	20	1,000	10,000
Building 4563 Post/Beams Measured Values	60	-75	242	573	5	75	3.8
Building 4563 Ceiling Measured Values	51	382	113	719	5	43	3.8

*Most limiting value from U.S. Department of Energy (DOE) Order 5400.5 (1990) and U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86 (1974)

- **2009 Sewer/Manhole Inspection**. Manhole B-12, located at the southeast corner of the Building 4563 area was inspected on March 30, 2009. The manhole depth was listed at 5.25 feet. The sewer line was described as clay pipe that went northeast from the manhole to Building 4021 and south from the manhole to another manhole (B-11) south of the RMHF perimeter. The inspection log noted that there was flowing water at the time of inspection and no solids or sedimentation. The piping was in good condition and

[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-3.
[2] Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, pgs. 24-29.
[3] Internal Correspondence from Peko, D. to McCurnin, W.R., Rockwell International, *Re: Radioactive Materials Disposal Facility Assessment Plan*, May 22, 1990.
[4] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys*, October 2007, pgs. 17, 31, 39.

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the manhole only had minor rust. The inspection log stated "no detection above background on multigas meter."[1]

Radiological Use Authorizations: At various times, the following use authorization was assigned to the RMHF complex.

- Use Authorization 27 was originally issued October 21, 1970 for the storage of irradiated stainless steel from the Systems for Nuclear Auxiliary Power 8 Development Reactor shield assembly at the RMHF storage yard. It is believed that the storage yard referenced is the Building 4563 area.[2,3]

Former Radiological Burial or Disposal Location: None found.

Aerial Photographs: Building 4563 is first identified on a 1965 aerial photograph as an open storage (OS) area, identified as OS-1 by the U.S. Environmental Protection Agency's (EPA's) aerial photographic analysis. OS-1 is originally located in the northern portion of the RMHF site and contains possible stains. In 1967, OS-1 nearly doubles in size to include an area along the north and west fence line of the RMHF. Staining also is identified in the area. In 1972, OS-1 is identified as a rectangular area in the southwest portion of the RMHF site and contains probable stains. In 1978, OS-1 includes most of the western portion of the RMHF site and contains possible stains, possible crates, and probable debris. In 1980, dark-toned material is identified on the west side of Building 4021. OS-1 is once again identified as a rectangular area in the southwestern portion of the RMHF site. Dark-toned material is noted extending from the north portion of OS-1 to the west side of Building 4021. In 1983, two separate areas in the western portion of the RMHF are identified as OS-1. In 1988, OS-1 is defined as the western portion of the RMHF site and contains stains. In 1995, multiple areas within the RMHF site are identified as OS-1 with probable stains. Staining is located in the west-central portion of the RMHF site. By 2005, OS-1 is defined as a rectangular area in the western portion of the RMHF site. Earth moving activity is noted in a large area along the northern perimeter of the RMHF site.[4]

Radionuclides of Concern: The most probable radionuclides of concern are uranium, plutonium, thorium, and mixed fission products.[5] These radionuclides of concern are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 11 – RFI Site Reports, Appendix G – Sewer Inspection Documentation Logs*, June 2009.
[2] *Radioactive Material Authorizations*, Rockwell International, BNA02647573.
[3] *Authorization for the Use of Radioactive Materials or Radiation Producing Devices*, Authorization No. 27A, Issue Date: October 21, 1971, Expiration Date: October 21, 1972.
[4] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[5] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 4

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Drainage Pathways: The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[1] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[2] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[3] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[4] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[5] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[6,7] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[8] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4563 area is Class 1, due to its former use as a storage yard and the lack of previous investigations.

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[1] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[2] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[4] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[5] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.
[6] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[7] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[8] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Additional soil sampling is recommended in the Building 4563 area. As discussed above, previous investigation and characterization studies for the Building 4563 area were incomplete and focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4563 area. This includes the following Building 4563 areas and appurtenances:

- Under the concrete foundation of Building 4563. The concrete foundation received only limited investigation. Because this area served as a storage location for radioactive materials, residual contamination may exist.

- Sewer line and manhole at the southeast corner of Building 4563. The 2009 sewer and manhole inspection found no contamination, but documentation was brief and this area should be inspected further. Residual contamination may exist.

- Asphalt-lined swale located north of Building 4563 that drained to the stormwater culvert at the west end of the RMHF complex. This drainage provides a possible pathway for contaminant migration and could result in residual contamination.

- Open storage area (OS-1) identified in aerial photographs with stains. Although, the aerial photograph analysis shows changes in OS-1 over time, a portion of OS-1 became Building 4563. Aerial photographs note stains in OS-1. This area requires further investigation for contamination.
- Surface drainage areas around the Building 4563 area. Because the Building 4563 area and surrounding areas were used for storage, and were not always covered, contamination from weathered storage containers or from spills further east in the RMHF complex could have followed drainage pathways near the building and could leave residual contamination.

2.7 Building 4621 Area

Site Description: The Building 4621 area comprises Building 4621 and the land surrounding it in the south-central portion of the Radioactive Material Handling Facility (RMHF) site, formerly the Radioactive Material Disposal Facility (RMDF) site. Building 4621 was constructed in the mid-1960s as the Radioactive Accountable Waste Storage Building. The building is located inside the 7-foot chain link fence area designated for the storage of containerized low to intermediate level radioactive waste.[1,2,3] Figures 2.7a through 2.7e provide a recent photograph

[1] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007,* pgs. A-2 – A-3.
[2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[3] Correspondence from Seward, F.A. to Nagel, W.E., *Re: Request for Radioactive Material and Radiation Producing Devise User Authorization for RMDF Operation*, December 10, 1985.

and the best available building-specific drawing(s) and photos that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: The building has a concrete foundation and floor with steel frame, roof and sides. It measures 21 feet by 32 feet and is 672 square feet in area. A 12-foot rollup door was located on the west side of the building. A paved, open, mixed waste storage yard was contiguous with Building 4621 on the north, east, and west side. Building 4621 is equipped with a criticality alarm that sounds locally and at the Santa Susana Field Laboratory (SSFL) Control Center.[1,2]

A 2009 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report states that a 500-gallon transfer tank used to transfer low-level radioactive waste water to the RMHF was stored in the mixed waste storage yard surrounding Building 4621.[3,4] However, a 1988 site visit found the same or similar 500-gallon portable radioactive tank was stored in Building 4022.[5]

A 700-gallon tank of waste antifreeze was being stored at Building 4621 during a visual site inspection in support of a 1994 RCRA Facility Assessment.[6]

Former Use(s): Building 4621 was a RCRA-permitted building used to store radioactive sources, radioactive low-level containerized waste and contaminated equipment. Dry and liquid mixed waste materials were stored in 55-gallon drums. Liquid mixed waste was stored on spill containment pallets. The mixed waste storage yard held non-liquid mixed waste in closed containers prior to offsite shipment.[7,8]

An Atomics International site waste management plan dated circa 1972 and an updated plan dated May 1974 provided information regarding the waste disposal activities at the SSFL. According to the waste management plan, which was prepared for the management of Atomic Energy Commission (AEC) contract wastes, AEC-owned waste management facilities, including treatment facilities and storage facilities, were located within the RMHF complex. These facilities included Building 4621. The waste management plan provided the following summary:

> "Temporary storage of low-level radioactive waste is performed in Buildings 621, 663, and 075. Low-level waste and contaminated equipment are temporarily stored in Buildings 075,

[1] Unknown Author, *RMDF Fire Preplans – Structures*, Unknown Date.
[2] Internal Correspondence from Horton, P.H. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Maderail [sic] and Radiation Producing Device User Authorization for RMDF Operations*, December 13, 1989.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures and Volume II – RFI Reports Appendix C*, June 2009, pgs. 2-6, C.2-5.
[4] Rockwell International Photograph, 6CZ11-4/5/89-S2F, April 5, 1989, HDMSP00033184.
[5] Lavagnino, G., *ETEC Meeting and Site Visit*, U.S. Department of Energy, August 17, 1988.
[6] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California, Technical Enforcement Support of Hazardous Waste Sites*, May 1994, p. 7-14.
[7] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, p. 11.
[8] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, pgs. A-2 – A-3.

> 621, and 663, and in the fenced storage area surrounding Building 621. These buildings are steel buildings, which are designed to provide protection from the elements and security for the stored items. Contamination control is provided by stringent packaging requirements, so exhaust filter systems and additional contamination control safeguards are unnecessary." [1,2]

An August 15, 1988 site visit report notes that radioactive solid wastes are "temporarily" stored in the RMHF yard during staging procedures. The report states that liquid waste was not stored outside any of the RMHF buildings, only solid waste, reducing the possibility of contamination in the yard. During the site visit, there was discussion about the possibility of drums "sweating," although the topic did not seem to be one that had been considered before. Interestingly, the report notes that "ETEC [Energy Technology Engineering Center] still does not consider adding berms and roofing in the RMDF Yard to be necessary." On the day of the visit, the Building 4621 yard contained 26 drums on pallets. Thirteen drums of "lead pigs" [shielded containment casks] contaminated with fixed low-level radiation were considered mixed waste and were awaiting transport to a U.S. Department of Energy (DOE) approved disposal site. The lead pigs were reported to be 15 years old, but had only been stored in the drums for the past 2 years. An additional 13 drums of nonradioactive lead components were stored on pallets in the Building 4621 yard as well.[3]

Information from Interviewees: None to date.

Radiological Incident Reports: There have been several incidents associated with Building 4621 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing. Summaries of only the incident reports that resulted or may have resulted in releases to the environment are provided following the table, when available. Summaries of all available incident reports are provided in Attachment A.

Building 4621 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0053	9/4/1975	621 Yard	Ra 226	During Tour Of RMDF A Lost Source Was Discovered.
A0055	6/2/1975	RMDF & Adjacent	Mixed Fission Product	Nine Spills Have Been Identified @ RMDF Complex.
A0570	8/18/1985	RMDF T-621		A False High Radiation Alarm Occurred And Was Responded To.
A0341	4/7/1989	T621 RAS		Response To False RAS Alarm.

- On September 4, 1975, a 132 millicurie (mCi) radium-226 (Ra-226) source was discovered lying on the ground between Building 4621 and Building 4075. The source was not in a shielded container and was not labeled or tagged and had two feet of string

[1] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.
[2] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.
[3] Lavagnino, G., *ETEC Meeting and Site Visit*, U.S. Department of Energy, August 17, 1988.

attached. Following its discovery, the source was properly marked and stored in a secure condition. According to the incident report, personnel assigned to the RMHF had been instructed to clean out building 4621. Personnel removed all sources stored within the building to the open yard. While moving items, personnel dropped the spherical container and spilled the encapsulated source on the ground. The incident report did not indicate how long the source remained unnoticed. The incident report indicated that no significant exposure or spread of contamination resulted from the incident (A0053).[1,2]

- An October 17, 1975, Rockwell letter discusses nine significant radioactive spill areas and numerous spot areas at the RMHF complex. Figure 2.7e presents the map of these areas, many of which were located in the western storage yard areas of the RMHF complex. The activity associated with the spills ranged from 0.5 to 3,500 millirads per hour. The spills were assumed to have occurred between 1972 and 1975 and to have followed the water course. One spill was a result of an empty high-level waste cask containing 15 rad per hour on the inside of the cask in the storage yard. The cask filled with rain water and flooded contaminated water out. Six similar casks were found. Additionally, three barrels of radioactive materials stored in "the backyard" tipped over and leaked or rotted out and leaked causing three other areas of contamination.[3] As of October 17, 1975, all spills in the storage yard and two spills outside the storage yard were decontaminated or removed. Cleanup on another spill had begun and two other areas were identified for cleanup, but had not yet been delineated (A0055).[4]

- A November 18, 1975 Rockwell letter follows up on the October 17, 1975 letter discussed above and describes the current status of the RMHF complex. The letter notes that there were three contaminated areas on the floor and shelves in Building 4621. One area appeared to be a result of liquid seeping from a barrel liner stored on one of the upper shelves. The second area appeared to be the result of a powdery substance on the floor. A third area of contamination was of an unknown origin.[5]

  The November 18, 1975 letter also describes the holdup yard as containing significant radiological sources including approximately 250 drums (30 and 50 gallons), 59 high level pigs, 50 liquid storage drums (30 gallon), 32 drums of high level waste, 20 pallets of concrete block, 9 concrete conduits, 10 pallets of miscellaneous materials, 4 transfer casks, and 3 pieces of contaminated Sodium Reactor Experiment (SRE) moderator handling equipment. Several areas of contaminated asphalt and approximately 35 contaminated pallets were noted in the holdup yard. The U.S. Environmental Protection Agency (EPA) finds it significant that the November 1975 letter notes that there were at least two separate major spills in the Building 4621 holdup yard, each covering

[1] Badger, F.H., Rockwell International Internal Letter, *Subject: Lost Source Discovery*, September 9, 1975.
[2] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 5.
[3] Based on the figure drawing, the research team believes the "backyard" area to be referencing the area north of Building 4621
[4] Internal Correspondence from Badger, F.H. to McCurnin, Jr., W.R., Rockwell International, *Re: Radioactive Spills in RMDF*, October 17, 1975.
[5] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.

approximately 100 square feet or more and several smaller spills of about 5 square feet or less.[1]

Additionally, external to all buildings and the holdup yard proper, an accumulation of boxes, barrels, conduits, liquid tanks, large rectangular metal containers, trash dumpsters, and other miscellaneous materials was noted.[2]

Several areas of contaminated asphalt and dirt were identified at the west end of the RMHF perimeter. The areas of contamination described in this letter appear to be the same areas described above in the October 17, 1975 letter. Contamination of dirt and asphalt was thought to be the result of long-term, outdoor storage. Contaminated items were generally wrapped in plastic and stored in the storage yard, but after three or more years of storage and exposure to weather, the integrity of the plastic wrapping was compromised exposing contaminated surfaces. Rain water could then carry contamination onto outer surfaces of containers and along drainage pathways of the RMHF complex. Rows of 30-gallon drums stacked on the asphalt at the west end of the RMHF perimeter and pallets of non-contaminated material presumably became contaminated in this manner.[3]

According to the November 1975 letter, since mid-July all of the contaminated and non-contaminated items were removed from Building 4621 holdup yard. Items that could be decontaminated were and items that could not be decontaminated were packaged for disposal. Asphalt and dirt were jack hammered out and put into 50-gallon drums. Concrete blocks were moved to the SRE for use as shielding during decontamination and decommissioning operations, if necessary. Contaminated items within Building 4621 were "decontaminated to as low as practical." The letter recommends that funds be made available soon to dispose of all the contaminated items found at the RMHF complex.[4]

Current Use: Building 4621 is still standing and along with the mixed waste storage yard is still active.[5,6] A 2009 site visit found 55-gallon drums on pallets and a large rectangular storage container inside Building 4621.[7] As of July 27, 2011, according to Boeing, three americium-241 (Am-241) calibration sources and six Am-241 smoke detectors were stored in Building 4621. Several contaminated treatment units, such as a cement mixer, fume hoods, a ball mill, and a drum mixer, were stored in a Sea-Land container immediately to the east of Building 4621.

[1] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.
[2] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.
[3] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.
[4] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.
[5] *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures,* MWH, June 2009, p. 3-9.
[6] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California,* March 2008.
[7] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **1981 Rockwell Environmental Survey**. In 1981, a preliminary survey was conducted to support RMHF decommissioning. Low levels of fixed and removable contamination were found in portions of the RMHF asphalt and in the soil beneath the asphalt paving. Localized areas of contamination were also discovered in the soil outside the north, west, and south fence perimeters. Thirty-seven locations were identified for sample collection with a micro-R meter. Samples were taken at the surface and at 12 inches below the surface (subsurface) to determine the extent of contamination. Surface soil sample activities ranged from 21.25 to 1,142.92 picocuries per gram (pCi/g). The soil activity at 12 inches deep ranged from 19.86 to 104.00 pCi/g. Sample results in the mixed waste storage yard and surrounding Building 4621 area are described in the table below. Boeing-stated background levels ranged from 20 to 30 pCi/g gross beta activity. Soil and asphalt sampling and radiological surveys identified eight areas with elevated radiological activity at the RMHF, including an area south of Building 4621. See Figure 2.1u for a more specific depiction of the sampling locations and Plate 1 for the location of contaminated areas.[1,2,3]

1981 Soil Sample Analysis Results

Sample Location	Surface Activity (pCi/g)	Subsurface Activity (pCi/g)
Western Mixed Waste Storage Yard	32.65	34.20
Western Mixed Waste Storage Yard	154.64	33.99
Western Mixed Waste Storage Yard	42.08	29.38
Outside North Storage Yard Fence	84.31	36.30
Outside Southern RMHF Perimeter Fence South of Building 4621	239.69	42.78
Outside Southern RMHF Perimeter Fence South of Building 4621	191.65	50.95

- **1991 Energy Technology Engineering Center Monthly Smear Surveys**. Project progress reports located for February, March, April, May, June, August, and October 1991 note that monthly smear surveys of Building 4621 found nothing unusual and no corrective actions were required.[4]

[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries,* May 2005, p. I-3.
[2] Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, pgs. 24-29.
[3] Internal Correspondence from Peko, D. to McCurnin, W.R., Rockwell International, *Re: Radioactive Materials Disposal Facility Assessment Plan*, May 22, 1990.
[4] Gaylord, G., *Energy Technology Engineering Center Project Progress Report Accounting Period for February-June 1991*, *August 1991*, *and October 1991*, *Radioactive Materials Disposal Facility (RMDF) Maintenance*, Engineering Technology Engineering Center, 1991, p. 2.

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Additionally, a 1991 Rockwell report notes that radiological conditions in the RMHF are determined by periodic surveys, which are summarized for the first quarter of 1991 in the report. Results are shown in the table below.[1]

RMHF Removable Contamination Levels for First Quarter, 1991

Location	Posting Status	Limits (dpm/100 cm^2) beta-gamma	Lowest Measured Level (dpm/100 cm^2) beta-gamma	Highest Measured Level (dpm/100 cm^2) beta-gamma
Building 4021 (Laundry, Change Room, Decontamination Room, Packaging Room)	Open	< 1,000	< 50	651*
	Contaminated Area	< 1,000	< 50	3,138**
Building 4022 Vault Storage	Open	< 1,000	< 50	5,000***
Building 4034 Offices	Open	< 1,000	< 50	< 50
Building 4044 Break Area	Open	< 1,000	< 50	< 50
Building 4075 Storage Area	Open	< 1,000	< 50	< 50
Building 4621 Storage Area	Open	< 1,000	< 50	< 50

* Alpha contamination of 33 dpm/100 cm^2 was found on the sink top in the change rom. The contamination was removed and subsequent surveyed showed levels to be < 20 dpm/100cm^2.
** Isolated instances of low-level (22 – 37 dpm/100cm2) alpha contamination were found on several occasions.
*** This measurement came from aluminum sheeting awaiting packing that was discovered during a routine smear survey. The sheet was sectioned and discarded as radioactive waste. No violation of U.S. DOE regulations occurred.

- **1997 Rockwell Radiation Survey**. A monthly radiation survey report dated May 27, 1997 found that Building 4621 had less than the 20 disintegrations per minute per 100 square centimeters (dpm/cm^2) limit of alpha activity and less than the 100 dpm/cm^2 limit of beta activity. The maximum exposure rate was 1.2 milliroentgens per hour (mR/hr).[2]

- **2003 RMHF South Fence Characterization**. In 2003, an extensive characterization was performed on soils outside the RMHF south fence. According to a 2003 Boeing site environmental report, this area has historically contained small amounts of cesium-137 (Cs-137). More than 40 soil samples were taken and analyzed for man-made gamma emitters. Cs-137 was detected in most samples and averaged 27 pCi/g, ranging from nondetectable to 124 pCi/g in isolated spots. The approved soil release criteria for Cs-137 was 9.2 pCi/g.[3] Contaminated soils were excavated. According to a 2009 RFI report, three small shallow excavations were performed south of Building 4621 and the mixed waste storage yard to mitigate the elevated mixed fission products (primarily Cs-137) detected in soils during the south fence characterization. The excavations measured 125 feet by 13 feet, 5 feet by 7 feet, and 7 feet by 12 feet. Excavation depths were

[1] Internal Correspondence from Barnes, J. to Rutherford, P., Rockwell International, *Re: First Quarter, 1991 ALARA Report*, August 8, 1991.
[2] Darcy, K., *Radiation Survey Report – T-0621*, Rockwell International, May 27, 1997, HDMSe00388911.
[3] Boeing, *Site Environmental Report for Calendar Year 2003, DOE Operations at The Boeing Company Rocketdyne Propulsion & Power, RD02-148-01*, September 2004, p. 5-13.

approximately 0.5 feet deep, with approximately 130 cubic yards of soil removed.[1,2] After removal of the contaminated soil, six more soil samples were taken from the area and the average Cs-137 concentration was lowered to 3.75 pCi/g, ranging from 1.65 to 7.08 pCi/g. According to Boeing, these samples were below the approved release criteria of 9.2 pCi/g, applicable at that time. Since the RMHF complex is still operating, a final cleanup survey will be performed after RMHF closure.[3]

- **2004 Boeing Demolition Program Management Plan**. According to a January 2004 demolition program management plan, Building 4621 will be surveyed to determine the presence and extent of any radiological contamination. If no contamination is present, the building will be demolished and removed by a subcontractor. If contamination is present, it will be removed to allow for subcontractor demolition or the contaminated structures will be dismantled and packaged as low-level radiological waste.[4]

- **2007 Boeing RMHF Building Radiological Surveys**. In 2007, Boeing performed radiological surveys on Buildings within the RMHF complex, including Building 4621. Building 4621 was divided into five survey units. The ceiling, the north wall, the east wall, the south wall and the west wall each composed a single survey unit. Data was also collected from and exterior doors, vents, and roof surfaces. The concrete foundation was outside of the scope of this survey. Measurements of fixed and removable surface residual radioactivity on the walls and ceiling of Building 4621 are described in the table below and are within Boeing-stated acceptable levels. However, limited investigation of building roofs concluded that additional survey data would be needed to determine suitability for release.[5]

[1] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California*, June 2009, p. 3-13.
[2] The research team could not verify this information from the source cited in the 2009 Resource Conservation and Recovery Act Facility Investigation report.
[3] Boeing, *Site Environmental Report for Calendar Year 2003, DOE Operations at The Boeing Company Rocketdyne Propulsion & Power, RD02-148-01*, September 2004, p. 5-13.
[4] Kneff, D.W. and R.D. Meyer, Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008, The Boeing Company, January 30, 2004, p. 19.
[5] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys*, October 2007, pgs. 17, 31, 39.

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Measured Surface Residual Radioactivity 2007 on Building 4621 Walls and Ceiling

Description	Average (dpm/100 cm^2)		Maximum (dpm/100 cm^2)		Removable (dpm/100 cm^2)		
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Tritium
DOE and NRC Allowable Limits*	100	5,000	300	15,000	20	1,000	10,000
Building 4621 North Wall Measured Values	15	673	129	1,045	2	75	17.3
Building 4621 East Wall Measured Values	25	189	68	918	2	58	17.3
Building 4621 South Wall Measured Values	23	277	101	724	2	58	17.3
Building 4621 West Wall Measured Values	23	-4	68	301	2	48	17.3
Building 4621 Ceiling Measured Values	27	557	65	831	2	20	17.3

*Most limiting value from U.S. Department of Energy (DOE) Order 5400.5 (1990) and U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86 (1974)

Radiological Use Authorizations: At various times, the following radiological use authorizations were assigned to Building 4621:

- Use Authorization No. 25 pertained to the storage of sources at Building 4621.[1]
- Use Authorization No. 33 was initially issued on March 17, 1971 and allowed for the use and storage of 5 millicuries (mCi) and 25 microcuries (µCi) cobalt-60 (Co-60) sealed sources and 40 mCi cesium-137 (Cs-137) sealed sources at 22 locations at the SSFL. The sealed sources were used for the calibration of fixed and portable radiological alarm systems at SSFL facilities, including the RMHF. The sealed sources were stored in Building 4621.[2,3,4]
- Use Authorization 72 was initially issued on January 8, 1974, for the storage of Cs-137 sealed sources at the RMHF storage building, Building 4621. The sources were used for continuous level measuring systems at the Building 4356 Sodium Component Test Installation.[5,1]

[1] Review of Radiation Safety Records Management System Index, November 2010.
[2] *Radioactive Material Authorizations*, Rockwell International, BNA02647573.
[3] Isotope Committee Chairman, *Authorization for Use of Radioactive Materials or Radiation Producing Device*, Authorization Nos. 33E-33H, 33J, 33L-33O, 33S, April 16, 1976 through March 26, 1990.
[4] Internal Correspondence from Barnes, J.G. to Logan, A.B., Rockwell International, Re: Notification for Renewal of Authorization for Use of Radioactive Materials or Radiation Producing Devices – Second Notice, March 3, 1994.
[5] Radioactive Material Authorizations, Rockwell International, BNA02647573.

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- Use Authorization 106 pertained to radioactive waste and contaminated materials generated at other authorized facilities. Use Authorization 106M, issued February 12, 1992, noted that operation of the RMHF included a) receiving, processing, packaging, and shipping radioactive wastes and materials generated by Rocketdyne activities, b) receiving, processing, packaging, and shipping radioactive laundry, c) receiving and processing liquid radioactive wastes, d) storing radioactive materials, and e) maintaining facilities equipment and materiel. Buildings 4021, 4022, 4044, 4075, and 4621 were listed as authorized use locations with the authorized users based out of Building 4034.[2]

- Use Authorization No. 107 was initially issued on April 18, 1977 for the use and storage of krypton-85 gas (Kr-85). A February 6, 1989 letter indicated that two Kr-85 aerosol neutralizers covered under Use Authorization 107 were not in active use and their storage in Building 4621 should be transferred to Use Authorization 125.[3,4]

- Use Authorization No. 125, issued September 18, 1981, authorized any isotope with an atomic number 3 through 105 in quantities within the limits of California License No. 0015-70 to be used or stored in Building 4621.[5] Internal Rockwell letters regarding use authorizations indicate the following sources have been stored in Building 4621: Am-241, Co-60, Cs-137, tritium (H-3), iridium-192 (Ir-192), plutonium-beryllium (PuBe), and "thorium-170 (Th-170)" [sic].[6,7,8,9] There is no known Th-170 isotope. The known isotopes of thorium range in mass number from 209 to 238. This may be a reference to thulium-170 (Tm-170) instead.

- Use Authorization 132E, issued November 25, 1991, was for the use and storage of a 0.1 µCi californium-252 (Cf-252) sealed source. The authorization noted that the source was to be transferred from a building at Rockwell International's Canoga Park facility to Building 4621 at the SSFL for storage.[10]

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[1] *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization No. 72, Issue Date: January 8, 1974, Expiration Date: January 8, 1975.
[2] Isotope Committee Chairman, *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization Nos. 106D, 106F-106M, Rockwell International, December 18, 1981 through February 12, 1992.
[3] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 5.
[4] Internal Correspondence from Stelman, D. to Nagel, W.E., Rockwell International, *Re: Transfer of Authorization 107 from Active to Storage Status*, February 6, 1989.
[5] *Authorization for Use of Radioactive Materials or Radiation Producing Device*, Authorization No. 125, Issue Date: September 18, 1981, Expiration Date: September 18, 1982.
[6] Internal Correspondence from Rowles, J.A. to Nagel, W.E., Rockwell International, *Re: Renewal of Authorization 125*, August 25, 1988.
[7] Internal Correspondence from Rowles, J. to Bulthuis, R., Rockwell International, *Re: Termination of Authorization 133*, May 9, 1991. This letter references a Th-170 source; however, no such isotope of thorium exists. The known isotopes of thorium range in mass number from 209 to 238. This reference may have meant thulium-170 (Tm-170).
[8] Internal Correspondence from Dix, T.E. to Rutherford, P.D., Rockwell International, *Re: Status of Use Authorization 18*, March 10, 1993.
[9] Internal Correspondence from Rutherford, P.D. to Klee, S.M., Rockwell International, *Re: Shipment of Radioactive Materials Under Use Authorization 75*, July 27, 1993.
[10] *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization No. 132E, Issue Date: November 25, 1991, Expire Date: November 25, 1992.

- Use Authorization No. 141 authorized the use of Am-241 in smoke detectors for any building at the SSFL, with the storage of unused smoke detectors in Building 4621.[1,2,3]

Former Radiological Burial or Disposal Location: None found.

Aerial Photographs: Building 4621 is first identified in a 1965 aerial photograph. It is located in the south-central portion of the RMHF site. Building 4663 is identified to the east of Building 4621. An open storage (OS) area, identified as OS-1 by the EPA's aerial photographic analysis, is located north of Building 4621. OS-1 contains possible stains. In 1967, OS-1 nearly doubles in size to include an area along the north and west fence line of the RMHF. Staining also is identified in the area. In 1972, OS-1 is identified as a rectangular area in the southwest portion of the RMHF site, abutting the west side of Building 4621, and contains probable stains. In 1978, OS-1 includes most of the western portion of the RMHF site and contains possible stains, possible crates, and probable debris. Dark-toned material is identified immediately northwest of Building 4621. In 1980, OS-1 is once again identified as a rectangular area in the southwestern portion of the RMHF site. OS-1 includes the area immediately north of Building 4621. Dark-toned material is noted extending from the north portion of OS-1 to the west side of Building 4021. In 1983, two separate areas in the western portion of the RMHF are identified as OS-1, including an area that abuts the north and west sides of Building 4621. In 1988, OS-1 is defined as the western portion of the RMHF site, abutting the north and west sides of Building 4621, and contains stains. In 1995, multiple areas within the RMHF site are identified as OS-1 with probable stains. One area identified as OS-1, includes the footprint of Building 4663, which is directly east of Building 4621. Staining is located in the west-central portion of the RMHF site, north of Building 4621. By 2005, OS-1 is defined as a rectangular area in the western portion of the RMHF site, west of Building 4621. Earth moving activity is noted in a large area along the northern perimeter of the RMHF site.[4]

Radionuclides of Concern: Building 4621 stored radioactive materials primarily in the form of mixed fission products from various waste sites.[5] A radioactive waste packaging document indicated that a container stored at Building 4621 included radioisotopes Co-60, Cs-137, strontium-90 (Sr-90), and thorium-232 (Th-232).[6] Internal Rockwell letters regarding use authorizations indicate the following sources have been stored in Building 4621: Am-241, Co-60, Cs-137, iridium-192 (Ir-192), plutonium-beryllium (PuBe), and "Th-170" [sic, possibly Tm-170]."[7,1,2] A 1992 semi-annual leak test and a 1995 radioactive materials license renewal

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[1] *Authorization for Use of Radioactive Materials or Radiation Producing Device*, Authorization No. 141H, Issue Date: February 27, 1996, Expiration Date: December 31, 1996.
[2] *Authorization for Use of Radioactive Materials or Radiation Producing Device*, Authorization No. 141I, Issue Date: December 16, 1996, Expiration Date: December 31, 1997.
[3] *Authorization for Use of Radioactive Materials or Radiation Producing Device*, Authorization No. 141K, Issue Date: December 15, 1998, Expiration Date: December 31, 1999.
[4] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[5] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. A-2.
[6] *Radioactive Waste Packaging Lot Follower and Procedure Verification Container No. L598*, Unknown Author, July 16, 1997.
[7] Internal Correspondence from Rowles, J.A. to Nagel, W.E., Rockwell International, *Re: Renewal of Authorization 125*, August 25, 1988.

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provided the following inventory of sources at Building 4621: Am-241, bismuth-210 (Bi-210), Cf-252, Cs-137, chromium-51 (Cr-51), cobalt isotopes (Co-56, Co-57, Co-58, and Co-60), Ir-192, lead-210 (Pb-210), Kr-85, manganese isotopes (Mn-52, and Mn-54), Ra-226, Sr-90, and thulium-170 (Tm-170).[3,4] All radionuclides of concern listed, with the exception of Cf-252, Co-56, Co-57, Co-58, Cr-51, Ir-192, Kr-85, Mn-52, Mn-54, and Tm-170, are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Cf-252, Co-56, Co-57, Co-58, Cr-51, Ir-192, Kr-85, Mn-52, and Mn-54 have relatively short half-lives and thus do not meet the criteria for analysis. Table 3.3 presents a summary of radiological contaminants of concern.

Drainage Pathways: Building 4621 and the mixed waste storage yard are surrounded by a berm, which would, in conjunction with the slope of the RMHF, direct a spill that is not immediately controlled to the stormwater catch basin identified as RMHF 4614 Holdup Pond.[5]

A channel in the pavement around Buildings 4621 prevents water from running into the building area. The same conditions are true for other buildings in the RMHF complex.[6]

The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[7] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[8] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[9] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[10] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any

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[1] Internal Correspondence from Rowles, J. to Bulthuis, R., Rockwell International, *Re: Termination of Authorization 133*, May 9, 1991. This letter references a Th-170 source; however, no such isotope of thorium exists. The known isotopes of thorium range in mass number from 209 to 238. This may have been a reference to a thulium-170 (TM-170) source.
[2] Internal Correspondence from Dix, T.E. to Rutherford, P.D., Rockwell International, *Re: Status of Use Authorization 18*, March 10, 1993.
[3] Wallace, J., *Semi-Annual Leak Text, T-621*, Rockwell International, April 10, 1992.
[4] Rockwell International, Rocketdyne Division, *Application for Renewal, State of California Broad Scope "A" Radioactive Materials License #0015-70, RI/RD-93-160, Exhibit 10: Inventory of Radioactive Sources*, Revised August 7, 1995, p. 6.
[5] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[6] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 63.
[7] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[8] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[9] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[10] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.

radioactive contamination enters the pond.[1] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[2,3] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

According to a June 2009 RFI report, the only portion of HSA-7 that naturally drains to the south is a small area south of the RMHF fence line. The area south of Building 4621 and the mixed waste storage yard is unpaved and surface water is conveyed via sheet flow to a south-facing slope that drains into concrete-lined drainage channel, which then discharges into a storm drain culvert.[4] A 1977 storm drain plan shows that this storm drain culvert channels surface drainage west to the RMHF 4614 Holdup Pond.[5]

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4621 area is Class 1, due to its former use as a mixed waste storage area and the numerous spills of radiological material in the area.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the Building 4621 area. As discussed above, Building 4021 was a mixed waste storage facility and there were several radiological incidents in the Building 4621 area. In addition, previous characterization studies for the Building 4621 area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4621 area. This includes the following Building 4621 areas and appurtenances:

- Under the concrete foundation of Building 4621. The concrete foundation received only limited investigation. Because this area served as a storage location for radioactive materials, residual contamination may exist.

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[1] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.
[2] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[3] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[4] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-7.
[5] Rockwell International Drawing, *Santa Susana Facility Area Plan, Storm Drain Master East, 303-GEN-C93*, September 1977.

- Open storage area (OS-1) near the north and west edge of Building 4621 where staining is noted in aerial photographs and radioactive spills have occurred as noted in Figure 2.7e. This area was used for open storage, contained visible staining, and was an area where numerous radioactive spills have been documented. The area may contain residual contamination.

- RMHF South Fence area located south of Building 4621. This area was previously found to be contaminated and was an area of natural southern drainage. Although previously contaminated spots have been excavated, the area should be reexamined.

- Surface drainage areas and berm around the Building 4621 area. Because the Building 4621 area and surrounding areas were used for storage, and were not always covered, contamination from weathered storage containers or from documented spills further east in the RMHF complex could have followed drainage pathways near the building and could leave residual contamination. The berm surrounding Building 4621 should also be examined as contamination could settle in corners of the berm.

2.8 Building 4622 Area

Site Description: The Building 4622 area comprises Building 4622 and the land surrounding it in the southeast corner of the Radioactive Material Handling Facility (RMHF) site, formerly the Radioactive Material Disposal Facility (RMDF) site. Building 4622 is identified on industrial planning maps as the Radioactive Waste Counting Building.[1] However, it is also identified as an Entry Building for the RMHF complex.[2] It first appears in a 1959 aerial photograph.[3] Figure 2.8 provides the best available photograph. The research team could not locate any building-specific drawing(s). Building 4622 was located at the southeast corner of the RMHF site. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4622 was approximately 500 square feet in size.[4]

Former Use(s): A July 3, 1962, Atomics International internal letter identifies Building 4622 as a “guard shack.” According to the letter, when the RMHF was activated, Building 4622 was equipped with a portal monitor and a hand-and-foot counter, to check all personnel in and out of the RMHF area. However, background activity levels rendered the equipment useless and it was replaced with portable equipment better suited for monitoring personnel.[5] A February 24, 1964, document outlining the emergency procedures for the RMHF also identifies Building 4622 as an entry building.[6] Historical documents indicate that Building 4622 was also used as a storage

[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[2] Shoemaker, *Operating Specification Radioactive Materials Disposal Unit*, February 24, 1964.
[3] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[4] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California*, *Volume 2 – Area IV Site Summaries,* May 2005, p. I-33.
[5] Schlapp, F.W., Atomics International Internal Letter, *Subject: Radiation Monitoring Equipment in Dormant Storage*, July 3, 1962.
[6] Shoemaker, *Operating Specification Radioactive Materials Disposal Unit*, February 24, 1964.

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location for visitor film badges and the control badge. It was reported on April 19, 1965, that Building 4022 had been used for the recent open air transfer of 20 Sodium Reactor Experiment (SRE) moderator cans in the vault of that building. As a result of the proximity of Building 4622 to Building 4022, background radiation in Building 4622 was raised from 0.05 "mr/hr" to approximately 0.2 "mr/hr" over a period of approximately 120 hours resulting in elevated film badge readings for the month of April.[1]

According to a 2005 historical site assessment (HSA) and a Resource Conservation and Recovery Act facility investigation work plan, Building 4622 was used as a health physics counting area. Samples of waste contained at the RMHF were taken to Building 4622 for radioactive counting. The research team could not locate historical documents to confirm these operations in Building 4622. It should be noted, however, that industrial planning maps for the Santa Susana Field Laboratory (SSFL) identify Building 4622 as Radioactive Waste Counting Building from March 1962 through March 1975. The building is no longer present on industrial planning maps beginning in July 1977.[2,3,4]

Information from Interviewees: None to date.

Radiological Incident Reports: None found.

Current Use: The 2005 HSA indicates that Building 4622 was demolished in approximately 1976.[5] The research team did not locate historical information to confirm the building's demolition in 1976; however, as indicated above, Building 4622 no longer appears on industrial planning maps beginning in July 1977.[6] Because limited information is available, the dimensions of any excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): According to the 2005 HSA, during its use, routine radiological surveys were conducted in Building 4622 to verify that the building had not become contaminated above the limits established by DOE Order 5480.11. The research team, however, did not locate any radiological surveys for the building.[7]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Location: None found.

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[1] Young, L.N., Atomics International Internal Letter, *Subject: Overexposure of April Film Badges at Building 622*, April 19, 1965.
[2] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries,* May 2005, p. I-33.
[3] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility FRI Site (SWMU 7.6 and Area IV AOC),* March 2008.
[4] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[5] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries,* May 2005, p. I-33.
[6] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[7] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries,* May 2005, p. I-33.

Aerial Photographs: Building 4622 first appears in a 1959 aerial photograph in the southeast portion of the RMHF site, at the northern terminus of 12th Street. In 1965, Buildings 4044 and 4688 are identified north of Building 4622. In 1980 and 1995, an aboveground pipeline is identified running along the eastern side of the RMHF site, east of former Building 4622. Based on aerial photographs, no other significant environmental features are visible in the immediate vicinity of Building 4622.[1]

Radionuclides of Concern: According to the 2005 HSA, Building 4622 was used as a health physics counting area. Samples of waste contained at the RMHF were taken to Building 4622 for radioactive counting.[2] A 1965 document states that custody of two radioactive items were transferred to an employee in Building 4622. The items included less than 1 "µc" of radium and 3 "mc" of strontium-90 (Sr-90).[3] The research team could not locate any more specific information on radionuclides of concern. It is presumed that waste handled at other RMHF complex buildings had the potential to be sampled and counted at Building 4622 and thus this building area should be surveyed for the same radionuclides of concern as the rest of the RMHF complex. Radionuclides of concern are included in the U.S. Environmental Protection Agency's (EPA's) October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[4] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[5] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[6] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[7] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[8] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground

[1] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[2] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries,* May 2005, p. I-33.
[3] Internal Correspondence from Tschaeche, A.N. to Schaubert, V.J., Atomics International, *Re: Transfer of Custody of Radioactive Material*, August 26, 1965.
[4] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[5] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[6] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[7] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[8] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.

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pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[1,2] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.
Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[3] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4622 area is Class 1, due to its possible use as a radioactive waste counting building and the limited information and investigation material available for this building.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Additional soil sampling is recommended in the Building 4622 area. As discussed above, little information is available on this building and the historical record does not provide conclusive evidence of Building 4622's function. Information on previous characterization studies for the Building 4622 area was also limited and focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4622 area. This includes the following Building 4622 areas and appurtenances:

- Former Building 4622 footprint. This building was possibly a counting area for radioactive waste samples. Residual contamination could be present. After the building was demolished, an aboveground pipeline crossed the building footprint in a north-south direction. If radioactive materials were released into the pipeline, residual contamination may exist in the materials inside and surrounding the pipeline.

- Surface drainage areas around the former Building 4622 area. Any releases of radioactive materials would have followed drainage pathways from the building and could leave residual contamination.

[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[2] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[3] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

2.9 Building 4658 Area

Site Description: The Building 4658 area comprises Building 4658 and the land surrounding it in the southeast corner of the Radioactive Material Handling Facility (RMHF) site, formerly the Radioactive Material Disposal Facility (RMDF) site. Building 4658 was originally constructed in 1959 as the Guard Shack. In 1981 or 1982, the entrance to the RMHF complex was reconfigured. New fencing, a new entrance gate, and a new guard shack were installed. The Guard Shack served as the main entrance point to the RMHF and is located adjacent to the entrance gate.[1,2,3] Figures 2.9a through 2.9e provide a recent photograph and the best available building-specific drawing(s) and photos that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4658 was approximately 100 square feet in area.[4]

Former Use(s): Building 4658 served as a guard shack throughout most of the operating history of the RMHF. In the late 1980s, security measures no longer required the use of the guard shack as an entrance to RMHF and its use was discontinued.[5]

Information from Interviewees: None to date.

Radiological Incident Reports: None found.

Current Use: Building 4658 is inactive.[6,7]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **2007 Boeing RMHF Building Radiological Surveys**. In 2007, Boeing performed radiological surveys on Buildings within the RMHF complex, including Building 4658. Building 4658 was divided into two survey units. The floor and lower walls below 2 meters compose one survey unit. The upper walls and ceiling compose the second survey unit. Data was also collected from exterior doors, vents, and roof surfaces. The concrete foundation was outside of the scope of this survey. Measurements of fixed and removable surface residual radioactivity on the floor and walls of Building 4658 are

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[1] Daniel, Mann, Johnson & Mendenhall, *R/A Waste and Fuel Storage, Guard Station, 303-022-A7*, September 25, 1959.
[2] Rockwell International Drawing, *RMDF Santa Susana Facility Security Systems Upgrade Fencing & Site Work, 303-022-C9*, September 22, 1981.
[3] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-7.
[4] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-7.
[5] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 5.
[6] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 5.
[7] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008.

described in the table below and are within Boeing-stated acceptable levels. However, limited investigation of building roofs concluded that additional survey data would be needed to determine suitability for release.[1]

Measured Surface Residual Radioactivity 2007 on Building 4658 Floor, Walls, and Ceiling

Description	Average (dpm/100 cm^2)		Maximum (dpm/100 cm^2)		Removable (dpm/100 cm^2)		
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Tritium
DOE and NRC Allowable Limits*	100	5,000	300	15,000	20	1,000	10,000
Building 4658 Floor and Lower Walls Measured Values	-12	-125	51	253	2	41	4
Building 4658 Upper Walls and Ceiling Measured Values	-16	82	17	816	2	19	4

*Most limiting value from U.S. Department of Energy (DOE) Order 5400.5 (1990) and U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86 (1974)

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Location: None found.

Aerial Photographs: Building 4658 cannot be clearly identified on aerial photographs. In 1980 and 1995, an aboveground pipeline is identified running along the eastern side of the RMHF site. Based on aerial photographs, no other significant environmental features are visible in the immediate vicinity of Building 4622.[2]

Radionuclides of Concern: Although no radionuclides of concern could be identified specific to Building 4658, this building was located at the entry point for all incoming and outgoing fuel and waste shipments. Therefore, radionuclides identified at other RMHF facilities should also be sampled for at this location. Radionuclides of concern are included in the Environmental Protection Agency (EPA) October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

[1] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys*, October 2007, pgs. 17, 31, 39.
[2] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.

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Drainage Pathways: The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[1] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[2] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[3] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[4] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[5] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[6,7] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[8] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4658 area is Class 1, due to its proximity to other buildings at the RMHF complex that handled radioactive material.

[1] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[2] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[4] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[5] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.
[6] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[7] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[8] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Additional soil sampling is recommended in the Building 4658 area. As discussed above, previous characterization studies for the Building 4658 area were limited and were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4658 area. This includes the following Building 4658 areas and appurtenances:

- Under the concrete foundation of Building 4658. The concrete foundation received only limited investigation. Because this area served as a storage location for radioactive materials, residual contamination may exist.

- Aboveground pipeline identified in aerial photographs along the eastern edge of the RMHF complex. The contents of this pipeline are unknown based on the aerial photograph, and it could have provided pooling locations for potential contaminants around pipeline supports. Residual radioactive contamination could be present.

- Surface drainage areas around the former Building 4658 area. Any releases of radioactive materials would have followed drainage pathways from the building and could leave residual contamination.

2.10 Building 4663 Area

Site Description: The Building 4663 area comprises Building 4663 and the land surrounding it in the south-central portion of the Radioactive Material Handling Facility (RMHF) site, formerly the Radioactive Material Disposal Facility (RMDF) site. Building 4663 was constructed in the late 1950s or early 1960s as an RMDF Storage Area.[1,2] Figures 2.10a through 2.10b provide the best available photograph and a relevant drawing. The research team could not locate any building-specific drawing(s). Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4663 features could not be found, but the building sat on a concrete pad that was approximately 1,300 square feet in size.[3]

Former Use(s): Building 4663 was a storage building and may have been used to store radioactive materials.[4,5]

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[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.

[2] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-39.

[3] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-39.

[4] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-39.

[5] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008.

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A 1964 inspection tour of Santa Susana Field Laboratory (SSFL) fuel storage areas notes that "the accumulation of 'loaded' filters in storage building 663 is becoming a problem. These filters are being 'loaded' at a rate of up to 20/week. Each filter may contain a meaningful quantity of uranium when one is machining fuels containing fully enriched uranium."[1] The Atomics International Reactor Fuels Committee discussed this accumulation of "loaded" ventilation system filters in Building 4663. According to the committee, these filters were being "loaded' at a rate of about 48 absolute filters per month (containing approximately 107 grams of uranium per absolute filter) and 48 pre-filters per month (containing approximately 80 grams of uranium per pre-filter) in the "FEM and FED" machining operations. The Committee thought that the uranium content of these filters could present problems, both with regard to potential criticality (following certain types of accidents, e.g., fires), and overall accountability economics. However, according to the Committee, at the time, the RMHF had no way of recovering these fuel values from the filter media.[2]

An Atomics International site waste management plan dated circa 1972 and an updated plan dated May 1974 provide information regarding the waste disposal activities at the SSFL. According to the waste management plan, which was prepared for the management of Atomic Energy Commission (AEC) contract wastes, AEC-owned waste management facilities, including treatment facilities and storage facilities, were located within the RMHF complex. These facilities included Building 4663. The waste management plan provided the following summary:

> "Temporary storage of low-level radioactive waste is performed in Buildings 621, 663, and 075. Low-level waste and contaminated equipment are temporarily stored in Buildings 075, 621, and 663, and in the fenced storage area surrounding Building 621. These buildings are steel buildings, which are designed to provide protection from the elements and security for the stored items. Contamination control is provided by stringent packaging requirements, so exhaust filter systems and additional contamination control safeguards are unnecessary."[3,4]

An August 15, 1988 site visit report notes that radioactive solid wastes are "temporarily" stored in the RMHF yard during staging procedures. The report states that liquid waste was not stored outside any of the RMHF buildings, only solid waste, reducing the possibility of contamination in the yard. During the site visit, there was discussion about the possibility of drums "sweating," although the topic did not seem to be one that had been considered before. Interestingly, the report notes that "ETEC [Energy Technology Engineering Center] still does not consider adding berms and roofing in the RMDF Yard to be necessary." On the day of the visit, the Building 4663 area contained a portion of approximately 300 drums of cobalt-60 (Co-60)-contaminated sand from the Building 4059 remediation. The remainder of the drums was stored inside and south of Building 4075. The site visit report notes that the drums of contaminated sand had concrete added to the top and bottom of each drum and were stored on 3-drum pallets with the

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[1] Internal Correspondence from Matten, K.L. to Fuel Committee Members, Atomics International, *Re: Inspection Tour of Santa Susana Fuel Storage Areas*, April 23, 1964.
[2] Internal Correspondence from Reactor Fuels Committee to Balent, R. et al., Atomics International, *Re: Tour and Inspection of AI Fuel Storage Facility – Minutes of Meeting of May 4, 1964*, May 14, 1964.
[3] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.
[4] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.

center drum "having the highest rad. level." Drums were reportedly stored outside during repalletizing or just prior to shipment. The drums were to be transported to Hanford, Washington for disposal. It was estimated that five to six truck loads would be required to handle the 300 drum total.[1]

Information from Interviewees: None to date.

Radiological Incident Reports: There has been one incident associated with Building 4663 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing. Summaries of only the incident reports that resulted or may have resulted in releases to the environment are provided following the table, when available. Summaries of all available incident reports are provided in Attachment A.

Building 4663 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0616	5/21/1967	RMDF Storage Yard	UC	A Drum Of U Metal Vented By Bullet Holes Caught Fire Upon Opening.

- On May 21, 1967, a 55-gallon drum containing uranium metal under calcium carbonate powder was found burning in the RMHF storage yard. Violent venting through a hole in the drum indicated a likely explosion. Three rifle shots were fired into the drum to relieve the pressure, and the drum was then moved by forklift to a steel rack. The fire "extinguished itself" and the drum was left outside to cool overnight. The drum was then moved to Building 4021 the following morning and was opened. Three of the 1-gallon cans within the drum began burning and the fire was extinguished with G-1 powder. The drum was left in Building 4021 until final disposition. According to the report, air samples, nasal swabs and contamination surveyed indicated that no significant release of radioactive materials or contamination of personnel occurred as a result of the fire (A0616).[2]

- An October 17, 1975, internal letter discusses nine significant radioactive spill areas and numerous spot areas identified at the RMDF complex. Figure 2.10b presents the map of these areas, most of which were located in the western storage yard areas of the RMDF complex. The activity associated with the spills ranged from 0.5 to 3,500 millirads per hour. The spills were assumed to have occurred between 1972 and 1975 and to have followed the water course. One spill was a result of a supposedly empty high level waste cask in the storage yard that filled with rain water and flooded contaminated water out. Six similar casks were found. Three barrels of radioactive materials stored in the backyard tipped over and leaked or rotted out and leaked causing three other areas. As of October 17, 1975, all spills in the storage yard and two spills outside the storage yard

[1] Lavagnino, G., *ETEC Meeting and Site Visit*, U.S. Department of Energy, August 17, 1988.
[2] Unknown Author to Remley, M.E., Atomics International Internal Correspondence, *Re: Radiation Safety Unit Weekly Newsletter for Period Ending May 27, 1967*, June 1, 1967.

were decontaminated or removed. Cleanup on another spill had begun and two other areas were identified for cleanup, but had not yet been delineated.[1]

Current Use: Demolished in the early 1970s. However, the remaining concrete pad serves as a storage area for non-radioactive material.[2] Based on available information, it is unclear if any excavation occurred during building demolition.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **1981 Rockwell Environmental Survey**. In 1981, a preliminary survey was conducted to support RMHF decommissioning. Low levels of fixed and removable contamination were found in portions of the RMHF asphalt and in the soil beneath the asphalt paving. Localized areas of contamination were also discovered in the soil outside the north, west, and south fence perimeters. Thirty-seven locations were identified for sample collection with a micro-R meter. Samples were taken at the surface and at 12 inches below the surface (subsurface) to determine the extent of contamination. Surface soil sample activities ranged from 21.25 to 1,142.92 picocuries per gram (pCi/g). The soil activity at 12 inches deep ranged from 19.86 to 104.00 pCi/g. Sample results in the Building 4663 area are described in the table below. Boeing-stated background levels ranged from 20 to 30 pCi/g gross beta activity. Soil and asphalt sampling and radiological surveys identified eight areas with elevated radiological activity at the RMHF, including an area south of Building 4663. See Figure 2.1u for a more specific depiction of the sampling locations and Plate 1 for the location of contaminated areas.[3,4,5]

1981 Soil Sample Analysis Results

Sample Location	Surface Activity (pCi/g)	Subsurface Activity (pCi/g)
Building 4633 Area North	25.33	34.38
Building 4633 Area South	33.79	24.54
Outside RMHF Perimeter Fence South of Building 4633	214.56	40.20

- **2005 Historical Site Assessment Routine Radiological Building Surveys**. According to a 2005 historical site assessment, during its use, routine radiological surveys were conducted in Building 4633 to verify that the building had not become contaminated

[1] Internal Correspondence from Badger, F.H. to McCurnin, Jr., W.R., Rockwell International, *Re: Radioactive Spills in RMDF*, October 17, 1975.
[2] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-39.
[3] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-3.
[4] Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, pgs. 24-29.
[5] Internal Correspondence from Peko, D. to McCurnin, W.R., Rockwell International, *Re: Radioactive Materials Disposal Facility Assessment Plan*, May 22, 1990.

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above the limits established by U.S. Department of Energy Order 5480.11. The research team, however, did not locate any radiological surveys for the building.[1]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Location: None found.

Aerial Photographs: Building 4663 is first identified in a 1965 aerial photograph. It is located in the south-central portion of the RMHF site. An open storage (OS) area, identified as OS-1 by the U.S. Environmental Protection Agency's (EPA's) aerial photographic analysis, is located north of Building 4663. OS-1 contains possible stains. In 1967, OS-1 nearly doubles in size to include an area along the north and west fence line of the RMHF. Staining also is identified in the area. In 1972, OS-1 is identified as a rectangular area in the southwest portion of the RMHF site, west of Building 4663, and contains probable stains. By 1978, Building 4663 is no longer visible in aerial photographs.[2]

Radionuclides of Concern: The most probable contaminants of concern associated with any possible radioactive material storage at Building 4663 were isotopes of uranium, plutonium, and thorium, and mixed fission products.[3] These radionuclides of concern are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[4] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[5] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[6] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[7] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm

[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-39.
[2] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[3] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-39.
[4] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[5] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[6] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[7] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.

Redacted

system to warn if any radioactive contamination enters the pond.[1] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[2,3] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[4] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4663 area is Class 1, due to its former use as a radioactive storage facility, a radiological incident and nearby spills, and its proximity to other facilities handling and storing radioactive waste.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Additional soil sampling is recommended in the Building 4663 area. As discussed above, previous characterization studies for the Building 4663 area were limited and focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Additionally, a radiological incident and spills near the Building 4663 area were noted in historical documents. Therefore, additional characterization is recommended for the Building 4663 area. This includes the following Building 4663 areas and appurtenances:

- Under the concrete foundation of Building 4663. The concrete foundation and roof have received only limited investigation. Because this area served as a storage location for radioactive materials, residual contamination may exist.

- Open storage area (OS-1) near north and west edge of Building 4663 where staining is noted in aerial photographs and radioactive spills have occurred as noted in Figure 2.10b.

[1] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California,* May 1994, pgs. 7-14 – 7-15.
[2] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[3] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[4] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

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This area was used for open storage, contained visible staining, and was an area where numerous radioactive spills have been documented. The area may contain residual contamination.

- Surface drainage areas around the Building 4663 area. Because the Building 4663 area and surrounding areas were used for storage, and were not always covered, contamination from weathered storage containers or from documented spills further east in the RMHF complex could have followed drainage pathways near the building and could leave residual contamination.

2.11 Building 4664 Area

Site Description: The Building 4664 area comprises Building 4664 and the land surrounding it in the northeastern portion of the Radioactive Material Handling Facility (RMHF) site, formerly the Radioactive Material Disposal Facility (RMDF) site. Building 4664 was constructed in 1964. It was identified on industrial planning maps as the Low-Level Waste Processing Building.[1,2] Figures 2.11a through 2.11o provide a photograph of the former location of Building 4664 and the best available building-specific drawing(s) and photographs that the research team could find. Building 4664 was located north of Building 4021. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4664 was approximately 1,200 square feet in size.[3] It was built near the abandoned Building 4021 septic tank and its construction required the removal of some cast iron sanitary sewer piping as a result. Construction also required new asphalt paving and relocation of the northern RMHF perimeter fence.[4,5] Drawings depict the low-level radioactive waste processing units and equipment on an uncovered equipment pad (see Figures 2.11b through 2.11n). This includes the clarification unit, evaporator unit, incinerator unit, and flocculation unit, exhaust stack, bag filter, cooling tower, and associated tanks, pumps, trench, and piping. Tank T-1 was the 5,000-gallon radioactive liquid storage tank outside Building 4021. Radioactive liquid waste was conveyed via piping to Tank T-2 located at the Building 4664 area. Tank T-2 was a 1,350-gallon radioactive waste storage tank. Tank T-3 was the 400-gallon clarification tower unit where radioactive waste would be filtered. Tank T-4 was the 200-gallon clarified water holdup tank. Tank T-5 was identified as a distillation holdup tank and T-6 was identified as an ion exchange tank. T-5 and T-6 have also been identified as condensate tanks. They were both located on the evaporator unit pad. A batch holdup tank was the primary unit of the evaporator. Evaporated liquids were exhausted from an approximately 15-foot stack that was monitored for radioactivity. Exhaust from the evaporator could be conveyed to either the bag filter at the Building 4664 complex or to Building 4022. The bag filter was connected to

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[1] Atomics International Drawing, *Low Level Radioactive Waste Facility, Mechanical Plan and Sections, 303-664-M2*, Approved February 1964.
[2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[3] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-41.
[4] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385,* Rockwell International, September 15, 1982, p. 11.
[5] Atomics International Drawing, *Low Level Radioactive Waste Facility, Site Plan & Details, 303-664-C1*, Illegible Date.

Building 4665. Drawings show radioactive liquids, as well as water, gas, electricity, and vent lines connected to Building 4664 from Building 4021 via overhead pipeline. A trench was also identified along the south side of the Building 4664 concrete pad to contain all wash down water.[1,2,3]

Former Use(s): Building 4664 was used as a processing facility for low-level radioactive waste at the RMHF. This building area was also formerly used as the flocculation and incinerator area. The flocculation tower was built to pretreat radioactively contaminated water to make it easier to filter. It was made unnecessary by better filters and was removed. According to a September 1964 letter, the RMHF acquired incineration equipment to burn low-level radioactive and toxic contaminated dry wastes generated by programs at Atomics International. The equipment was to be operational after October 5, 1964. The incinerator was to burn contaminated wood, plastics, paper, rags, leather and other burnables containing less than 10 percent moisture at the rate of 100 pounds per hour.[4,5,6.7]

A 1967 test report for the Building 4664 incinerator notes that an acceptance test was successful in that cellulose waste was safely incinerated at the design rate of 100 pounds per hour. Metallic objects were not reduced as successfully as paper products. No information regarding management of the incinerator ash was located. The test report also notes that the concrete trench, designed to receive any contaminated spill, is not waterproofed and seeped water at a slow rate. This seepage was noted as undesirable and the concrete was waterproofed as a result.[8]

According to Rockwell, the incinerator was a test installation. It was tested with nonradioactive waste, and failed to function well, so it was dismantled. According to Boeing, it was never tested with radioactive waste. The U.S. Environmental Protection Agency (EPA) does not have evidence that only non-radioactive waste was burned in the incinerator. Therefore, radioactive waste and material are presumed to have been stored and handled at this facility.[9,10,11.1]

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[1] Atomics International Drawing, *Modification for Low Level Radioactive Waste Equipment, Bldg. 664 – Plans, Sections & Details, 303-664-S4*, January 1966.

[2] Atomics International Drawing, *Low Level Radioactive Waste Facility 664, Flow Diagram, 303-664-P1*, Illegible Date.

[3] Atomics International Drawing, *Low Level Radioactive Waste Facility, Flow Diagram & Details, 303-664-M1*, Date Illegible.

[4] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-41.

[5] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008.

[6] Rockwell International, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective, N001ER000017*, December 1989, Rev. C May 30, 1991, p. 29.

[7] Internal Correspondence from Schlapp, F.W. to All P.E.s, R.E., and Supervision, Atomics International, *Re: Segregation of Radioactive (R/A) Wastes*, September 18, 1964.

[8] Internal Correspondence from Ehrlich, S. to Hartzler, R., Atomics International, *Re: RMDF Incinerator, Building 664 Santa Susana – Acceptance Text Report, Subsequent Work, and Miscellaneous Comments – PEWR 72515*, January 31, 1967.

[9] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-41.

[10] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008.

[11] Rockwell International, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective, N001ER000017*, December 1989, Rev. C May 30, 1991, p. 29.

Atomics International site waste management plans dated in the mid-1970s note the use of the flocculation tower and January 1979 incident reports (see radiological incident reports A0077 and A0232 below) note there was an overflow of the flocculation tower.[2,3,4,5] These incident reports show that the flocculation system was being used during this time, but also suggest a time where use of the system may have been reconsidered.

In 1977, the Building 4664 evaporator and incinerator systems were partially removed, leaving only the flocculation tower and the treated water tank.[6,7] The flocculation tower was removed sometime prior to February 1981.[8]

In 1982, the Building 4664 incinerator and support equipment were removed. The incinerator was disposed as radioactive waste, despite reportedly not being used with radioactive waste, and the support equipment was disposed for salvage. The concrete pad that previously supported the flocculation tower was scabbled to reduce the contamination to less than 500 counts per minute. About 800 square feet of contaminated asphalt and soil was removed and disposed as radioactive waste. This is depicted on Plate 1. The area was repaved with new asphalt. A September 24, 1982 letter notes that work continues on cleaning the concrete pad and the area between the pad and the fence. [9,10,11]

Information from Interviewees: None to date.

Radiological Incident Reports: There have been four incidents associated with Building 4664 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing.

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[1] Internal Correspondence from Schlapp, F.W. to All P.E.s, R.E., and Supervision, Atomics International, *Re: Segregation of Radioactive (R/A) Wastes*, September 18, 1964.

[2] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.

[3] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.

[4] Gardner, F.W. Rockwell International Internal Correspondence, *Re: Release of Radioactivity from RMDF – January 1979*, February 23, 1979.

[5] Gardner, F.W., Rockwell International Internal Letter, *Subject: Radiological Safety Incident Report RMDF*, February 26, 1979.

[6] Rockwell International, Photograph Number 7704-62920, June 15, 1977, HDMSP 00015902.

[7] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC),* June 2009, p. C.2-11.

[8] Internal Correspondence from Tuttle, R.J. to Francis, M.A., Rockwell International, *Re: Sources of Radioactively Contaminated Water at Santa Susana*, February 17, 1981, p. 2.

[9] Internal Correspondence from Page, J.P. to Roberts, W.J., Rockwell International, *Re: Engineering Development & Text Highlites – Week Ending 9/24/82*, September, 27, 1982.

[10] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC),* June 2009, p. C.2-12.

[11] Internal Correspondence from McCurnin, W.R. to Walter, J.H., *Re: Highlights – Week Ending 09-24-82*, September 24, 1982.

Building 4664 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0362	2/10/1965	T664 Flocculation Tower	Mixed Fission Product	R/A Liquid Processing System Tygon Hose Separated Spilling Onto Pavement.
A0489	5/13/1965	Bldg 22 Area	Mixed Fission Product	Flocculating Tower Overflowed Spilling R/A Water On Equipment, Pad And Soil.
A0615	5/21/1967	RMDF Truck	UC	A Drum Of UC Sludge Exploded On A Truck Outside.
A0077/A0232	1/17/1979	Floc Tower Area	Mixed Fission Product	R/A Water From Flocculation Tower Contaminated Drainage Ditch And Pond.

- On February 10, 1965, the evaporator system backed up. While attempting to remove a stoppage by reverse flow provided by the circulating pump of the flocculation system, excessive pressure buildup occurred and blew the flexible hose from its connection, releasing approximately 5 gallons of radioactive contaminated liquid onto the asphalt. The asphalt was contaminated to a maximum level of 2,000 disintegrations per minute (dpm/100 cm^2). Other components of the system were also contaminated to a maximum level of 2,000 dpm/100cm^2. Decontamination of the area was performed with hydrochloric acid and a scrub brush (A0362).[1]

- On May 13, 1965, while filling the flocculation tower with treated liquid for separating the sludge from liquid "suitable for processing in the evaporator system," the operator's attention was diverted and he failed to see the level indicator light on. The flocculation tower overflowed, spilling approximately 10 gallons of "chemically treated contaminated liquid" onto the tank and the tank equipment, the cement pad, and the surrounding soil. The incident report stated that smears indicated no contamination to the employee; however, the incident report did not indicate whether the surrounding area had been contaminated or whether the area was cleaned up (A0489).[2]

- On May 21, 1967, one of eighteen 55-gallon drums of uranium carbide sludge and other unspecified sludges exploded on a truck outside the RMHF incinerator, contaminating asphalt and evaporator equipment. The drum contained three 1-gallon cans of uranium carbide sludge that had been removed from the scrubber at Building 4005. Vermiculite and uranium contamination was blown into the evaporator and incinerator area, areas of asphalt, and over the north boundary fence. Contamination levels ranged from 300 to 5,000 dpm/100 cm^2. Initial cleanup of the area was performed with a vacuum cleaner and the evaporator and incinerator equipment was scrubbed down. The area was then "hosed down." The truck was decontaminated in the decontamination room and the drums were placed in the packaging room where the six drums containing sludge material

[1] Young, L.N., Atomics International Internal Correspondence, *Re: Incident Report RMDF – Building 664, February 10, 1965*, February 12, 1965.
[2] Young, L.M., Atomics International Internal Correspondence, *Re: Incident Report Building 022, May 13, 1965*, May 18, 1965.

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were kept until final disposition. The other twelve drums containing uranium carbide were decontaminated and shipped to Building 4064 for storage. The incident report did not include additional information regarding the decontamination procedures or the level to which the area was decontaminated. While the report indicated that area was "hosed down," additional information was not provided to indicate whether the area was still contaminated or whether the runoff was collected or allowed to enter the surrounding drainage channels (A0615).[1]

- A November 18, 1975 Rockwell letter describes an "area of concern" at the Building 4664 pad. The letter notes the equipment pad contained the "old evaporator, incinerator, and oxidation equipment." Although activity from the evaporator was sufficient to prevent the detection of contamination near the area, the letter states that preliminary indications show the ditch outside the fence is contaminated to the west of Building 4664. No other details are provided in the letter to indicate what may have caused the contamination, how or when it occurred, or what further steps were taken to characterize and remediate the contaminated area.[2]

- On January 17, 1979, radioactive water from the Building 4664 flocculation tower was leaked onto paving and rinsed into the RMHF 4614 Holdup Pond contaminating the drainage ditch and pond. It was estimated that approximately 2 gallons of contaminated water containing approximately 5×10^{-2} microcuries per milliliter (µCi/mL) of mixed fission products leaked from the tank. The incident report indicated that initially the flocculation tower pad and runoff ditch contained contamination levels of 25,000 counts per minute (cpm) with hot spots of 35,000 cpm. There was no information about any cleanup or removal actions. However, an asphalt sealant was applied on January 31, 1979, and levels reduced to 20 to 50 percent of the original values with an additional reduction of approximately 20 percent following the "runoff of the sealant." This incident is discussed in greater detail in Section 2.18, below, RMHF 4614 Holdup Pond (A0077, A0232).[3,4]

- On October 23, 1979, approximately 1 gallon of radioactive liquid representing waste from both the Sodium Reactor Experiment and Hot Lab was released into a catch basin under the "Building 4021" flocculation tower. The catch basin was "cleaned to about the same contamination level as usual," which was less than 1,000 dpm/100 cm^2 of beta-gamma activity. The incident report noted it was not practical to remove more activity at the time due to the deteriorated condition of the metal floor.[5]

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[1] Unknown Author to Remley, M.E., Atomics International Internal Correspondence, *Re: Radiation Safety Unit Weekly Newsletter for Period Ending May 27, 1967*, June 1, 1967.
[2] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.
[3] Gardner, F.W. Rockwell International Internal Correspondence, *Re: Release of Radioactivity from RMDF – January 1979*, February 23, 1979.
[4] Gardner, F.W., Rockwell International Internal Letter, *Subject: Radiological Safety Incident Report RMDF*, February 26, 1979.
[5] Internal Correspondence from Owens, D.E. to Radiation & Nuclear Safety Energy Systems Group, Rockwell International, *Re: Radiological Safety Incident Report, RMDF, October 23, 1979*, dated October 29, 1979.

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Current Use: Building 4664 was demolished in the early 1980s.[1] Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **1981 Rockwell Environmental Survey**. In 1981, a preliminary survey was conducted to support RMHF decommissioning. Low levels of fixed and removable contamination were found in portions of the RMHF asphalt and in the soil beneath the asphalt paving. Localized areas of contamination were also discovered in the soil outside the north, west, and south fence perimeters. Thirty-seven locations were identified for sample collection with a micro-R meter. Samples were taken at the surface and at 12 inches below the surface (subsurface) to determine the extent of contamination. Surface soil sample activities ranged from 21.25 to 1,142.92 pCi/g. The soil activity at 12 inches deep ranged from 19.86 to 104.00 pCi/g. One sample was taken in the northern drainage north of Building 4664. Sample results showed 37.60 pCi/g surface activity and 26.24 pCi/g subsurface activity. Boeing-stated background levels ranged from 20 to 30 pCi/g gross beta activity. Soil and asphalt sampling and radiological surveys identified eight areas with elevated radiological activity at the RMHF. See Figure 2.1u for a more specific depiction of the sampling locations and Plate 1 for the location of contaminated areas.[2,3,4]

- **2005 Historical Site Assessment Routine Radiological Building Surveys**. According to a 2005 historical site assessment, during its use, routine radiological surveys were conducted in Building 4664 to verify that the building had not become contaminated above the limits established by U.S. Department of Energy Order 5480.11.[5]

- **2006 RMHF North Slope Excavation**. According to a 2009 Resource Conservation and Recovery Act Facility Investigation report, in 2006 an approximately 100-square foot area northwest of Building 4664, on the RMHF northern slope adjacent to the asphalt swale, was excavated to approximately 0.5 feet below ground surface to mitigate elevated Cs-137 levels detected during site surveys. Approximately 50 cubic feet of soil was removed.[6,7]

Radiological Use Authorizations: None found.

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[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. L-41.
[2] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-3.
[3] Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, pgs. 24-29.
[4] Internal Correspondence from Peko, D. to McCurnin, W.R., Rockwell International, *Re: Radioactive Materials Disposal Facility Assessment Plan*, May 22, 1990.
[5] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-41.
[6] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures,* June 2009, p. 3-13.
[7] The research team was unable to verify this information from the source cited in the 2009 Resource Conservation and Recovery Act Facility Investigation report.

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Former Radiological Burial or Disposal Locations: Historical photographs taken in 1976 depict a disturbed area on the hillside north of Building 4664.[1,2]

Aerial Photographs: Building 4664 is never identified as a building in aerial photographs. In approximately 1960 plus or minus a year a probable open storage (OS) area is noted north of Building 4021. In 1965, an OS area, identified as OS-1 by the EPA's aerial photographic analysis, is located along the northern RMHF perimeter north and west of Building 4021. Possible staining is noted in OS-1. From 1967 through 1980, an aboveground pipeline extends from the north end of Building 4021 to the north end of the RMHF perimeter. This pipeline presumably connects to Building 4664 or some other feature in the location of Building 4664. In 1967, staining is noted in OS-1, west of the Building 4664 area. In 1978, a possible vertical tank is identified north of Building 4021, in the vicinity of Building 4664. OS-1 includes most of the western portion of the RMHF site and contains possible stains, possible crates, and probable debris. In 1980, the aboveground pipeline extending north from Building 4021 appeared to terminate in a subsurface feature identified as an area of dark-toned material. This are of dark-toned material was in the Building 4664 footprint. Drainage from this area is directed west along the RMHF perimeter. In 1995, multiple areas within the RMHF site were identified as OS-1 with probable staining, including an area in the former Building 4664 footprint. By 2005, OS-1 is defined as a rectangular area in the western portion of the RMHF site. Earth moving activity is noted in a large area along the northern perimeter of the RMHF site.[3]

Radionuclides of Concern: The most probable contaminants of concern are isotopes of uranium, plutonium, and thorium, and mixed fission products.[4] These radionuclides of concern are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: A trench was also identified along the south side of the Building 4664 concrete pad to contain all wash down water from the building units.[5]

The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[6] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[7] Surface water within the RMHF fenced area generally

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[1] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-4.
[2] MWH, *RCRA Facility Investigation Work Plan Addendum Second Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, October 2008, p. HDMSP00015875.
[3] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[4] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. L-41.
[5] Atomics International Drawing, *Modification for Low Level Radioactive Waste Equipment, Bldg. 664 – Plans, Sections & Details, 303-664-S4*, January 1966.
[6] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[7] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.

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flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[1] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[2] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[3] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[4,5] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[6] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4664 area is Class 1, due to its former use as a low-level radioactive waste processing facility, radiological incidents, and lack of previous investigation.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the Building 4664 area. As discussed above, there were radiological incidents at Building 4664 documenting radiological releases. Previous characterization studies for the Building 4664 area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by

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[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[2] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[3] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.
[4] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[5] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[6] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

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the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4664 area. This includes the following Building 4664 areas and appurtenances:

- Former Building 4664 footprint where the evaporator, flocculation tower, storage tanks, sumps, and piping were located. Any leaks in equipment that stored or processed radioactive waste could led to contamination and pooling in sump areas. Residual radioactive contamination could be present.

- Under the abandoned in place septic tank located below grade and between Building 4664 and 4665, north of the asphalt swale. Documented releases to the RMHF leach field indicate the septic tank may have left residual contamination in the area.

- Pathway of overhead pipeline that carried radioactive waste from Building 4021 to Building 4644. If this pipeline leaked it could have released radioactive contamination to the ground below and should be investigated for residual contamination.

- South side of Building 4664 footprint where trench was located to capture wash down water. As a low-lying area designed to capture liquids, this area could collect any contamination in the area. Residual radioactive contamination could be present.

- RMHF north slope excavation area northwest of Building 4664 where a 100-square foot area was excavated in 2006. Residual contamination was found in this area and it was excavated; however, residual contamination may still exist.

- Possible vertical tank location identified in 1978 aerial photograph. The contents of the vertical tank are unknown. Leaks in the tank could contribute to contamination or the tank foundation could have provided low lying areas that collected drainage. Residual radioactive contamination could be present.

- Area of dark-toned material in the Building 4664 footprint identified in a 1980 aerial photograph. If radioactive materials were released in this dark-toned material, residual contamination may be present.

- Disturbed area north of Building 4664 noted in a 1976 aerial photograph. That nature of this disturbance is unknown and should be further investigated to ensure radiological contamination does not exist.

- Asphalt-lined swale located north of Building 4664 that drained to the stormwater culvert at the west end of the RMHF complex. This drainage provides a possible pathway for contaminate migration and could result in residual contamination.

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- Surface drainage pathways associated with Building 4664. The primary local drainage was to the south of the Building 4664 concrete pad. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert at the western perimeter of the RMHF complex. Additional surface water flows from east to west across the RMHF complex to a storm drain culvert at the western perimeter of the area. If radioactive materials were released from Building 4664, drainage pathways should be examined for residual contamination.

2.12 Building 4665 Area

Site Description: The Building 4665 area includes Building 4665 and the land surrounding it along the northern fence line of the Radioactive Material Handling Facility (RMHF), formerly known as the Radioactive Material Disposal Facility (RMDF). Building 4665 was constructed in the 1964 as the RMDF Oxidation Facility.[1,2] Figures 2.12a through 2.12f provide a recent photograph and the best available building-specific drawing(s) and photos that the research team could find. Building 4665 was located north of Building 4022. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4665 has a concrete foundation and floor with a steel frame, roof, and sides. There were two 8-foot high sliding doors, one on the east side of the building and the other on the south side. Building 4665 measures 24 feet long by 20 feet wide by 10 feet high and is approximately 480 square feet.[3,4] Building 4665 was built near the abandoned Building 4021 septic tank and its construction required the removal of some cast iron sanitary sewer piping as a result. Construction also required new asphalt paving and relocation of the northern RMHF perimeter fence.[5,6] Drawings describe equipment associated with Building 4665, including the oxidizing mixer and collection hood. A water line is also shown connecting from Building 4664.[7,8,9] A 2009 site visit photograph shows a floor drain in the north end of the building. The site visit documentation also identifies a drainage pipeline located on the RMHF northern slope, but it is not clear if that pipeline is the discharge point for the Building 4665 drain or for the filter/blower areas trenches between Buildings 4021 and 4022.[10,1]

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[1] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 11.

[2] Atomics International Drawing, *Radioactive Scrap Oxidation Facility, Building 665, Santa Susana Field Laboratory, Floor Plan, Elevations, and Details, 303-665-A1*, Illegible Date.

[3] Unknown Author, *Building Reconnaissance Report, Building 665*, November 8, 1996.

[4] Unknown Author, *RMDF Fire Preplans – Structures*, Unknown date.

[5] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 11.

[6] Atomics International Drawing, *Low Level Radioactive Waste Facility, Site Plan & Details, 303-664-C1*, Illegible Date.

[7] Atomics International Drawing, *Radioactive Scrap Oxidation Facility, Miscellaneous Details, 303-665-M5*, Illegible date.

[8] Atomics International Drawing, *Radioactive Scrap Oxidation Facility, Equipment Layout Plan & Elevation, 303-665-M1*, Illegible date.

[9] Atomics International Drawing, *Radioactive Scrap Oxidation Facility, Building 665, Oxidizing Mixer Modification Details, 303-665-M3*, December 31, 1967.

[10] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.

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Former Use(s): Building 4665 was used as an oxidation facility and equipment storage area for the RMHF. It was used for long-term storage of sodium that had previously been temporarily stored in Building 4022 and at the Sodium Reactor Experiment.[2,3,4]
An undated fire preplan report notes that Building 4665 was used for the storage of paper, plastics, paints, filters, and lighting.[5]

A November 1996 building reconnaissance report states that the building had a minor crack in its floor and was used for the storage of hazardous materials. Equipment and supplies were noted throughout the building. The report states that less than 300 gallons of hazardous material was in the building storage racks at the time.[6]

Information from Interviewees: None to date.

Radiological Incident Reports: According to Boeing, there are no accidental releases or incident reports associated with Building 4665.[7]

Current Use: A 2009 RMHF site visit included photographs of Building 4665. Building 4665 was empty at the time and the oxidation equipment was removed. The concrete appeared to be in good condition.[8] The building may have also been used as a storage area for non-radioactive equipment and materials.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **1981 Rockwell Environmental Survey**. In 1981, a preliminary survey was conducted to support RMHF decommissioning. Low levels of fixed and removable contamination were found in portions of the RMHF asphalt and in the soil beneath the asphalt paving. Localized areas of contamination were also discovered in the soil outside the north, west, and south fence perimeters. Thirty-seven locations were identified for sample collection with a micro-R meter. Samples were taken at the surface and at 12 inches below the surface (subsurface) to determine the extent of contamination. Surface soil sample activities ranged from 21.25 to 1,142.92 pCi/g. The soil activity at 12 inches deep ranged from 19.86 to 104.00 pCi/g. One sample was taken in the northern drainage north of

1 Correspondence from Chell, M., MWH, to Waite, P., Boeing, *Re: Conversation with Paul Waite Regarding RHMF [sic] Site History,* February 23, 2009.
2 The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-5.
3 MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008.
4 MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. C.2-11.
5 Unknown Author, *RMDF Fire Preplans – Structures*, Unknown date.
6 Unknown Author, *Building Reconnaissance Report, Building 665*, November 8, 1996.
7 The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-5.
8 MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.

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Building 4665. Sample results showed 59.51 pCi/g surface activity and 42.19 pCi/g subsurface activity. Boeing-stated background levels ranged from 20 to 30 pCi/g gross beta activity. Soil and asphalt sampling and radiological surveys identified eight areas with elevated radiological activity at the RMHF. See Figure 2.1u for a more specific depiction of the sampling locations and Plate 1 for the location of contaminated areas.[1,2,3]

- **1995 Rockwell Building Radiological Surveys**. Routine quarterly and monthly radiological surveys are conducted in Building 4665 to determine if it had become contaminated above the limits established by U.S. Department of Energy Order 5480.11.[4] A November 2, 1995 quarterly radiation survey report found Building 4665 to have less than the 20 disintegrations per minute per 100 square centimeters limit (dpm/100 cm^2) alpha and less than 50 dpm/100 cm^2 beta (limit 100 dpm/100 cm^2). Exposure rates ranged between 0.03 and 0.06 milliroentgens per hour (mR/hr).[5] Monthly radiation survey reports dated May 27, 1997 and December 7, 1998 found Building 4665 to have less than 20 dpm/100 cm^2 alpha activity and less than 100 dpm/100 cm^2 beta activity. Exposure rates were less than 100 µR/h.[6,7]

- **2007 Boeing RMHF Building Radiological Surveys**. In 2007, Boeing performed radiological surveys on Buildings within the RMHF complex, including Building 4665. Building 4665 was divided into five survey units. The ceiling, the north wall, the east wall, the south wall, and the west wall each compose a single survey unit. Data was also collected from exterior doors, vents, and roof surfaces. The concrete foundation was outside of the scope of this survey. Measurements of fixed and removable surface residual radioactivity on the floor and walls of Building 4665 are described in the table below and are within Boeing-stated acceptable levels. However, limited investigation of building roofs concluded that additional survey data would be needed to determine suitability for release.[8]

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[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-3.
[2] Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, pgs. 24-29.
[3] Internal Correspondence from Peko, D. to McCurnin, W.R., Rockwell International, *Re: Radioactive Materials Disposal Facility Assessment Plan*, May 22, 1990.
[4] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-41.
[5] Wallace, J., *Radiation Survey Report, T-665*, Rockwell International, November 2, 1995, HDMSe00378816.
[6] Darcy, K., Radiation Survey Report, T-665, Rockwell International, May 27, 1997, HDMSe00388907.
[7] Garrett, R., *Radiation Survey Report, T-665*, The Boeing Company, December 7, 1998, HDMSe00381320.
[8] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys*, October 2007, pgs. 19, 31, 39.

Measured Surface Residual Radioactivity 2007 on Building 4665 Walls and Ceiling

Description	Average (dpm/100 cm^2)		Maximum (dpm/100 cm^2)		Removable (dpm/100 cm^2)		
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Tritium
DOE and NRC Allowable Limits*	100	5,000	300	15,000	20	1,000	10,000
Building 4665 North Wall Measured Values	-1	938	32	1,753	2	19	4.9
Building 4665 East Wall Measured Values	16	720	32	1,101	2	25	4.9
Building 4665South Wall Measured Values	18	1,287	48	2,056	2	25	4.9
Building 4665 West Wall Measured Values	13	1,254	48	1,775	2	96	4.9
Building 4665 Ceiling Measured Values	20	1,548	48	2,562	2	41	4.9

*Most limiting value from U.S. Department of Energy (DOE) Order 5400.5 (1990) and U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86 (1974)

Radiological Use Authorizations: None found.

Former Burial Radiological or Disposal Location: None found.

Aerial Photographs: Building 4665 is first identified on a 1965 aerial photograph. It is located along the northern fence line of the RMHF, north of Building 4022. In 1978, a possible vertical tank is identified between Buildings 4664 and 4665. In 1980, an area containing crates is identified east of Building 4665. In 1995, multiple areas within the RMHF site were identified as an open storage (OS) area, OS-1, by the U.S. Environmental Protection Agency's (EPA's) aerial photographic analysis, with probable staining, including an area west of Building 4665 in the former Building 4664 footprint. By 2005, earth moving activity is noted in a large area along the northern perimeter of the RMHF site.[1]

Radionuclides of Concern: Radioactive waste and material may have been stored or handled at this facility. The most probable radionuclides of concern are isotopes of uranium, plutonium, and thorium, and mixed fission products.[2] These radionuclides of concern are included in the

[1] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[2] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, pgs. 6-7.

EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[1] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[2] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[3] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[4] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[5] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[6,7] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[8] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4665 area is Class 1, due to its potential for contamination by storing items previously stored in Building 4022, the RMHF storage vault, as well as its proximity to Building 4022.

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[1] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[2] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[4] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[5] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.
[6] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[7] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[8] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

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Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Additional soil sampling is recommended in the Building 4665 area. As discussed above, previous characterization studies for the Building 4665 area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4665 area. This includes the following Building 4665 areas and appurtenances:

- Under the floor drain located in the north end of Building 4665. If any undocumented releases of radiological contamination occurred in the building, the floor drain may provide a discharge point for these releases and should be investigated for residual contamination.

- Under the concrete foundation of Building 4665. The concrete foundation received only limited investigation. Because this area served as a storage location for radioactive materials, residual contamination may exist.

- Under the abandoned in place septic tank located below grade and between Building 4664 and 4665, north of the asphalt swale. Documented releases to the RMHF Leach Field indicate the septic tank may have left residual contamination in the area.

- Possible vertical tank location identified in 1978 aerial photograph. The contents of the vertical tank are unknown. Leaks in the tank could contribute to contamination or the tank foundation could have provided low lying areas that collected drainage. Residual radioactive contamination could be present.

- Asphalt-lined swale located north of Building 4665 that drained to the stormwater culvert at the west end of the RMHF complex. This drainage provides a possible pathway for contaminate migration and could result in residual contamination.

- Surface drainage pathways associated with the Building 4665 area. This includes the drainage pathway west of Building 4665 that eventually drains to RMHF 4614 Holdup Pond. Residual contamination may exist in the drainage pathways.

2.13 Building 4688 Area

Site Description: The Building 4688 area comprises Building 4688 and the land surrounding it along the east fence line of the Radioactive Material Handling Facility (RMHF), formerly known as the Radioactive Material Disposal Facility (RMDF). Building 4688 was originally constructed northeast of Building 4003 (located in the Sodium Reactor Experiment [SRE] Complex Area) in approximately 1962 and was moved to the RMHF in approximately 1967 to serve as a storage structure.[1,2] Figure 2.13a provides a recent photograph and Figure 2.13b provides an historical photograph of pouring the concrete slab in the Building 4688 area. The research team could not locate any building-specific drawing(s). Building 4688 was located on the eastern edge of the RMHF complex. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4688 measures 21 feet by 30 feet and is 630 square feet in area. The building consisted of a steel frame with a corrugated metal canopy roof and no exterior walls.[3]

Former Use(s): Building 4688 was used as a storage facility and likely supported sodium cleaning activities. The building was used primarily as protection against the rain and sun.[4,5] A 1993 report states that Building 4688 was a hazardous materials storage shed that stored chemicals in small containers of one gallon or less. Chemicals included acetone, alcohols, solvents, laboratory reagents, paints, oils, and gasoline.[6] A large storage container, with unknown contents, is visible in the Building 4688 area in historical photographs from 1961 to 1989. Prior to the construction of the storage structure, the northern portion of the Building 4688 area was a concrete slab used for drum storage and it contained an oil sump. The sump was approximately 4 feet square by 6 feet deep, draining to a small (less than 1 foot square by 0.5 feet deep) depression containing the sump pump. The oil sump was taken out of service and the sump was removed in 2007. A 5 foot by 15 foot area was excavated and assumed to be backfilled. The concrete was not repaired, but a metal plate was placed over the excavation.[7,8] The research team could not locate additional information on the oil sump period of use, discharge point, or excavation details.

Information from Interviewees: None to date.

Radiological Incident Reports: None found.

Current Use: A 2009 site visit notes that the Building 4688 area is currently used for equipment, hazardous waste, and chemical storage. Three locked storage cabinets located under the Building 4688 awning stored hazardous waste and chemicals that are inspected weekly. A

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[1] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-6.
[2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[3] Unknown Author, *RMDF Fire Preplans – Structures*, Unknown Date.
[4] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-6.
[5] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 7.
[6] *Current Conditions Report and Draft RCRA Facility Investigation Work Plan, Area IV Santa Susana Field Laboratory, Ventura County, California, Part 1 – Current Conditions Report Volume 1*, ICF Kaiser Engineering, October 1993, p. 4-39.
[7] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Table C.3-2A, Attachment C-4.
[8] Daniel, Mann, Johnson & Mendenhall, *R/A Waste and Fuel Storage, Plumbing Site Plan, General Notes & Legend, 303-022-M1*, September 25, 1958.

large storage container is located on top of the former oil sump between Building 4688 and 4044. The area north of Building 4688 contained a metal structure and was used as a drum and packaging inspection area. The site visit identified cracked, worn, and degraded concrete in the Building 4688 area.[1]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **1975 Rockwell Preliminary Survey**. A November 18, 1975 Rockwell letter describes an "interim storage yard" between the RMHF complex and the SRE. A map attached to an October 17, 1975 depicts this area east of Building 4688. According to the November 18, 1975 letter, preliminary surveys of this "interim storage yard" indicated that there were areas of contamination on the ground. The letter notes that the area must be cleared of brush and pallets of material must be moved to further delineate the spill areas.[2,3] No other details have been located on this storage yard, including the type and extent of contamination and any remedial actions.

- **2007 Boeing Radiological Survey**. In 2007, Boeing performed radiological surveys on Buildings within the RMHF complex. Although no survey units were developed for Building 4688, a limited amount of survey data was collected from roof surfaces. Also, spot checks of the building revealed significant levels of beta-emitting residual radioactivity on several of the support columns. Boeing directed the survey activities be discontinued. Limited investigation of the building roof concluded that additional survey data would be needed to determine suitability for release.[4]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Location: A debris survey conducted in February 2008 identified a debris area on the hillside east of Building 4688, where an empty 55-gallon drum was found.[5]

Aerial Photographs: Building 4688 is first identified in a 1967 aerial photograph. It is located along the northeast border of the RMHF site. In 1980, a north-south running aboveground pipeline is identified along the east side of Building 4688, with an east-west running pipeline terminating near Buildings 4044 and 4688. In 1983, 1988, 1995, and 2005 the east-west running

[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II –RFI Site Reports, Appendix C*, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), June 2009, p. Attachment C-4.
[2] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.
[3] Internal Correspondence from Badger, F.H. to McCurnin, Jr., W.R., Rockwell International, *Re: Radioactive Spills in RMDF*, October 17, 1975.
[4] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys*, October 2007, pgs. 19, 40.
[5] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-4.

pipeline is still identified. In 2005, earth moving activity is noted in a large area along the northern perimeter of the entire RMHF site.[1]

Radionuclides of Concern: Although designated a non-radioactive chemical storage facility, radioactive material was apparently stored under the Building 4688 structure. The most probable radionuclides of concern are isotopes of uranium, plutonium, and thorium, and mixed fission products.[2] These radionuclides of concern listed are included in the U.S. Environmental Protection Agency (EPA) October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[3] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[4] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[5] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[6] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[7] The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[8,9] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.

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[1] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[2] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 7.
[3] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[4] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.
[5] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[6] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.
[7] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.
[8] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[9] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.

Redacted

Chatsworth Formation groundwater flow in the vicinity of RMHF is to the northwest as indicated by water level elevations at monitoring wells.[1] This is an important consideration for the RMHF complex because contamination has been fixed in place in the asphalt paving at various times. Over the years, degradation of the asphalt creates a potential for contamination to be released underneath the pavement, and as noted in a 1993 letter (See Section 2.1), Rockwell staff suspect significant contamination exists beneath the asphalt-covered RMHF area.

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4688 area is Class 1, due to the drum storage in the area and Building 4688's proximity to RMHF Building 4022, which stored radioactive materials, and limited previous investigations.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Additional soil sampling is recommended in the Building 4688 area. As discussed above, previous characterization studies for the Building 4688 area were limited and were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4688 area. This includes the following Building 4688 areas and appurtenances:

- Under the concrete foundation of Building 4688. The concrete foundation received only limited investigation. Because this area served as a storage location for radioactive materials, residual contamination may exist.

- Drum storage and packaging area north of Building 4688. This area was uncovered and if containers were stored for a long period of time they could be compromised by weathering and leak contents. This area should be investigation for residual contamination.

- Former oil sump in the Building 4688 area. A 2009 photograph shows a large rectangular container sitting over the former oil sump, which was covered with a metal plate. Although this was an oil sump, it provides a low area that could retain stormwater that is contaminated with radioactivity and, therefore, residual contamination could exist.

- Debris area/interim storage yard on the hillside east of Building 4688 identified in a February 2008 survey and 1975 drawing. Because information on this area is limited and a 1975 letter indicates possible spill areas, further investigation is needed to determine if any contamination exists.

- Pipelines associated with the Building 4688 area should be examined because they could provide drainage pathways for contaminant migration. Residual contamination may exist.

[1] Haley & Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 2-3.

- Asphalt-lined swale located north of Building 4688 that drained to the stormwater culvert at the west end of the RMHF complex. This drainage provides a possible pathway for contaminate migration and could result in residual contamination.

- Surface drainage pathways associated with the Building 4688 area. This includes the drainage pathway west of Building 4688 that eventually drains to RMHF 4614 Holdup Pond. Residual contamination may exist in the drainage pathways.

2.14 RMHF Leach Field Area

Site Description: The Radioactive Materials Handling Facility (RMHF) Leach Field area comprises the RMHF Leach Field and the land surrounding it north of the RMHF fence line and near the northern edge of the Area IV boundary. The RMHF Leach Field was constructed in early 1959 for the Radioactive Materials Disposal Facility (RMDF), later known as the RMHF. The RMHF consists of seven functional buildings on approximately 3 acres of land.[1,2] Figures 2.14a through 2.14h provide a recent photograph and the best available drawing(s) and photos that the research team could find.

Building Features: The RMHF Leach Field was constructed as an irregular-shaped excavation approximately 35 feet wide, 110 feet long, and 6 feet deep. It was constructed as an excavation that was backfilled with 4 feet of gravel, covered with a paper barrier, and then covered with native soil to the original grade. The excavation was made to the fractured sandstone rock common in the area or in the soil overburden where underlying rock was deeper than the excavation. The RMHF Leach Field was the gravity-fed disposal point for a 1,500-gallon septic tank sanitary waste system that accepted waste from the Building 4021 lavatories, shower, and toilets. The septic tank was buried at the top of the embankment forming the north side of the RMHF site. A second connection to the RMHF Leach Field, bypassing the septic tank, was made from the radioactive water processing system at the waste holdup tank (T-1) on the west side of Building 4021. Liquid waste from the radioactive holdup tank was reportedly discharged to the leach field only after sample analysis indicated radioactive contamination was within "acceptable limits."[3,4,5] The term "acceptable limits" are not know in this context and are not likely compliant with the December 2010 Administrative Order on Consent AOC.

The RMHF Leach Field consisted of a 3,400-square foot transpiration bed with two parallel perforated pipes that extended 100 feet to a concrete distribution box. The distribution box was located at the west end of the leach field and was connected to the outlet of the septic tank by a 4-inch diameter cast iron sanitary sewer pipe. The sanitary sewer pipe also connected to the Building 4021 radioactive liquid storage tank (T-1) via a sanitary wye. The septic tank inlet was

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[1] Internal Correspondence from Horton, P.H. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Maderail [sic] and Radiation Producing Device User Authorization for RMDF Operations*, December 13, 1989.
[2] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385,* Rockwell International, September 15, 1982, p. 11.
[3] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385,* Rockwell International, September 15, 1982, p. 11.
[4] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures,* June 2009, pgs. 3-7–3-8, 3-18.
[5] Collins, J., *Final Radiological Inspection of the RMDF Leach Field for Release for Unrestricted Use, N704TP990010*, Rockwell International, August 12, 1980, p. 9.

connected to the Building 4021 outfall. Approximately 300 feet of sanitary sewer pipe was buried with 2 to 3 feet of soil cover.[1,2]

Former Use(s): The RMHF Leach Field was used from early 1959 through late 1961 for the disposal of sanitary waste associated with Building 4021. In late 1961, a central sanitary sewer system was constructed at the Santa Susana Field Laboratory and Building 4021 was connected to it. RMHF sanitary waste was subsequently accepted at the Area III sewage treatment plant. The RMHF septic system was abandoned in place. Buildings 4664 and 4665 were built in 1964 on the site of the septic tank. A portion of the connecting sanitary sewer was removed because it interfered with building construction.[3,4,5]

Information from Interviewees: A number of former employees were interviewed about their experience at the Santa Susana Field Laboratory. Three remembered specific information about the RMHF Leach Field. Excerpts from these interviews are included below.

Interviewee 254 worked at the Santa Susana Field Laboratory from 1957 to 1989 and became the Engineer in Charge (EIC) at the RMDF, now known as the RMHF. The following excerpts were pulled from the interview.

> *"The RMDF had some spills over the years. There was a spill into the leach field that happened before my time. I only learned about it because we had a big program, with a big budget, to clean up the leach field. It was going on while I was at the RMDF, but I wasn't directly involved in the clean up at the leach field itself. The people working on the clean up had to be fully dressed in protective clothing that was supplied by the RMDF.*
>
> *There was absolutely no on-site disposal of radiological waste to my knowledge. I mentioned the spill at Building 20 from the transfer tank overflowing, the leach field spill at RMDF, and the "dip-leg tube" at SRE.*
>
> *I had a couple of jobs that involved searching through junk that was deposited in canyons. Debris, deemed to be clean at the time, had been disposed in the canyons and when we learned about the hazards of asbestos I had the job of searching through the debris piles to get the asbestos out. This occurred when I worked at RMDF when I was heading up D&D teams."*[6]

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[1] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 11.
[2] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures,* June 2009, p. 3-8.
[3] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 11.
[4] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-4.
[5] ICF Kaiser Engineers, *Current Conditions Report and Draft RCRA Facility Investigation Work Plan, Area IV, Santa Susana Field Laboratory, Ventura County, California, Part 1- Current Conditions Report, Volume 1*, October 1993, p. 4-40.
[6] Interview No. 254 conducted by DOE and EPA on July 20, 2010.

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Interviewee 419 retired from Rockwell International/ Boeing as the Division Director for Environment, Health and Safety. The interviewee was a member of the Environmental Health and Safety group for 22 years. The following excerpts were pulled from the interview.

> *"The parking lot at the RMDF drained to the RMDF pond, which was also radiologically monitored. There was a cleanup on the RMDF slope between the parking lot and the end of the property. It entailed cleanup of the parking lot, slope, and an adjacent leach field. After the cleanup was completed, asphalt was put in place to seal any remaining contamination in place during the RMDF leach field clean up. The spill was the result of a large plastic carboy that failed."* [1]

Interviewee 277 started working at SSFL in May 1975 as a technician in Building 4006 for Atomic International's Sodium & Component Technology Group. The interviewee was transferred 2 to 3 years later to work at the RMHF. The following excerpts were pulled from the interview.

> *"After working for 2 or 3 years at Building 006, I was transferred to RST's department at the radioactive materials disposal facility (RMDF).*
>
> *Once we had a spill of water at the RMHF when a tech left the water running and the fill tank with radioactive water in it overflowed onto the asphalt. It was handled immediately like the charge of the light brigade. I was called in at night in the rain to help vacuum the water off the asphalt that drained to the pond at the bottom of the hill. The pond did overflow into the canyon in heavy rains. The pond is no longer there – it was dug out. The pond was actually built for Building 28 – there was a drainage line direct from Building 28 to the pond. Now drainage water is pumped into a Baker tank, to 17th Street and then to Silvernale Reservoir and to outfall 18, I think. There was also a septic tank and leachfield in the canyon to the north of the RMHF. In 1984, maybe 1985, they found radioactive water got into the septic system; the leachfield was dug up and never replaced. The septic tank remains but it was plugged with cement."* [2]

Radiological Incident Reports: There have been a couple of incidents associated with the RMHF Leach Field that indicate a release to the environment. The following table provides information presented in an incidents database provided by Boeing. Summaries of only the incident reports that resulted or may have resulted in releases to the environment are provided following the table, when available. Summaries of all available incident reports are provided in Attachment A.

[1] Interview No. 419 conducted by DOE in 2010.
[2] Interview No. 277 conducted by DOE in 2010.

RMHF Leach Field Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0056/A0064	11/3/1976	RMDF Leach Field	Mixed Fission Product	Contaminated Leach Field Discovered During RMDF North Slope Recovery.
	2/14/1978	RMDF Leach Field	Mixed Fission Product	Leach Field During Decontamination Flooded With Rain Water.

- According to the 1982 RMDF Leach Field decontamination final report, prior to the connection of Building 4021 to the central sanitary sewer in late 1961, a valve to the emergency overflow of the radioactive water processing system was left partially open and allowed an unknown amount of contaminated water to enter the leach field system. Further investigation indicated that the distribution box flooded and leaked near its upper surface when the radioactive materials were introduced. The radioactive materials percolated northeasterly as well as down the north leach line and into the gravel bed. Historical information regarding this release of contaminated water to the leach field could not be located by the research team.[1] According to a 1992 report on tritium release, the RMHF Leach Field became contaminated as a result of releasing approximately 5,000 gallons of water from the RMHF radioactive water system. It was assumed the major source of radioactive water at that time came from cleanup of the Building 4020 hot cells after examination of fuel assemblies from the first Sodium Reactor Experiment (SRE) core or from wash water used at the SRE. The 1992 Rockwell report author estimates 0.1 curies (Ci) of cesium-137 and 0.017 Ci of tritium were released to the leach field, although the values are arbitrary as they try to account for losses to evaporation. According to the 1992 report, the RMHF Leach Field is considered a possible source of tritium in groundwater.[2]

- On November 3, 1976, the RMHF Leach Field connected to Building 4021 was found to be contaminated at levels up to 200 millirads per hour (mrad/hr). To date, the research team has not located the incident report documenting this incident.[3]

- On February 14, 1978, the RMHF Leach Field was found to have contaminated water draining from it as a result of heavy rains in February. These rains caused mud slides blocking some of the drainage paths around the leach field resulting in flooding of the field. This was compounded by flow of surface water directly into the gravel bed of the leach field through exploratory wells that had been drilled during 1976.

  The drainage water was reported to be contaminated with strontium-90 (Sr-90) at a level of 4×10^{-5} microcuries per milliliter (µCi/mL) gross beta activity although other contaminants were possible. The point of drainage was dammed by use of sandbags and

[1] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, pgs.12, 14.
[2] Tuttle, R.J., *Tritium Production and Release to Groundwater at SSFL, RI/RD92-186*, Rockwell International, December 1, 1992, pgs. 4-10–4-11.
[3] The incident reports database indicated that Incident Number A0056 refers to the discovery of the contaminated leach field during the RMHF North slope recovery; however Incident Report A0056 refers to a February 14, 1978, incident.

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a sump was dug to retain additional drainage. Soil was removed from the surface of drainage channels downstream of the leach field to remove the contamination deposited by the runoff.

A "large number" of water and soil samples were taken and analyzed from the point of drainage downstream to the "site boundary and beyond." The results showed that surface water runoff samples ranged from a maximum of 4.6 x 10^{-5} µCi/mL beta in the drainage from the leach field to 1.0 x 10^{-7} µCi/mL beta approximately 0.25 miles past the Area IV boundary line. Soil radioactivity ranged from a maximum of 1,880 picocuries per gram (pCi/g) beta at the leach field to normal background of approximately 24 pCi/g beta near the Area IV boundary line.
Based on estimates, the U.S. Environmental Protection Agency (EPA) finds it significant that the incident report indicated that the release from the leach field was estimated to not exceed 3.2 millicuries (mCi). It was recommended the leach field be decontaminated in 1978. The incident report did not provide a figure showing the extent of contamination (A0056, A0064).[1]

Current Use: The RMHF Leach Field was not used following the construction of the central sanitary sewer in late 1961.[2,3] Decontamination and cleanup of the RMHF Leach Field (see below) has left the area below its original grade.[4]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s):

- **1966 Environmental Survey**. On January 4 and 10, 1966, a special environmental survey of the RMHF area was performed. Samples of soil, vegetation, and water were obtained outside the north fence line of the RMHF, in the drum storage yard, and in the ravine north of the RMHF. Gross beta-gamma activity levels ranged from 26 to 1,005 pCi/g for soil, 161 to 70,680 pCi/g for vegetation, and 30 to 30,400 picocuries per liter for water. The maximum soil radioactivity was found north of the drum storage yard. The maximum vegetation radioactivity was found in the ravine north of Building 4021, in what appears to be the location of the RMHF Leach Field. The maximum water radioactivity was found in a sample location described as "North 10 x 10." No other information is provided to determine where this water sample was collected. A vegetation sample from the ravine north of the RMHF was sent to the Reactor Chemistry Group to determine if the contamination found in the ravine could have been caused by sodium oxide.[5] Sample collection, analysis and validation associated with the data were not provided in the 1966 letter report and thus the validity of the data cannot be verified.

[1] Tuttle, R.J., Rockwell International Internal Correspondence, *Re: Contaminated Runoff from RMDF Leach Field*, March 2, 1978.
[2] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 11.
[3] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-4.
[4] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385,* Rockwell International, September 15, 1982, pgs. 21, 23, 29, 39.
[5] Internal Correspondence from Moore, J.D., to Hill, R.M. Atomics International, *Re: Environmental Survey Report, Building 022, Santa Susana Area*, January 26, 1966.

- **1975 Rockwell Site Survey**. During a site survey in July 1975, radioactively contaminated vegetation was discovered at the RMHF Leach Field area. Further contamination was discovered in the leach field distribution box. The source of vegetation contamination was identified as root uptake from the underlying leach field. Plant material was removed from the site and the leach field area was surveyed to determine the extent of contamination.[1] Decontamination of the leach field was initiated by Rockwell in 1975 and continued until its completion in 1978. According to Rockwell, during all of this time the site was under Federal Government control and was thus exempt from federal and state licensing regulations per 10 CFR Sections 50 and 170 and Section 202 of the Energy Reorganization Act of 1974.[2]

- **1976 Rockwell Characterization Survey**. In 1976, 30 6-foot deep test holes were drilled to identify the limits of radioactive material migration in the RMHF Leach Field. According to the 1982 report titled *RMDF Leach Field Decontamination Final Report*, the RMHF Leach Field probably contained some activated material as well as fission products. The only significant isotopes identified were Sr-90, yttrium-90 (Y-90), and cesium-137 (Cs-137). No estimates of the radioactive inventory were available due to the lack of precise data on the nature and quantity of the dissolved material introduced into the RMHF Leach Field. The exploration with test holes was designed to identify only the limits of migration of the radioactive materials in the RMHF Leach Field. Five holes penetrated through the overburden and leach field gravel. The remaining holes were drilled around the periphery of the RMHF Leach Field in undisturbed rock and soil. Small test samples of soil were removed at 1-foot intervals from each hole as it was drilled. A light water spray was used to reduce dust dispersal. High volume air samples located about 4 feet from the bore site were monitored for airborne activity. The immediate count indicated no more than 3.8×10^{-11} µCi/mL beta-gamma contamination. Laboratory analysis and surveying of the soil samples were used to develop models of contaminant distribution. From the combination of data, Rockwell assumed that the distribution box flooded and leaked near its upper surface and radioactive materials flowed down the north leach line and percolated in a northeasterly direction. The test hole soil sample just east of the distribution box was found to have levels of radioactivity as high as 115,392 pCi/g. No water samples were taken during the characterization because the leach field was dry. Following the characterization survey, the RMHF Leach Field was covered with plastic and plywood to prevent surface water from adding to the migration of radioactive materials.[3,4,5,6]

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[1] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, pgs. 12, 14, 21, 25.
[2] Rockwell International, *Draft Radioactive Materials Disposal Facility Leach Field Environmental Assessment*, January 1981, p. 5.
[3] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, pgs. 12, 14, 21, 25.
[4] Bradbury, S.M., *Radiological Survey Results - - Release to Unrestricted Use, RMDF Leach Field, SSFL, N704TI990042*, Rockwell International, November 7, 1978.
[5] Collins, J., *Final Radiological Inspection of the RMDF Leach Field for Release for Unrestricted Use, N704TP990010*, Rockwell International, August 12, 1980, pgs. 9-12.
[6] Internal Correspondence from Badger, F.H., to Tuttle, R.J., Rockwell International, *Re: Summary of RMDF Leach Field Assessment*, November 3, 1976.

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- **1978 Rockwell Leach Field Survey and Excavation.** A June 29, 1978 RMHF Leach Field survey drawing depicts contamination ranging from 100 to 30,000 counts per minute (cpm), with pieces of pipe along the eastern perimeter of the survey area measuring 36,000 cpm. Background levels were noted by Rockwell to be 50 to 60 cpm. The highest readings were located at the eastern portion of the site.[1] Beginning in mid-1978, non-contaminated overburden at the RMHF Leach Field was excavated and stockpiled at the east end of the leach field as backfill material. Then the contaminated soil and gravel were excavated and placed in plastic-lined boxes via backhoe. These boxes were transported by overhead crane to the RMHF yard. While onsite, the boxes of contaminated soil and gravel were monitored. Surveys taken at the surface of the boxes showed readings around 500 counts per minute or 0.12 milliroentgens per hour (mR/h) gross beta-gamma activity. The clay piping was surveyed and measured up to 4 mR/h gross beta-gamma activity. It was placed in the center of the shipping boxes so that contaminated gravel could be used as additional shielding. The remaining loose gravel and soil left by the backhoe was removed with hand shovels.[2,3,4]

  During the excavation process, 580 soil samples, 8 vegetation samples, and 23 water samples were analyzed for gross beta-gamma activity and used to guide the soil removal operation. Radiological surveys indicated that some of the contamination had penetrated the pores and fractures in the underlying sandstone rock surface. A crack filled with porous material was found along the north wall of the excavation measuring up to 2,500 pCi/g. This crack was excavated 10 feet below the bedrock and found to split and wander under the leach field excavation. A hydraulic actuated jackhammer attached to the arm of a backhoe was used to crush and split off the surface rock layers and get to the contaminated areas. Contaminated rock was removed as much as possible. The RMHF Leach Field was then backfilled with approximately 6 to 12 feet of clean fill and finished to a grade several feet lower than the original surface. The RMHF Leach Field area was graded to pass surface water to the west. Upon completion of the decontamination effort, a walk-through survey was conducted. The maximum dose rate detected from the newly placed fill material and surrounding vegetation was 0.06 millirads per hour (mrad/hr) with an average background of 0.03 mrad/hr. All readings were below the 0.1 mrad/hr limit. According to a 1982 decontamination final report, the RMHF Leach Field project salvaged overburden dirt to use as backfill and "very little 'new' local soil was needed to complete the backfill."[5] The source of the "new local soil" is not clear. A follow-up survey was performed and found 30 to 50 microroentgens per hour (µR/h) throughout the RMHF Leach Field area; however, the activity was reportedly from the RMHF complex a few hundred feet away and not the leach field itself. A final random soil sampling of the leach field fill material showed gross beta specific activity ranging from 15 to 46 pCi/g. Soil contamination was to be removed to levels reported by Rockwell as "low as

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[1] Robinson, G., *Survey of Leach Field*, June 29, 1978.
[2] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, pgs. 21, 23, 29, 39.
[3] Stelle, A. M., *RMDF Leach Field Mapping and Assessment of Contamination, N704ER990006*, Rockwell International, November 22, 1976.
[4] Harris, J.M., *RMDF – Leach Field Soil Removal Detailed Working Plan, N704DWP990-022*, Rockwell International, January 11, 1977.
[5] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 54.

reasonably achievable," but in all cases to levels below 100 pCi/g, the limit (according to Rockwell) required to release the RMHF Leach Field area to unrestricted use at that time. Approximately 28,000 cubic feet of contaminated soil excavated from the leach field was disposed in Beatty, Nevada. Another, 8,100 cubic feet was sent to Rockwell's Hanford site in Richland, Washington.[1,2,3,4,5,6,7,8]
According to discussions with Boeing personnel, two 5,000-gallon storage tanks brought up from the SRE were placed in Vault 2 of Building 4022 and used to store water, primarily rain water, during RMHF Leach Field cleanup operations.[9]

- **1978 Contaminated Cracks**. By the fall of 1978, three contaminated cracks remained at the RMHF Leach Field area. The cracks were 7, 12, and 19 feet in length at the surface. They averaged 1.5 inches wide and were estimated to extend no more than 10 feet into the bedrock. The average radioactivity in the exposed cracks was 300 pCi/g. The three areas were coated with a bituminous mastic to seal out percolation water that might increase radioactive material penetration. The RMHF Leach Field was then backfilled with approximately 6 to 12 feet of clean fill and finished to a grade several feet lower than the original surface. The RMHF Leach Field area was graded to pass surface water to the west.[10,11,12]

- **1980 Rockwell Final Radiological Inspection Plan.** A 1980 Rockwell inspection plan hypothesizes on contamination in the RMHF Leach Field area. The RMHF Leach Field was nestled into the side of a canyon that runs in a southwest direction from its head, with the southwestern section of the SRE in an area near the canyon head. The inspection plan postulates that windborne particles could have been picked up from the RMHF Leach Field surface during decontamination and been deposited in the canyon, primarily on the

[1] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385,* Rockwell International, September 15, 1982, pgs. 21, 23, 29, 39.
[2] Stelle, A. M., *RMDF Leach Field Mapping and Assessment of Contamination, N704ER990006*, Rockwell International, November 22, 1976.
[3] Harris, J.M., *RMDF – Leach Field Soil Removal Detailed Working Plan, N704DWP990-022*, Rockwell International, January 11, 1977.
[4] Bradbury, S.M., *Radiological Survey Results - - Release to Unrestricted Use, RMDF Leach Field, SSFL, N704TI990042*, Rockwell International, November 7, 1978.
[5] Rockwell International, *Radioactive Materials Disposal Facility Leach Field Evaluation Report, ESG-DOE-13365*, February 23, 1982, pgs. 9-10.
[6] Collins, J., *Final Radiological Inspection of the RMDF Leach Field for Release for Unrestricted Use, N704TP990010,* Rockwell International, August 12, 1980, pgs. 9-12.
[77] *Scope of Work and Specifications for Earthwork for Excavation of the RMDF Leaching Field, Santa Susana Facility, Ventura County, California, Construction Specification, 303-021-03,* Rockwell International, April 17, 1978.
[8] Internal Correspondence from Tuttle, R.J. to Those Listed, Rockwell International, *Re: Status Review – RMDF Leach Field, September 1978*, October 4, 1978.
[9] Correspondence from Chell, M., MWH, to Waite, P., The Boeing Company, *Re: Questions for Paul Waite Regarding RHMF [sic] Site History (Discussion took place via email during March, 2009),* March 16, 2009.
[10] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 29.
[11] Rockwell International, *Radioactive Materials Disposal Facility Leach Field Environmental Evaluation Report, ESG-DOE-13365*, February 23, 1982, pgs. 8-10.
[12] Rockwell International, *Radioactive Materials Disposal Facility Leach Field Evaluation Report, ESG-DOE-13365*, February 23, 1982, pgs. 9-10.

northwest canyon walls and at the head of the canyon. Subsequent rains could have washed the particles down the canyon. Further, windborne particles from the SRE could have been deposited at the head of the leach field canyon and likewise washed down during rains. While the inspection plan states the likelihood of these events is remote, it notes there is a potential that contaminants could have been carried by rain runoff to natural pooling places along the course of the canyon and could concentrate in these areas. The plan also notes that there was another remote possibility of groundwater percolating through the RMHF Leach Field and being carried to natural pooling places along the canyon. The inspection plan states the most likely place for contaminants to be present in traceable quantities would be in natural pooling places in the canyon below the RMHF Leach Field. Surveys were to be conducted at the RMHF Leach Field, along the canyon watercourse, and the high canyon area above the leach field. It is not clear if this plan proposed surveys other than those described below.[1]

- **1981 RMHF Leach Field Environmental Assessment.** A draft environmental assessment was prepared in January 1981 in consideration of releasing the RMHF Leach Field for release for unrestricted use. The RMHF Leach Field was an area of about one-quarter acre that was owned by the Federal Government on land leased with the option to buy from Rockwell International. Upon release of the leach field from Federal control, health and safety issues would be placed under the provisions of California law. For this reason the area must be shown to be decontaminated to levels acceptable to the state of California for an unlicensed area. The draft environmental assessment states that contamination of surface water from the leach field is not probable. Surface water samples taken at the site boundary during decontamination work showed less than 3.0×10^{-7} µCi/mL. The assessment also notes that the sandstone bedrock forms a virtually impermeable boundary to subterranean groundwater and the groundwater underlying the site is completely contained by geologic barriers and does not migrate to groundwater in the surrounding valleys. As with other report conclusions made by Rockwell or Rocketdyne, EPA does not necessarily agree with the conclusions described in this report. Because the RMHF Leach Field was decontaminated to near background levels of radioactivity, the environmental assessment notes that atmospheric resuspension of soil from the leach field would not result in activity above the maximum permissible concentration allowed during continuous (168 hours/week) use for the general public in an unrestricted area allegedly per California Radiation Control Regulations effective at the time. The assessment also finds contamination of vegetation and wildlife from the leach field unlikely as the amount of remaining activity is located approximately 10 feet below the surface and has been immobilized. No discernable increase in surface dose rate, above that naturally occurring, will reportedly result for radioactivity remaining in the leach field. The average concentrations of Sr-90 and Cs-137 in surface samples taken across the leach field were 1.0 and 0.3 pCi/g, respectively.[2]

- **1982 Rocketdyne Release Request**. The RMHF Leach Field was reportedly decontaminated to levels that would allow it to be released for unrestricted use in 1982,

[1] Collins, J., Final Radiological Inspection of the RMDF Leach Field for Release for Unrestricted Use, N704TP990010, Rockwell International, August 13, 1980, pgs. 22-26.
[2] Rockwell International, *Draft Radioactive Materials Disposal Facility Leach Field Environmental Assessment, ESG-DOE-13342*, January 1981.

and Rockwell requested such a release.[1] However, soil sampling events in 1988 and 1989 proved this 1982 request as premature and inappropriate.

- **1988 Rocketdyne Sampling**. A 1988 soil and shallow groundwater study included collection of six surface soil samples at the RMHF Leach Field. Gross alpha contamination ranged from 15.0 to 41.6 pCi/g. Gross beta contamination ranged from 59.0 to 4,970.0 pCi/g. An area of elevated activity was noted in the western portion of the leach field.[2]

- **1988 DOE Environmental Survey**. A June 30, 1988, U.S. Department of Energy (DOE) status report states that the RMHF Leach Field was a potential source of groundwater contamination and because no groundwater monitoring had been performed in the area, the area had not been adequately characterized.[3]

- **1989 Rocketdyne Sampling**. On May 17, 1989, a radiological inspection was conducted by the Radiation & Nuclear Safety Group of Rocketdyne around the RMHF Leach Field area. Soil samples were collected and boulders on the north slope of the leach field leading down to the ravine were surveyed for beta radiation. Surveying was focused on likely locations where surface water runoff might cause particulates to collect. See Figure 2.14g. Fifteen soil samples were collected from six areas (RMDF-1 through RMDF-6). Soil samples found gross alpha levels ranging from 28.9 to 313.1 pCi/g and gross beta levels ranging from 26.0 to 2,121.0 pCi/g. The highest alpha and beta levels were detected in a sample taken at a 12-inch depth in a location identified as RMDF-6 shown on Figure 2.14g. Four of the six sample areas measured high levels of beta radiation at the ground surface (688 $\pm$ 803.2 pCi/g) as compared to the limit for unrestricted use at the time, which was 100 pCi/g for beta. Alpha counts in these four sample areas (126.9 $\pm$ 107.0 pCi/g) exceeded the limit for unrestricted use at the time, which was 50 pCi/g for alpha, but Rocketdyne stated that the high alpha counts were likely due to crosstalk between the alpha and beta channels in the detector electronics, which, despite manufacturer's specifications, had not been accounted for in analysis. Rocketdyne attributed the large standard deviation values in the data to spotty contamination. Notwithstanding the inherent problems in the data analysis, Rocketdyne stated that these results indicate "slight radioactive contamination" exists in the soil in an area measuring no more than 20 square feet north-northwest of the former RMHF Leach Field. According to Rocketdyne, this area was located on "loose backfill." Additionally, one boulder at the bottom of the ravine was emitting beta radiation above Rocketdyne-stated background levels (15,000 cpm; 400,000 dpm/100cm^2). The greatest radiation levels were found at the ground-to-boulder boundary. The boulder was painted yellow on top for easy identification by future surveyors.[4]

[1] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 57.
[2] Rockwell International Corporation, Rocketdyne Division, *Radiological Characterization Plan, Santa Susana Field Laboratory, Area IV, A4CM-AN-0003, Rev. A*, March 30, 1994, pgs. 4-1, 4-4, 4-11–4-12.
[3] Weiner, L.A. and Barisas, S., *Status Report of the DOE Activities at the Santa Susana Field Laboratories Site Environmental Survey*, U.S. Department of Energy, June 30, 1988, pgs. 3-4.
[4] Internal Correspondence from Chapman, J.A. to Tuttle, R.J., Rockwell International, *Re: RMDF Leach Field: Soil Samples Collected in the General Vicinity, May 17, 1989*, May 24, 1989.

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Radiological Use Authorizations: See Section 2.1 for Building 4021 radiological use authorizations that might have implications for the RMHF Leach Field area.

Former Radiological Burial or Disposal Locations: The June 2009 Resource Conservation and Recovery Act Facility Investigation (RFI) report depicts a large potential debris area north and east of the RMHF Leach Field. The potential debris area covers part of an access road extending north from the RMHF Leach Field. The RFI report calls this area the Western Drainage Debris area and associates it with Building 4133; however, the accompanying figure places the debris area closer to the RMHF Leach Field. The debris noted as concrete, scrap metal, and empty drums may be associated with Building 4133, but the location depicted is nearer the RMHF Leach Field.[1]

Aerial Photographs: The RMHF Leach Field area is identified in a 1959 aerial photograph as fill area. The area continues to be identified as a fill area in the early 1960s. A drainage pathway directed to the west is identified north of the RMHF Leach Field in aerial photos from 1959 to 1978. A 1978 aerial photograph indicates the RMHF Leach Field area has been graded and the area west of the leach field is identified as an area of disturbed ground. An access road is identified from the north side of the RMHF Leach field area. The road loops north from the RMHF Leach Field and then turns south to intersect with the Building 4133 area. A 1980 aerial photograph indicates the following features in the RMHF Leach Field area: possible stain, disturbed ground, light-toned material, probable waste disposal area, probable pit, and dark-toned material. In 1983, the RMHF Leach Field area is described as having a ground scar and by 1988 the area appears revegetated. A 2005 aerial photograph indicates a large area of earth moving activity covering most of the area north of the RMHF complex and including the RMHF Leach Field area.[2]

Radionuclides of Concern: Radionuclides of concern detected in the RMHF Leach Field include Cs-137, Sr-90, and Y-90.[3,4] Other radionuclides of concern likely associated with the RMHF Leach Field are those associated with Building 4021, primarily mixed fission products and fuels.[5] Radionuclides potentially present at the RMHF include: uranium fuel materials (U-234, U-235, U-238), transuranic isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242) and americium-241 (Am-241), fission products Cs-137, Sr-90, krypton-85 (Kr-85), and promethium-147 (Pm-147), thorium breeder material (Th-228, Th-232), and possible neutron activation products such as cobalt-60 (Co-60), europium isotopes (Eu-152, Eu-154), hydrogen-3 (H-3), iron-55 (Fe-55), nickel isotopes (Ni-59, Ni-63), managense-54 (Mn-54), potassium-40 (K-

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[1] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures,* June 2009, pgs. 3-17–3-8.

[2] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.

[3] Rockwell International, *Radioactive Materials Disposal Facility Leach Field Environmental Evaluation Report, DOE-SF-3*, February 23, 1982, p. 8.

[4] Collins, J., *Final Radiological Inspection of the RMDF Leach Field for Release for Unrestricted Use, N704TP990010*, Rockwell International, August 13, 1980, p.11.

[5] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007,* p. A-1.

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40), and sodium-22 (Na-22).[1,2,3,4] All radionuclides of concern listed, with the exception of Fe-55, Kr-85, Mn-54, and Na-22 (due to relatively short half-lives), are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of radionuclides of concern.

Drainage Pathways: Surface water from the RMHF Leach Field followed one of two drainage pathways either to the north or west. Both pathways eventually drained to a northwest concrete catch basin at Outfall 003.[5,6]

Radiological Contamination Potential: The preliminary MARSSIM classification for the RMHF Leach Field area is Class 1, due to its former use and the radiological contamination found in the RMHF Leach Field.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the RMHF Leach Field area. As discussed above, there were a couple of radiological incidents involving the RMHF Leach Field and evidence of radiological releases. Previous characterization studies for the RMHF Leach Field area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the RMHF Leach Field area. This includes the following RMHF Leach Field areas and appurtenances:

- Former RMHF Leach Field area, including former distribution box and piping. Documented releases to the RMHF Leach Field may have left residual contamination in soils in the area. An aerial photograph from 1980 notes the RMHF Leach Field area contained a possible stain, a pit, disturbed ground, dark and light-toned material, and was a probable waste disposal area. Additionally, there are three known areas of bedrock contamination that have been sealed to prevent migration. Reevaluation of the RMHF Leach Field area can verify that migration from these areas is not occurring.

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[1] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, pgs 7-8.

[2] U.S. Department of Energy Environment, Safety and Health Office of Environmental Audit, *Environmental Survey Preliminary Report, DOE Activities at Santa Susana Field Laboratories, Ventura California*, February 1989, p. 3-11.

[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 11 – RFI Site Reports, Appendix G – Sewer Inspection Documentation Logs*, June 2009, p. Figure G-1.

[4] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rockwell Division, Santa Susana Field Laboratory, Ventura County, California, Technical Enforcement Support at Hazardous Waste Sites, TES 11, DCN: TZ4-R09015-RN-M21460*, May 1994, p. 7-14.

[5] *Radiological Characterization Plan, Santa Susana Field Laboratory, Area IV, A4CM-AN-0003, Revision A.*, Rockwell International Corporation Rocketdyne Division, March 30, 1994, p. 3-15.

[6] *Stormwater Pollution Prevention Plan for Santa Susana Field Laboratory, Revision 2*, MWH, June 2006, Figure 7A.

- Disturbed ground area west of the RMHF Leach Field identified in a 1978 aerial photograph. This area may be related to the remedial excavation. It should be examined to ensure no residual contamination exists.

- Western drainage debris area located north and east of the RMHF Leach Field and depicted in the 2009 RFI report. The debris may be associated with Building 4133, but the debris area is located closer to the RMHF Leach Field. This debris area should be investigated further.

- Access road identified in a 1978 aerial photograph that ran north of the RMHF Leach Field and looped around to Building 4133. This road may have been used during remedial excavation and it has also been associated with the western drainage debris area. It should be examined to make sure residual contamination was not tracked or deposited along the access road.

- Surface drainage pathways north and west of the RMHF Leach Field. Residual radioactive contamination may be present in the RMHF Leach Field and any surface drainage pathways would provide pathways for migration of contamination.

2.15 Building 4133 Area

Site Description: The Building 4133 area comprises Building 4133 and the fenced area around it measuring approximately 87 feet by 71 feet. The Building 4133 area was located west of 11th Street in the middle of an approximately 6,600 square foot mostly asphalt lot. A portion of Building 4133 was initially constructed as Building 4724, the Contaminated Sodium Cleaning Facility and used to support the Sodium Reactor Experiment (SRE). More information on Building 4724 can be found in HSA-6. When Building 4724 was closed, the upper portion of the building was decontaminated and released for unrestricted use. This portion of the building was used for construction of Building 4133. In December 1977, Building 4133 was constructed at its current location. It has been identified as the Sodium Burn Facility on industrial planning maps, but also is collectively referred to as the Hazardous Waste Management Facility (HWMF) with Building 4029, discussed in HSA-5A. Unlike the Sodium Burn Pit, this facility treated sodium and other metals inside the building structure.[1,2,3,4,5,6] Figures 2.15a through 2.15n provide a recent photograph and the best available building-specific drawing(s) and photos that the research team could find. Plate 1 presents a summary of all identified features for this site.

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[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. G-11.
[2] McGinnis, E.R., *Building 4133 Radiation Survey Report, RS-00015*, The Boeing Company, January 14, 2004, p. 8.
[3] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[4] Knudsen, K.T., *Safety Analysis Document – Building 133 Hazardous Waste Management Facility, 133-ZR-0003, Rev. C*, Energy Technology Engineering Center, June 28, 1991, Revised April 1, 1996, p. 5.
[5] *The Boeing Company Closure Plan Hazardous Waste Management Facility, Buildings T029 and T133, Santa Susana Field Laboratory, Ventura County, California*, MWH, December 2003, p. 3-5.
[6] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports*, June 2009, pg. B.2-2.

Building Features: Building 4133 was constructed on a concrete slab and the entire Building 4133 area is covered with asphalt or concrete and surrounded by an 8-inch berm. The portion of Building 4133 originally built as Building 4724 was a 21-foot long by 10-feet wide steel structure with large doors at one end. When moved to its present location, this portion of the building, known as the treatment room, contained an enclosed burn room with a 6.25 square foot burn pan heated on a natural gas fired hearth. An elevated steel lining, approximately 9 feet by 14 feet, served as a drain pan and was located in the southern portion of the treatment room. It was connected to a steel-lined sump in the treatment room. The sump is approximately 16 inches by 21 inches and 27 inches deep. A 4-inch diameter drain line within an 18-inch wide by 23-inch high concrete containment trench connects the sump to a below-grade storage tank. A structure was added to the east of the original building that included a control room, offices, and a restroom/shower (see Figure 2.15g). Building 4133 is now a 462 square-foot single-story structure with a galvanized steel roof and walls anchored to a concrete slab floor.[1,2,3,4,5,6,7]
The Building 4133 area consists of two concrete storage pads with a ramp separating the two pads. Each pad has its own runoff collection sump to avoid mixing incompatible wastes from the two pads. Pad 1 measures approximately 25 by 13 feet and was used to store acids, oxidizers, and other compatible wastes in drums. Pad 2 measures approximately 25 by 27 feet and was used to store alkaline hazardous wastes. The truck unloading area and the area surrounding these pads was unpaved soil.[8]

Building 4133 was designed for the treatment of non-radioactive alkali metals, including sodium, sodium-potassium alloy (NaK), and lithium. In preparation for treatment, solid components were size reduced to fit on the treatment burn pan. This operation was performed on the cement handling area south of the treatment room under a 15-foot by 10-foot canopy. The handling area used a metal pan placed on the concrete as secondary containment and a hoist to transfer components to the treatment room. Scrap material and other components containing solid alkali metals were placed on the burn pan in the treatment chamber and heated for 3 or 4 hours to oxidize the metal. The metal oxides were removed from the air by a Peabody Variable Throat Venturi air scrubber and spray tower located outside and west of Building 4133 in an area bermed with a 2-inch metal plate. Residual metal oxides were washed from components and from inside the treatment chamber using water, which converted the oxides into aqueous hydroxides. Rinse water from the treatment chamber and from the spray tower drained to either

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[1] Energy Technology Engineering Center, *Operation Plan: Hazardous Waste Management Facility, 133-AN-0001*, March 3, 1991, p. 25.
[2] Knudsen, K.T., *Safety Analysis Document – Building 133 Hazardous Waste Management Facility, 133-ZR-0003, Rev. C*, Energy Technology Engineering Center, June 28, 1991, Revised April 1, 1996, p. 5.
[3] Benjamin, S., *Hazardous Waste Management Facility Program Management Plan, 133-AN-0003*, Energy Technology Engineering Center, June 4, 1992, p. 3.
[4] *Operation Plan, Hazardous Waste Management Facility, 133-AN-0001*, Energy Technology Engineering Center, March 3, 1991, p. 25.
[5] ABB Environmental Services, Inc., *Text Plan: Air Emission Source Texting of the Thermal Treatment Facility, Building 133, Rocketdyne Santa Susana Field Laboratory*, December 10, 1990.
[6] QA2 Environmental, *Draft Closure Plan for Hazardous Waste Management Facility, Santa Susana Field Laboratory, Area IV, Ventura County, California*, January 18, 1999, p. 11.
[7] *The Boeing Company Closure Plan Hazardous Waste Management Facility, Buildings T029 and T133, Santa Susana Field Laboratory, Ventura County, California*, MWH, December 2003, pgs. 3-5–3-9.
[8] *DTSC Proposed Approval of Rockwell Rocketdyne Closure Plan for Two Former Hazardous Waste Storage Areas at Rockwell, Santa Susana Field Laboratory, Fact Sheet*, California Environmental Protection Agency Department of Toxic Substances Control, November 1995, pgs. 1-2.

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a below grade neutralizing pit or storage tank (T-1) located outside Building 4133 at the northwest corner of the building at different times during the facility's operation. This liquid waste could also be pumped to an aboveground storage tank (T-3) at the northeast corner of the building if the below grade tank was full.[1,2,3]

The process for treating liquid alkali wastes was similar to that of solids, except that the liquid would be transferred under pressurized argon gas to an aboveground tank (T-2) and then fed from the tank into the treatment chamber.[4]

There is one below-grade tank (T-1) and four above-grade tanks (T-2, T-3, T-4A, T-4B) at Building 4133. T-1, also known as the scrubber effluent catch tank, was used to capture wastes (hydroxide solutions) produced during the treatment of alkali metal wastes. When the capacity of T-1 was reached, waste was transferred to the T-3, an above-grade tank for temporary storage until arrangements can be made for off-site disposal. T-1 was a rectangular tank approximately 5 feet wide by 11 feet long by 6 feet deep. It had a capacity of 1,318 gallons. T-1 was installed in 1988 within an 8-inch thick concrete secondary containment pit coated with epoxy. It replaced a prior caustic vessel referred to as the "sump pit" in the first RCRA Part B permit for the HWMF. The "sump pit," also referred to as the "neutralizing pit" and waste pit in drawings, was 12 feet long by 6 feet wide by 6 feet deep. It was lined with 4-inch thick concrete and was replaced because it did not have secondary containment. A temporary underground storage tank located north of the asphalt berm was used to store caustic wastes generated by the treatment process while T-1 was being installed. Figure 2.15m depicts this installation. T-1 was installed in the same location as the "sump pit" with the new secondary containment pit having double the concrete lining. The steel pipe from the treatment room sump to T-1 was located in an 1.5-foot wide by 2-foot high epoxy-coated concrete trench.[5,6,7] A 1988 as-built drawing of a trench installation plan shows the trench connection between Building 4133 and the tank pit.[8,9]

T-2, also known as the NaK tank, was used as a feed tank to supply waste NaK to the treatment pan for use in the oxidation process. The waste NaK was transferred to T-2 and then to the treatment pan using an argon cover gas. T-2 was a stainless steel horizontal tank, 3 feet in diameter and 5 feet long. The tank was elevated nearly 2 feet above grade and sits on a 4-inch

[1] ABB Environmental Services, Inc., *Text Plan: Air Emission Source Texting of the Thermal Treatment Facility, Building 133, Rocketdyne Santa Susana Field Laboratory*, December 10, 1990.
[2] *The Boeing Company Closure Plan Hazardous Waste Management Facility, Buildings T029 and T133, Santa Susana Field Laboratory, Ventura County, California*, MWH, December 2003, pgs. 1-5, 3-6–3-7, 3-12.
[3] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports*, June 2009, pg. B.2-2–2-3.
[4] *The Boeing Company Closure Plan Hazardous Waste Management Facility, Buildings T029 and T133, Santa Susana Field Laboratory, Ventura County, California*, MWH, December 2003, p. 3-7.
[5] Energy Technology Engineering Center, *Operation Plan: Hazardous Waste Management Facility, 133-AN-0001*, March 3, 1991, pgs. 61-65.
[6] *The Boeing Company Closure Plan Hazardous Waste Management Facility, Buildings T029 and T133, Santa Susana Field Laboratory, Ventura County, California*, MWH, December 2003, pgs. 3-9–3-12.
[7] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports*, June 2009, pg. B.2-2.
[8] *SSFL Area IV, Bldg. 133, Trench Installation Plan, 303-133-S4*, Rockwell International, November 1, 1988.
[9] Rockwell International Drawing, *SSFL Area IV, Bldg. 133, Trench Installation Plan, M33-69239-SM1*, November 1, 1988.

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thick concrete slab inside a 7-foot by 4-foot by 2-foot steel containment area. T-2 had a capacity of approximately 300 gallons.[1,2]

T-3, also known as the waste storage tank, was used to store waste hydroxide solutions prior to offsite disposal. T-3 was batch loaded from T-1 when T-1 approached its capacity. A sump pump transferred the waste liquid from T-1 through an aboveground rubber hose to an opening at the top of T-3. Caustic waste from T-3 would then be removed by vacuum truck for offsite management at a permitted facility. T-3 was a 6,600-gallon vertical double-walled polyethylene tank that sat in a 4-inch thick asphalt slab. The inner tank was approximately 10 feet in diameter and 9 feet high. The outer tank was approximately 12 feet in diameter and 8 feet high.[3,4]

Tanks T-4A and T-4B, also known as rinse tanks, were small rinse tanks that were used to remove adherent hydroxides from metal components. T-4A was a 128-gallon stainless steel tank. It was approximately 2.5 feet in diameter and 3 feet high. T-4B was a 71-gallon stainless steel tank. It was approximately 2.5 feet in diameter and 2.5 feet high. T-4A and T-4B rested on a 4-inch thick asphalt base and are contained in a 7-foot by 5-foot by 2-foot steel containment area.[5]

In 1989, a lithium hydride disposal facility was added to the sodium burn facility and was operated under the existing hazardous waste facility permit (No. CAD-000-629-972). The lithium hydride facility comprised a 500-gallon, stainless-steel reaction tank (also known as T-3); tank hoppers for adding batch quantities of lithium hydride; a stainless-steel catch pan sized to contain all of the reaction water; and a large vent line connecting from the reaction vessel to the facility exhaust stack for exhausting the hydrogen gas produced during disposal. Caustic solutions formed during the disposal reactions were pumped to a holdup tank used during sodium disposal.[6]

Substances that may be contained in the scrap materials to be treated in the facility include: sodium, lithium, potassium, NaK, and lithium hydride.[7]

Building 4133 is connected to the sanitary sewer system. Storm drainage was directed around the facility.[8] There is a 2-inch below-grade water pipeline that services Building 4133 and ties into a 10-inch water main southeast of the fenced enclosure, and enters the building from the

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[1] Energy Technology Engineering Center, *Operation Plan: Hazardous Waste Management Facility, 133-AN-0001*, March 3, 1991, pgs. 66-68.
[2] MWH, *The Boeing Company Closure Plan Hazardous Waste Management Facility, Buildings T029 and T133, Santa Susana Field Laboratory, Ventura County, California*, December 2003, pgs. 3-10–3-11.
[3] Energy Technology Engineering Center, *Operation Plan: Hazardous Waste Management Facility, 133-AN-0001*, March 3, 1991, pgs. 68-71.
[4] *The Boeing Company Closure Plan Hazardous Waste Management Facility, Buildings T029 and T133, Santa Susana Field Laboratory, Ventura County, California*, MWH, December 2003, p. 3-11.
[5] Energy Technology Engineering Center, *Operation Plan: Hazardous Waste Management Facility, 133-AN-0001*, March 3, 1991, pgs. 71-75.
[6] Johnson, R., *Safety Analysis Report for Lithium Hydride Disposal Facility – B133, 133-ZR0001*, Energy Technology Engineering Center, March 2, 1989, p. 3.
[7] ABB Environmental Services, Inc., *Text Plan: Air Emission Source Texting of the Thermal Treatment Facility, Building 133, Rocketdyne Santa Susana Field Laboratory*, December 10, 1990.
[8] Energy Technology Engineering Center, *Operation Plan: Hazardous Waste Management Facility, 133-AN-0001*, March 3, 1991, p. 25.

east.[1] Two sumps are located in the Building 4133 area for rainwater collection. One is located in the northeast corner and the other is located in the northwest corner of the Building 4133 area.[2]

Former Use(s): According to a 1994 Resource Conservation and Recovery Act (RCRA) Facility Assessment Report, in the 1960s and 1970s, the Building 4133 area was used as a drum and equipment storage area.[3] The June 2009 RCRA Facility Investigation (RFI) report states that the Building 4133 area was unpaved during this time. The RFI report also notes that prior to 1978 the Building 4133 area was used for parking and equipment/drum storage in support of the Sodium Reactor Experiment operations.[4]

The HWMF began operation in 1978 as a drum storage yard and was a fully permitted in 1983 as a RCRA hazardous waste treatment and storage facility for non-radiological chemical wastes generated onsite. The RCRA operating permit was renewed in 1988 and 1993. Due to funding limitations, the facility was operated only intermittently. Operations under the RCRA permit included the treatment of sodium, sodium-potassium, or lithium waste and contaminated equipment at Building 4133. The HWMF also held a Ventura County Air Pollution Control District Permit to Operate No. 0271, which regulated the operation of the air scrubber at Building 4133. In 1997, the HWMF was deactivated and all operations ceased. Remaining hazardous waste was removed. In 1998, the facility entered regulatory closure. In 2007, the HWMF Closure Plan was implemented after approval by the California Department of Toxic Substances Control (DTSC) [5,6,7,8]

Status reports for 1993 indicate that while operating as the HWMF, Building 4133 received pipes and tubes that were radioactively contaminated above background levels. Standard operating procedure at Building 4133 dictated that if an object with sealed, inaccessible, internal surfaces was to be cut open at Building 4133, then a radiation survey overcheck was to be performed during and after cutting operations. Any material found to have radioactive contamination was transferred to the Radioactive Material Handling Facility (RMHF). One status report also notes

[1] Energy Technology Engineering Center, *Operation Plan: Hazardous Waste Management Facility, 133-AN-0001*, February 12, 1998, p.30.
[2] QA2 Environmental, *Draft Closure Plan for Hazardous Waste Management Facility, Santa Susana Field Laboratory, Area IV, Ventura County, California*, January 18, 1999, p. 11.
[3] Science Applications International Corporation, *Final RCRA Facility Assessment (RFA) Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, p. 7-3.
[4] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p.3-4, Table ES-2.
[5] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, pgs.3-4–3-6.
[6] *The Boeing Company Closure Plan Hazardous Waste Management Facility, Buildings T029 and T133, Santa Susana Field Laboratory, Ventura County, California*, MWH, December 2003, pgs. 1-4–1-6.
[7] Energy Technology Engineering Center, *Operation Plan: Hazardous Waste Management Facility, 133-AN-0001*, December 17, 1992, p. 135.
[8] U.S. Department of Energy, *Hazardous Waste Management Facility*, Energy Technology Engineering Center (ETEC) Website, http://www.etec.energy.gov/History/Sodium/HWMF.html, accessed November 1, 2010, p.1.

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that after checking the pH of standing rain water in the yard area, the rain water was pumped down the control room shower drain.[1,2]

A 1993 Rockwell letter states that water used to wash buried objects from the Building 4886 Sodium Disposal Facility at Building 4133 was found to contain low concentrations (less than 10 pCi/L) of cesium-137 (Cs-137). The water was captured for disposition and the letter discusses taking the contaminated water to the RMHF for evaporation. While the letter does not indicate a release to the environment, it suggests a potential means of radioactive contamination at Building 4133.[3]

Information from Interviewees: A number of former employees were interviewed about their experience at the Santa Susana Field Laboratory. One remembered Building 4133. Excerpts from this interview are included below.

As manager of Atomic International's Engineering Department for System and Test, Interviewee 101 managed Buildings 4133, 4005, 4006, and 4023, as well as some inactive buildings. The following excerpts were pulled from the interview.

> *"During the time I managed Building 133 it was used roughly between 1986 and 1989 as a Sodium Disposal Facility, which was a licensed facility, used to burn off sodium metal from parts.*
>
> *The product gas was passed through a water scrubber and the liquid was collected in a tank onsite.*
>
> *A hazardous waste contractor hauled the liquid waste off site. This building replaced activities at the sodium burn pit as a controlled way of cleaning sodium. I had no experience with the sodium burn pit.*
>
> *Logs would have been kept in Building 133, including hours operating, materials processed, etc. The environmental group would probably have those. I kept no logs or documentation from my time there aside from some tech papers and component photographs. I believe most of the documentation from my group (Test Procedures, Test Reports, etc.) ended up at Iron Mountain."* [4]

Radiological Incident Reports: No radiological incident reports were found, but numerous sodium hydroxide spills have been documented as well as sodium metal, mercury, and oil spills.[5] Refer to the June 2009 *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California* by MWH Americans, Inc. for a listing of these incidents.

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[1] *B/133 Status Report*, Unknown Author, March 15, 1993 through October 29, 1993, HDMSe00381574 – HDMSE 00381640.
[2] Soucy, R.C., *ETEC Waste Verification Plan for the Hazardous Waste Management Facility (HWMF), GEN-AN-0041*, Energy Technology Engineering Center, November 29, 1993, p. 5.
[3] Internal Correspondence from Tuttle, R.J. to Rutherford, P.D., Rockwell International, *Re: Disposal of Potentially Contaminated Wash Water at T133*, June 3, 1993.
[4] Interview No. 101 conducted by DOE in 2010.
[5] Review of Radiological Incident Database, 2010.

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Current Use: In December 2006, the DTSC approved the RCRA Closure Plan for the HWMF.[1] In 2007, the NaK tank at Building 4133 was disassembled as part of the initial phase of implementing the HWMF Closure Plan.[2] Building 4133 is still standing.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s):

- **1977 Rockwell Smear Surveys**. On July 13, 1977, a smear survey of Building 4724 was conducted covering the concrete floor and walls of the building. An instrument survey of the floor indicated radiation levels to 0.4 millirads per hour (mrad/hr) beta-gamma. Smear samples found six areas with removable contamination above action levels. Decontamination was performed on the walls to bring them under Rockwell-stated acceptable limits of 20 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) alpha and 100 dpm/100 cm^2 beta.[3]

- **1977 Rockwell Smear Survey**. On December 1, 1977, a smear survey of the inside and outside surfaces of Building 4133 was conducted. Contamination levels were less than 50 dpm/100 cm^2 beta, below the Rockwell-stated 100 dpm/100 cm^2 limit.[4]

- **1977 Rockwell Radiological Survey**. On December 19, 1977, Building 4742 was cut away from its foundation and resurveyed for radiological contamination. Areas were found above action limits. These areas were cut away from the building and the walls were resurveyed and found to be within the acceptable limits of 20 dpm/100 cm^2 alpha and 100 dpm/100 cm^2 beta. Building 4724 was released for unrestricted use and relocated to the Building 4133 area for use as a sodium burn facility.[5]

- **1988 Rocketdyne Radiological Survey**. In 1988, a radiological survey of Area IV was conducted by Rocketdyne. During this survey, four soil samples were taken north of Building 4133, including one sample from a tank excavation dirt pile, and two soil samples were taken in a pipe trench west of Building 4133. Sample results ranged from 7.4 to 36.8 picocuries per gram (pCi/g) gross alpha and 32.6 to 51.6 pCi/g gross beta, which, according to Rocketdyne, may be within the range of normal variability for the area.[6]

- **1988 Rockwell SRE to RMHF Field Survey**. An area between the RMHF complex and Building 4133 has been identified as an interim storage yard and as the SRE-to-RMHF field. According to a 1988 Rockwell radiological survey report, construction material

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[1] U.S. Department of Energy, *Hazardous Waste Management Facility*, Energy Technology Engineering Center (ETEC) Website, http://www.etec.energy.gov/History/Sodium/HWMF.html, accessed November 1, 2010, p.1.

[2] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California*, June 2009, p. 3-12.

[3] Internal Correspondence from Begley, F.E., to R.J. Tuttle, Rockwell International, *Re: Unconditional Release of Building T724 for Unrestricted Use*, January 18, 1978.

[4] Internal Correspondence from Begley, F.E., to R.J. Tuttle, Rockwell International, *Re: Unconditional Release of Building T724 for Unrestricted Use*, January 18, 1978.

[5] Internal Correspondence from Begley, F.E., to R.J. Tuttle, Rockwell International, *Re: Unconditional Release of Building T724 for Unrestricted Use*, January 18, 1978.

[6] Rockwell International Corporation, Rocketdyne Division, *Radiological Characterization Plan, Santa Susana Field Laboratory, Area IV, A4CM-AN-0003, Rev. A*, March 30, 1994, pgs. 4-1, 4-4, 4-11–4-12.

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and trash from the SRE were stored in this area in the 1970s, this includes the possibility of radioactive material storage barrels. The western boundary of this area drops off about 25 feet into the RMHF Leach Field and the eastern boundary is near Building 4133. No radioactive contamination incidents are known to have occurred in this field and in 1988 it was clean of debris. The field was surveyed for mixed fission products by measuring ambient gamma exposure rates 1 meter above the ground survey surface. Fifty-five gamma exposure rate measurements were taken in the field. Soil samples were required by the site survey plan only if gamma exposure measurements indicated the possibility of contamination. The mean exposure rate for the field was 20.7 microroentgen per hour (µR/h). Background was initially calculated by Rockwell to be 15.3 µR/h, which meant that the survey results were above the Nuclear Regulatory Commission guideline of 5 µR/h above background. Upon examining the statistical calculations and the exposure rates at the RMHF fence line more closely, the area was determined by Rockwell to have higher ambient background levels than other areas in the survey. The authors concluded that skyshine and direct radiation from the RMHF affected measurements and the background levels in this area were likely close to 20 µR/h. Therefore, according to Rockwell, exposure rates did not indicate the need for soil sampling in the SRE to RMHF Field and the authors concluded that the field was uncontaminated.[1]

- **1999 Rocketdyne Radiological Survey**. In the fall of 1999, Rocketdyne performed a radiation survey for the Building 4133 area at the request of the DTSC. DTSC had concerns over possible radiological contamination at the building, despite it not being a radiological facility. The survey included surface scans and smears for total alpha and beta contamination of the building structure and equipment. Surveyed areas included floors, ceilings, walls, pumps, pipes, and tanks. The highest total alpha and beta surface contamination were measured at 36 dpm/100 cm^2 and 1,292 dpm/100cm^2, respectively. The highest removable alpha and beta surface contamination was measured at 6 dpm/100 cm^2 and 24 dpm/100 cm^2, respectively. Of the 304 surface contamination measurements taken, 302 were at or below the minimum datable activity (MDA) of the instrumentation and all 304 were below the U.S. Department of Energy (DOE) surface contamination release criteria (see the table below). A gamma scan was performed inside the fenced area of the site. The highest observed net ambient gamma reading was 2.9 µR/h, which, according to Rocketdyne, is below the action level of 5 µR/h and within the typical range of natural background variability. Three soil and three asphalt surface samples were also collected inside the fenced area. One sample was found to have 0.1 pCi/g of Cs-137, typical of local background (0.2 pCi/g) according to Rocketdyne, and the others did not meet the MDA level of 0.03 pCi/g. Results for this survey were below 1999 release limits.[2]

[1] Chapman, J.A. et al., Radiological Survey of the T513 Parking Lot; Old R/A Laundry Area; Plot 333; and Areas Between the SRE to RMDF, and KEWB to RMDF, GEN-ZR-0009, Rockwell International, August 26, 1988, pgs. 20, 54, 69, 77.

[2] McGinnis, E.R., *Building 4133 Radiation Survey Report, RS-00015*, The Boeing Company, January 14, 2004.

Surface Contamination Guidelines from DOE Order 5400.5 (1990) and NRC Regulatory Guide 1.86 (1974)

Allowable Total Residual Surface Contamination (dpm/100 cm^2)			
Radionuclides	**Average**	**Maximum**	**Removable**
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, and I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, and I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000β-γ	15,000β-γ	1,000β-γ
External Gamma Radiation			
The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h.			

Source: U.S. Atomic Energy Commission (now NRC) Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors, June 1974, p. 1.86-5.
U.S. Department of Energy Order 5400.5, Radiation Protection of the Public and the Environment, February 8, 1990, p. IV-6.

- **1999 ORISE Verification Survey**. On October 28, 1999, the Oak Ridge Institute for Science and Education (ORISE) conducted an independent verification survey of Building 4133. The survey included document reviews, surface scans, surface activity measurements, exposure rate measurements, and soil sampling. Interior building surveys found total beta surface activity levels ranging from -900 to 2,300 dpm/100 cm^2. Removable surface activity levels ranged from 0 to 3 dpm/100 cm^2 for alpha and "-4" to 6 dpm/100 cm^2 for beta. Exposure rates ranged from 7 to 9 μR/h. Exterior building surveys found total beta surface activity levels ranging from "-440" to 770 dpm/100 cm^2. Removable surface activity levels ranged from 0 to 1 dpm/100 cm^2 for alpha and from -2 to 6 dpm/200 cm^2 for beta. Exposure rates ranged from 15 to 17 μR/h with a background of 14 μR/h. According to the ORISE report, all total and removable surface activity levels and exposure rate guidelines met the DOE average and maximum guidelines for release for unrestricted use (see table above). Soil sample results and guidelines for the Santa Susana Field Laboratory are presented in the table below. All soil samples results were less than DOE guideline levels. ORISE verified Rocketdyne's conclusion that Building 4133 satisfied the DOE criteria for release for unrestricted use effective at that time.[1]

- **1999 California DHS Limited Confirmation Survey**. On October 28, 1999, the California Department of Health Services (DHS), Radiologic Health Branch (RHB) conducted a limited confirmatory survey of Building 4133. The survey consisted of exposure rate surveys, gamma scans, and one soil sample. No elevated areas were founding during the survey in the Building 4133 structure and associated pits and catch tank. All measurements were similar to background radiation levels, as stated in the

[1] Morton, J.R., *Verification Survey of Building 4133, Santa Susana Field Laboratory, The Boeing Company, Ventura County, California, ORISE 00-0577*, April 2000.

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survey report. One soil sample was collected down gradient of the site to determine if any soil had been impacted by surface runoff. The soil concentrations reported were also similar to background samples collected at various times prior to this survey. The California DHS, RHB concluded that after reviewing survey data from The Boeing Company, ORISE, and its own efforts, that there were no elevated areas of radioactivity inside or outside the fence perimeter, no surface contamination of the structures within the area, and no soil contamination down gradient of the site.[1]

- **2002 Boeing Supplemental Area IV Survey.** In August 2002, concerns over the 1988 and 1994 Area IV radiological characterization surveys led to a reexamination of certain areas. The 2002 survey used the same grid system previously established. Grid blocks S19 and T19 covered the Building 4133 area. Twenty soil samples were taken in the two grid blocks. Samples in grid block T19 indicated some evidence of potential Cs-137 contamination, ranging from below detection limits to 0.8 pCi/g. Samples from grid block S19 showed evidence of Cs-137 contamination, ranging from below detection limits to 4.9 pCi/g. According to Boeing, all samples were below the cleanup standard of 9.2 pCi/g at that time, and, therefore, required no remediation.[2]

- **2003 Boeing Soil Sampling**. In June 2003, additional sampling was conducted in grid blocks S19 and T19. A sample taken northwest of Building 4133 was discovered to have 15.1 pCi/g of Cs-137 and 1.2 pCi/g of Sr-90. The sitewide release limits for these isotopes are 9.2 pCi/g and 36 pCi/g, respectively. Weed abatement was performed and a walk-about gamma scan survey of the area was conducted. Based on detectable elevated exposure levels (1,000 to 3,200 net counts per minute, 4.7 to 14.9 μR/h) an area approximately 15 feet by 15 feet was marked for remediation. One foot of soil was excavated and packaged for radioactive disposal. A post-remedial sample and gamma spectroscopy indicated no man-made isotopes were present. The 2003 memo describing this remediation notes that in the future contractors should be brought in to do a larger weed abatement to facilitate more extensive surveys and sampling to determine if a hot spot is an isolated case.[3]

- **2007 Release to Unrestricted Use**. On March 13, 2007, the California DHS, RHB issued a letter to Boeing finding Building 4133 suitable for release for unrestricted use.[4]

Radiological Use Authorizations: None found.

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[1] Lupo, R.K., *Confirmatory Survey, Building 4133 Hazardous Material Treatment Facility (HMTF), Santa Susana Field Laboratory, Boeing – Rocketdyne, Ventura County, California*, California Department of Health Services, Radiologic Health Branch, October 28, 1999.
[2] Boeing, *Site Environmental Report for Calendar Year 2002, DOE Operations at The Boeing Company Rocketdyne Propulsion & Power, RD02-148-01*, September 2003.
[3] Internal Correspondence from McGinnis, E.R. to Sujata, B.D., The Boeing Company, *Re: Grid S19/T19 Interim Soil Remediation*, November 19, 2003.
[4] Correspondence from Butner, G., California Department of Health Services, Radiologic Health Branch to Rutherford, P., The Boeing Company, *Re: Building 4133, Area IV, Santa Susana Field Laboratory*, March 13, 2007.

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Former Radiological Burial or Disposal Location: During a 2005 site inspection, a debris area was noted at the bottom of the hillside of Building 4133. The observed debris consisted of 55-gallon drums and smaller containers that were rusted, empty, and had no labels.[1]

A 2008 waste debris survey identified 10 debris areas in the vicinity of Building 4133. All of the debris areas were less than 100 square feet in size. Debris included concrete, asphalt, polyvinyl chloride pipe, broken glass, two empty 55-gallon drums, one empty 12-ounce can, one empty 30-ounce can, one empty 1-gallon paint can, one empty 2-gallon steel bucket, two empty 2.5-gallon cans with wire handles (possibly paint cans), one empty 2-gallon galvanized steel bucket, one water-filled 250-millilter glass bottle, one 0.5-gallon rectangular metal container, one 12-inch long by 6-inch diameter metal container possibly filled with concrete, grey crumbling substance (possibly grout), scrap and sheet metal, clay pipe, stainless steel tubing, cylindrical equipment air filter.[2]

A June 2009 RFI report depicts a large potential debris area west of Building 4133. The RFI report calls this area the Western Drainage Debris area and associates it with Building 4133; however, the accompanying figure places the debris area closer to the RMHF Leach Field. The debris noted as concrete, scrap metal, and empty drums is associated with Building 4133 and looks to be a composite of debris areas noted in the 2008 survey described above.[3]

Aerial Photographs: Building 4133 is first identified on a 1978 aerial photograph. The building is located in an area that was identified as fill area 5 (FA-5) by the U.S. Environmental Protection Agency's (EPA's) aerial photographic analysis in aerial photographs dating back to approximately 1960 plus or minus a year. Light-toned material was seen at the fill area from 1959 through approximately 1960 plus or minus a year. Around 1960 plus or minus a year, the fill area was configured into an upper section and a lower section. By 1965 deposition of fill material appeared to cease and no activity was noted until building construction in 1978. An open storage (OS) area is noted to the east of Building 4133. Two access roads connect to the general Building 4133 area from the north. One access road runs north and the other runs northwest before turning south. The roads are visible from 1978 to 2005, but it is not clear if they were used during the entire time, particularly with regard to the northwest access road. In 1980, Building 4133 is surrounded by an OS area. An aboveground pipeline is noted south of Building 4133. The pipeline is present from 1980 to 2005. Also in 1980, a long, narrow strip of cleared area is noted in north of Building 4133. In 1983, the OS area surrounding Building 4133 is identified as OS-14 by the EPA's aerial photographic analysis and contains a possible stain. In 1988, Building 4133 is identified as part of a processing area, PA-6 by the EPA's aerial photographic analysis. PA-6 contains a probable pipeline, possible stains, medium-toned mounded material, a revetment, and OS-14. In 1995, PA-6 contains Building 4133, storage

[1] MWH, RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California, March 2008, p. 2-4.

[2] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Appendix F: Group 7 2008 Waste Debris Survey Results, June 2009.*

[3] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures,* June 2009, pgs. 3-17–3-8.

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tanks, an overhead pipeline, dark-toned material, and stains. In 2005, PA-6 contains Building 4133 and a vertical tank in the north east corner of the area.[1]

Radionuclides of Concern: Although Building 4133 was considered a non-radiological site, low levels of Cs-137 were discovered here. Radiological surveys were conducted at the building area because of inadvertent radiological contamination of the facility (Building 4029) that provided the residual sodium for treatment in Building 4133.[2]

Drainage Pathways: According to a 2009 RFI report, a 4-inch polyvinyl chloride drain pipe conveyed treated waste solutions from the Building 4133 neutralizing pit to an asphalt-lined drainage ditch 300 feet east of the building. The drainage ditch directed surface water flow to a concrete-lined ditch that discharged into the southeastern portion of the SRE Pond, where surface water was pumped and discharged to an asphalt-lined drainage in the southern portion of the Old Conservation Yard site. The neutralizing pit drain pipe at Building 4133 was permanently plugged in 1986 after an expandable plug failure at the pit led to the release of approximately 1,000 gallons of sodium hydroxide solution to the SRE Pond.[3]
Surface water in the bermed asphalt areas surrounding Building 4133 flows to the northeast and northwest corners of the area where it is captured by two 1.5 foot by 1.5 foot by 2.5 foot deep below grade sumps at each corner of the Building 4133 area. The sumps are collection features and do not drain to any other location. Surface water collected in these sumps has been and continued to be pumped out.[4]

A 40-foot underground drain pipe is located at the northeast part of the Building 4133 bermed area. It terminates at an asphalt-paved flood control culvert downslope and east of Building 4133. The culvert is approximately 300 feet long and 4 feet wide. Its main purpose was to direct stormwater from Building 4041.[5] Surface water runoff at Building 4133 generally flows to the north and west to an east-west trending drainage north of the RMHF.[6] This pathway eventually drains to a concrete catch basin at Outfall 003.[7,8]

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[1] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[2] Morton, J., *Draft Verification Survey of Building 4059 (Phase 1), Building 4133, and the 17th Street Drainage Area, Santa Susana Field Laboratory, The Boeing Company, Ventura County, California*, Oak Ridge Institute for Science and Education, February 2000, pgs 2-3.
[3] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California*, June 2009, p. 2-6.
[4] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California*, June 2009, p. 2-5.
[5] *The Boeing Company Closure Plan Hazardous Waste Management Facility, Buildings T029 and T133, Santa Susana Field Laboratory, Ventura County, California*, MWH, December 2003, pgs. 3-14, 9-8, Figure 31.
[6] MWH, *Group 7 - Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6, Figure 2-7B.
[7] *Radiological Characterization Plan, Santa Susana Field Laboratory, Area IV, A4CM-AN-0003, Revision A.*, Rockwell International Corporation Rocketdyne Division, March 30, 1994, p. 3-15.
[8] *Stormwater Pollution Prevention Plan for Santa Susana Field Laboratory, Revision 2*, MWH, June 2006, Figure 7A and 7E.

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Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4133 area is Class 1, due to the possibility of cutting of radioactive contaminated pipes and tubes, and proximity to other radiological facilities.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Additional soil sampling is recommended in the Building 4133 area. As discussed above, even though Building 4133 was not considered a radiological facility, it did on occasion receive radioactively contaminated pipes and tubes. Standard operating procedures required a radiation check of sealed objects. Additionally, characterization was not conducted to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4133 area. This includes the following Building 4133 areas and appurtenances:

- Under the Building 4133 treatment room sump and drain line. Although Building 4133 should not have treated any radioactive waste and previous investigations did not detect contamination, these areas should be surveyed to confirm the absence of any residual contamination.

- Under the below-grade tank (T-1), containment pit, piping and trench pit connecting T-1 to Building 4133. T-1 was installed in the former location of a sump pit and although Building 4133 was not designed to treat radioactive waste, sump areas may have collected potential radioactive contamination from surface drainage. If radioactive materials were included in surface runoff, residual contamination may exist in these below-grade features.

- Temporary underground storage tank located north of the Building 4133 asphalt berm used to store caustic wastes generated by the treatment process while T-1 was being installed. Although Building 4133 was not designed to treat radioactive waste, sump areas may have collected potential radioactive contamination from surface drainage. If radioactive materials were included in surface runoff, residual contamination may exist in these below-grade features.

- Cement handling area south of the Building 4133 treatment room under the canopy where solid components were size reduced to fit on the treatment burn pan. If any of these components were radioactively contaminated, the handling area may contain residual contamination.

- Unpaved truck unloading area and areas surrounding the Building 4133 concrete storage pads. Because these areas were unpaved they may be more likely to have collected any potential radioactive contamination either from material brought into the building area or from surface water drainage.

- Under the Building 4133 restrooms and shower drain. A status report notes that standing water in the yard areas was pumped down the shower drain. If radiological materials contaminated the standing water, residual contamination may exist in the shower drain.

- Underground drain pipe located at northeast corner of the Building 4133 berm. This drain pipe terminates at an asphalt-paved flood control culvert downslope and east of Building 4133. If radiological materials were released into this drain pipe, residual contamination may exist in the materials inside and surrounding the pipe and culvert.

- Sumps located at the northeast and northwest corners of the Building 4133 area. These sumps were located inside a bermed area and contained surface water. Any contamination that may have been released in the Building 4133 area could have flowed to these sumps and left residual contamination.

- Drainage ditch located east of Building 4133 that collected surface water and directed it to a concrete-lined ditch that discharged to the southeast portion of the SRE Pond. This ditch could provide a pathway for contaminant migration and should be investigated for residual contamination.

- Debris areas noted in 2005 and 2008 surveys. There were numerous areas around Building 4133 were debris was noted. These areas should be further investigated to rule out residual radiological contamination.

- Access roads that terminate at the Building 4133 area and were noted in aerial photographs from 1978 to 2005. The access roads could have allowed for tracking of contamination across facilities and were near some of the debris areas noted in 2005 and 2008 surveys. These roads should be examined for residual contamination.
- Cleared area noted north of Building 4133 in 1980 aerial photograph. It is not clear why this strip of land was being cleared and it required further investigation to determine if any potential contamination exists.

- Aboveground pipeline located south of Building 4133 identified in aerial photographs from 1980 to 2005. The contents of this pipeline are unknown based on the aerial photograph, and it could have provided pooling locations for potential contaminants around pipeline supports. Residual radioactive contamination could be present.

- Open storage area (OS-14) identified in 1983 aerial photograph surrounding Building 4133. OS-14 was noted to contain a possible stained area and requires further investigation. Residual contamination may exist.

- Processing area (PA-6) stain and mounded material locations identified in aerial photographs. These areas should be examined for residual contamination.

- Surface drainage pathways associated with Building 4133. This includes the drainage pathway north and west of Building 4133 that eventually drains to a catch basin at Outfall

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003. Residual contamination may exist along this drainage and continue outside of Area IV.

2.16 Building 4654 Area

Site Description: The Building 4654 area comprises Building 4654 and the land surrounding it along E Street. The facility area measured 65 by 40 feet and was paved with 2-inch thick asphalt. A chain link fence with two sliding gates enclosed the facility. Building 4654 was constructed in 1958 as the Interim Storage Facility (ISF) to support the Sodium Reactor Experiment (SRE). The ISF was designed to store dummy and spent fuel elements, shipping and storage casks, and hot waste generated at the SRE. It consisted of a concrete structure in the ground that anchored the tops of eight storage tubes. The tubes extended into large holes drilled in the bedrock, and were embedded with drilling mud. A paved pad was adjacent to the in-ground structure and provided a fenced storage area.[1,2,3,4] Figures 2.16a through 2.16k provide a recent photograph and the best available building-specific drawing(s) and photographs that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4654 comprised eight 20-inch diameter galvanized-steel tubes, extending 25 feet into 32-inch diameter wells drilled into rock strata. The top portions of the storage tubes were encased in a common concrete trench and berm structure. The bottom ends of the tubes were seal-welded closed. The annular space around each cell was packed with sand.[5,6] It is worth noting that Building 4654 was open to the environment providing the potential for surface water to seep into the storage tubes and possibly corrode the steel pipes. This building design increased the potential for contaminated water to leak into the subsurface below the storage tubes.

Former Use(s): Building 4654 was originally used to store dummy and spent fuel elements, shipping and storage casks, and hot waste generated at the SRE. After the SRE stopped operating, Building 4654 was also used to store waste from the Organic Moderated Reactor Experiment (OMRE) and the Systems for Nuclear Auxiliary Power (SNAP). Building 4654 was taken out of service in 1964 and did not support an active program from 1964 through 1984. Because low-level radiation was released from the storage of containers at this facility it was kept in surveillance and maintenance mode to contain the contamination until decommissioning began in 1984.[7,1]

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[1] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 1, 3.
[2] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 5.
[3] Dahl, Farley, C., *Building T654 Supplemental Final Radiological Survey Report, SSWS-AR-0011*, The Boeing Company, January 20, 1999, p. 3.
[4] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports*, June 2009, pg. B.2-7.
[5] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 5.
[6] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports*, June 2009, pg. B.2-7.
[7] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, p. 1.

A 1964 inspection tour of Santa Susana Field Laboratory (SSFL) fuel storage areas notes that one of the SRE Core I fuel elements removed from the Building 4654 storage pits contained in an unwelded tube, which separated just as it was being fitted into the RMHF storage thimble. It was recommended that the tube be weld sealed for contamination control. The inspection report notes that the Building 4654 storage area was also temporarily being used to store classified scrap materials.[2]

Information from Interviewees: A number of former employees were interviewed about their experience at the SSFL. One remembered Building 4654. Excerpts from the interview are included below.

Starting as a fireman at Santa Susana, Interviewee 155 was eventually transferred to the Radiation Safety Department (Health Physics) to work as a monitor. The following excerpts were pulled from the interview.

> *"They had a storage facility at the top of the road (pointing to Building 654)….I think it was used for storing radioactive material before Buildings 21 and 22 (the RMDF) were built."*[3]

Radiological Incident Reports: There have been a couple incidents associated with Building 4654 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing. Summaries of only the incident reports that resulted or may have resulted in releases to the environment are provided following the table, when available. Summaries of all available incident reports are provided in Attachment A.

Building 4654 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0014	1/23/1962	T654 R/A STORAG	Mixed Fission Product	Loss Of Containment Of R/A Equipment Stored Outside.
A0079	7/5/1979	654 R/A YARD	Mixed Fission Product	Contamination Found On Pavement And Outside Storage Yard Fence.

- On January 23, 1962, a radiation survey of Building 4654 was conducted and revealed contamination had spread from the inside of the fenced area to the asphalt outside the fence. At that time, the contamination level outside the fenced area of Building 4654 was between 2 and 3 millirads per hour (mrad/hr). The contamination on exposed equipment surfaces inside the fence was as high as 17 rads per hour (rad/hr). This information was written in the SRE operations logbook. The incident report indicated that no action was taken to decontaminate the area or prevent further spread of contamination. On February

[1] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 12.
[2] Internal Correspondence from Matten, K.L. to Fuel Committee Members, Atomics International, *Re: Inspection Tour of Santa Susana Fuel Storage Areas*, April 23, 1964.
[3] Interview No. 155 conducted by DOE in 2010.

Redacted

13, 1962, a similar survey was conducted and indicated an increased spread of contamination due to rain. The contamination on the pavement was between 2 and 17 mrad/hr outside the enclosure. Exposed equipment surfaces inside the enclosure showed loss or displacement of 5 rad/hr of contamination as the maximum detectable level was 12 rad/hr. Four soil samples were taken along the drainage pathways. Soil contamination ranged from 20 to 43 "uuc/gm" (presumably µCi/g). Additional information regarding any cleanup of the area, or whether contamination continued to spread, was not provided in the incident summary (A0014).[1]

- During a preliminary survey of the storage yard on July 5, 1979, contaminated shipping casks stored in the area were found to be emitting high levels of radiation. These high levels were noted in the northeast corner of the fenced area. An area of asphalt measured greater than 50,000 disintegrations per minute (dpm) with the PUG-1 used.[2] A smear of a 3-gallon shipping cask found radioactive contamination of 12,000 dpm and an instrument survey indicated 35 mrad/hr at the cask. Some of the other casks surveyed indicated radioactive intensities of 40 mrad/hr. A preliminary survey of the soil outside the fenced area indicated possible soil contamination along the northeast fence line along the east side ranging from 200 to 400 counts per minute (cpm). The incident report did not include information to indicate any clean up operations of the area (A0079).[3]

- Seals and packing on some casks and equipment stored at the ISF deteriorated from exposure to the elements to such an extent that low-level contamination was released. This release contaminated the asphalt surface near the casks and soil just outside the ISF fence. The casks and other sources of potential contamination were sent to an offsite disposal facility. Radioactive core components placed in the storage tubes contaminated the internal storage cells.[4] The exact location where the casks and equipment were stored inside the ISF fenced storage area is unknown.

- During decontamination and decommissioning (D&D) excavation activities, the hydraulic hammer mounted on the end of the backhoe punctured storage tube 7. The area was surveyed for contamination, but none was found.[5]

Current Use: Building 4654 was demolished in 1985. Numerous surveys have been completed since 1985 and are summarized below. On February 1, 2005, the U.S. Department of Energy (DOE) stated that Building 4654 met DOE and California Department of Health Services approved soil cleanup limits and was suitable for release for unrestricted use.[6] Today the site is vegetated.

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[1] Badger, F.H., Atomics International Internal Letter, *Re: Spread of Contamination in Area # 654*, February 18, 1962.
[2] A PUG is a radiation survey instrument made by Technical Associates, which has been developing radiation detection equipment since 1946.
[3] Owen, R.K., Handwritten Note Re: SRE Interim Storage Yard, July 5, 1979.
[4] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, p. 1.
[5] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 9, 13.
[6] Correspondence from Lopez, M., U.S. Department of Energy National Nuclear Security Administration Service Center, to Lee, Majelle, The Boeing Company, Re: *Release of Building 4654*, dated February 1, 2005.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- **Monthly Surveillance and Maintenance**. Because low-level radiation was released at Building 4654, it was kept in surveillance and maintenance mode until decommissioning began in 1984. This surveillance included a monthly measurement of liquid levels within the ISF storage cells. Measurements were also to have been completed following heavy rains. According to a 1983 ISF decommissioning plan, water was discovered within the storage cells in March 1981. Since the discovery, the water was pumped to within 6 inches of the bottom. According to the decommissioning plan, the removed water was 30 times above acceptable limits, showing readings of 7.76 x 10^{-6} millicuries per milliliter (mCi/mL).[1] The decommissioning plan assumed there to have been no, or very little, leakage of the contaminated water into the bedrock. However, the plan notes that periodic monitoring of the water level in the storage tubes during fiscal year 1983 cannot prove conclusively that the tubes have not leaked at some time.[2,3,4,5]

- **1983 Site Radiation Survey**. A 1983 ISF decommissioning plan describes a site radiation survey at the ISF that found a few contaminated areas outside the northern perimeter fence. The contaminated areas were limited to surface contamination and ranged from 100 to 1,000 cpm. The storage yard itself was found to have surface contamination in spot areas up to 20 mrad/hr. Twelve core samples were taken at strategic locations in and around the ISF, determined by geography and water runoff patterns. Each core sample was dug to a depth of 10 feet, unless bedrock was reached. Each core sample was analyzed at 6-inch intervals for its entire length. Core sample analysis showed no contamination below 6 inches in the samples taken outside the storage yard and no contamination below the asphalt for the cores taken in the storage yard.[6] The definition of "contamination" was not provided in this survey.

- **1984 and 1985 Rockwell Characterization and Final Radiation Survey**. In 1984, prior to decommissioning, a radiation survey of Building 4654 was conducted to plot areas of contamination. D&D was completed in two phases beginning in 1984 and ending in 1985. Phase 1 began with a characterization radiation survey. Any surface radiation in excess of 50 cpm of beta activity or with any detectable alpha activity was deemed to be contaminated. Soil samples indicating cobalt-60 (Co-60) and cesium-137 (Cs-137) levels above 1 picocurie per gram (pCi/g) were also considered contaminated.

[1] A note within the margins of this scanned report indicates that the water may have actually showed readings of 7.76 x 10^{-6} µCi/mL. Additional information to confirm this error within the decommissioning plan could not be located.
[2] Lang, J.F., Rockwell International Document No. N001T1000188, *Interim Storage Facility Decommissioning Plan*, June 28, 1983.
[3] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, p. 1.
[4] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 12.
[5] MWH, *Offsite Data Evaluation Report, Santa Susana Field Laboratory, Ventura County, CA*, December 2007, p.2-5
[6] Lang, J.F., Rockwell International Document No. N001T1000188, *Interim Storage Facility Decommissioning Plan*, June 28, 1983.

The characterization survey results led to decontamination of the concrete berm, soil and asphalt removal, removal of contaminated dummy fuel element baskets, and fixing contaminated water with concrete in four storage cells.[1,2]

The contaminated concrete trench and berm were decontaminated with pneumatic scabblers with high-efficiency particulate air (HEPA)-filtered vacuum systems attached to capture concrete dust. The concrete surfaces were resurveyed and rescabbled until "all surface contamination" was reported to have been removed. Contaminated soils were transferred to waste containers for shipment to the DOE Hanford disposal site. The amount of contaminated soil removed was not documented. In addition to contaminated soil, sections of contaminated asphalt were also found to be contaminated and were removed, broken into small pieces, and loaded into radioactive waste packages for offsite shipment and disposal.[3,4] Of the eight storage tubes, five were found to contain contaminated internal storage baskets. These were removed and each basket was drawn into a plastic bag as it was removed from its respective storage tube. The baskets were then transferred to the Radioactive Materials Handling Facility (RMHF) for size reduction and packaging for shipment to the DOE Hanford disposal site. Following removal of the baskets, four of the eight storage tubes were found to contain water contaminated with Cs-137. The table below shows the water level found in the ISF tubes. The storage tubes were reported to have been filled with Redimix concrete to absorb the contaminated water and to fix the contamination in place.[5]

ISF Storage Tube Water Levels Upon Phase I D&D Activities

Storage Tube Number	1	2	3	4	5	6	7	8
Water Level in Tube (inches)	Dry	31.0	24.0	13.5	Dry	6.0	Dry	Dry

The Building 4654 area was resurveyed and additional soil was found to be contaminated and removed. "Less than 6 inches of soil in approximately 10% of the total area and up to 18 inches of soil in approximately 1% of the total area."[6] A final radiation survey before Phase II confirmed that "all surface contamination had been removed and all radiation levels were within acceptable limits," presumably based on DOE Order 5400.5.[7,1]

[1] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 3, 7, 9, 16-23, 27.
[2] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 11.
[3] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 12.
[4] Tuttle, R.J., Rockwell International Document No. SSWA-AR-0009, *Building T654 Supplemental Final Radiological Survey Plan*, December 4, 1996.
[5] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 12.
[6] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 13.
[7] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 3, 7, 9, 16-23, 27.

- **1984 and 1985 D&D Soil Sampling**. Phase II of D&D operations in 1984-1985 involved excavation of the storage tubes and backfill operations. The first excavation operation required removing the concrete trench that contained the upper portion of the storage tubes. This reportedly uncontaminated material was temporarily stored in a retention area and then later used for backfill material. The excavation of soil and rock from the north side of the storage tubes exposed the tubes for removal to a depth of 23 feet. At approximately 15 feet the hydraulic hammer mounted on the end of a backhoe punctured storage tube 7. The area was surveyed for contamination, but none was found and the excavation continued. Soil and structure surfaces were continually monitored during the excavation. Excavated soils and rock were surveyed and sampled for Co-60, Cs-137, and other gamma emitters and were reported to be "free of contamination," according to Rockwell. This material was stored for later use as backfill material. According to Rockwell, no measurable contamination was found on the soil or surrounding rock. Logical paths of contaminant migration (e.g., runoff channels) were sampled and no measurable contamination was found. Soil samples were obtained during the soil removal process and at the maximum extent of the excavation project. The only non-naturally occurring isotope found was Cs-137. The decommissioning report states none of the samples contained Cs-137 in excess of 2.0 pCi/g, or had a total of 36 pCi/g maximum beta activity, although a corresponding table in the decommissioning report suggests a sample of 2.145 pCi/g Cs-137.[2,3]

  The removal of each storage tube was accomplished with a mobile crane that placed each tube on a flatbed truck for transport to Building 4021 at the RMHF for size reduction and packaging. Upon removal, each storage tube was surveyed to be verified as externally free of contamination. A plastic bag was placed around the lower section of the tube to prevent any spread of existing contamination during transit to the RMHF. Soil samples were taken from each borehole as each tube was removed. These samples were also analyzed for Co-60, Cs-137, and other gamma emitters and were reported to contain less than the release criterion of 100 pCi/g gross detectable activity.[4,5]

  Following removal of the storage tubes, the excavation was backfilled with clean concrete rubble reported to have been surveyed to assure that material with "no detectable activity" was placed in the ground. The excavation was then reported to have been filled with the local soil that had been previously excavated and the surface was graded to a natural grade.[6,1] A total of 168.5 cubic meters of low specific activity waste

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[1] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 13.
[2] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 3, 7, 9, 16-23, 27.
[3] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 11.
[4] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 3, 7, 9, 13, 16-23,26- 27.
[5] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 12.
[6] Tuttle, R.J., Rockwell International Document No. SSWA-AR-0009, *Building T654 Supplemental Final Radiological Survey Plan*, December 4, 1996.

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consisting of 126 King-Pac containers of soil asphalt, and concrete and 12 wood box containers of size reduced storage tubes and baskets were generated during decommissioning and demolition operations.[2]

A final statistical survey of the ISF area for gross gamma activity was conducted following backfilling. After accounting for sky shine, the adjusted mean exposure rate was found by Rockwell to be 12 µR/h, "slightly" above the 10 µR/h background level. Rockwell stated that the U.S. Nuclear Regulatory Commission (NRC) exposure rate limit is 5 µR/h above background. According to Rockwell, uncontaminated excavation material was stored in a retention area and later used as backfill. Accumulated waste, including soil, asphalt, and tube sections, was sent to the RMHF before shipment to the Hanford Reservation in Washington State for burial. A Rockwell post-decommissioning radiological survey included and soil sampling showed that contamination was below release criteria in 1984.[3,4]

- **1995 ORISE Verification Survey**. In 1995, the Oak Ridge Institute for Science and Education (ORISE) performed independent verification of Rocketdyne's final status survey of Building 4654 following 1984-1985 D&D efforts. ORISE conducted a document review and independent measurement and sampling. ORISE found deficiencies in Rocketdyne's final status documentation. Deficiencies included inadequate final status survey methods, no discussion of specific contaminants, inconsistent specification of all applicable guidelines and presentation of data that may be compared to the guidelines, absence of quantitative laboratory data, and inconsistent presentation of adequate figures documenting remediated areas and measurement and sampling locations. Surface scans for alpha, beta, and gamma activity did not identify any locations of residual contamination. Exposure rates for the ISF ranged from 10 to 15 µR/h. According to ORISE, background rates ranged from 12 to 16 µR/h with an average of 14 µR/h. The NRC exposure rate limit is 5 µR/h above background. Radionuclide concentrations in soil at the ISF are listed in the table below and are comparable to background levels. Although sampling results were within acceptable release criteria at the time, ORISE was unable to verify the radiological status of the ISF because of document deficiencies and recommended additional surveys. A supplemental survey plan was developed by Rocketdyne for a cooperative soil sampling effort with ORISE.[5,6,1]

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[1] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California*, June 2009, p. 3-12.
[2] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 3, 7, 9, 13, 16-23,26- 27.
[3] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 3, 7, 9, 16-23, 27.
[4] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 11.
[5] Vitkus, T.J. and Bright, T.L., *Verification Survey of the Interim Storage Facility; Buildings T030, T641, and T013; an Area Northwest of Buildings T019, T013, T012, and T059; and a Storage Yard West of Buildings T626 and T038, Santa Susana Field Laboratory, Rockwell International, Ventura County, California, ORISE 96/C-4*, Oak Ridge Institute for Science and Education, February 1996, pgs. 5-15.
[6] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, pgs. 11, 14.

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Soil Sample Results at ISF

Radionuclides	Sample Results (pCi/g)
Cs-137	< 0.1 – 0.4
Ra-226	0.8 – 1.2
Th-228	1.3 – 1.6
Th-232	1.5 – 1.7
U-235	< 0.1
U-238	1.0 – 1.7

- **1997 ORISE Verification Survey**. In 1997, ORISE performed an independent verification survey of Building 4654. Subsurface soil samples, surface soil samples, surface scans, and exposure rate measurements were collected. Surface scans did not identify any locations of elevated direct radiation indicative of residual contamination. Beta-gamma scans of soil sample cores did not identify any elevated direct radiation. Exposure rates were 15 µR/h at the ISF compared to ORISE-determined background rates between 12 and 16 µR/h with an average of 14 µR/h. The NRC exposure rate limit is 5 µR/h above background. Radionuclide concentrations from surface and subsurface samples are listed in the table below. According to the ORISE report, most radionuclides were below their respective minimum detectable concentrations and all results were less than the guidelines for unrestricted release in 1997.[2,3]

ORISE Soil Sample Results at ISF

Radionuclides	Sample Results (pCi/g)
Cs-137	< 0.22 – 0.43
Ra-226	< 0.61 – 1.25
Th-232	0.67 – 1.94
U-235	< 0.84
U-238	< 2.35

- **1997 Rocketdyne Radiological Survey**. In 1997, Rocketdyne performed a supplemental final radiological survey and finalized the report in 1999. This survey involved a 100 percent direct qualitative scan for gamma exposure rate and collecting 93 surface soil samples. Cs-137, the primary radioactive contaminant at the ISF, ranged from 0.02 to 6.99 pCi.g, less than the sitewide release criteria of 9.2 pCi/g. The maximum Sr-90 sample was 1.3 pCi/g, less than the site wide release criteria of 36 pCi/g reported to be

[1] Vitkus, T.J., *Verification Survey of the Interim Storage Facility (T654), Santa Susana Field Laboratory, Rockwell International, Ventura County, California, ORISE 97-1900*, Oak Ridge Institute for Science and Education, November 1997, pgs. 4, 6.
[2] Vitkus, T.J., *Verification Survey of the Interim Storage Facility (T654), Santa Susana Field Laboratory, Rockwell International, Ventura County, California, ORISE 97-1900*, Oak Ridge Institute for Science and Education, November 1997, pgs. 3-8.
[3] A September 4, 1997, email from Robert Tuttle, indicated that soil samples required for the ORISE survey needed to go to bedrock at Building 4654, which was indicated to be approximately 32 feet belowground surface.

effective at the time. The survey report concluded that the Building 4654 area was suitable for release for unrestricted use.[1]

- **1999 Draft Certification Docket Issued**. In May 1999, the DOE issued a draft certification docket for the release of Building 4654 without radiological restriction.[2]

- **2002 Boeing Supplemental Area IV Survey.** In August 2002, concerns over the 1988 and 1994 Area IV radiological characterization surveys led to a reexamination of certain areas. The 2002 survey used the same grid system previously established. Grid blocks S19 and T19 neighbored the former Building 4654 area. Twenty soil samples were taken in the two grid blocks. Samples in grid block T19 indicated some evidence of potential Cs-137 contamination, ranging from below detection limits to 0.8 pCi/g. Samples from grid block S19 showed evidence of Cs-137 contamination, ranging from below detection limits to 4.9 pCi/g. According to Boeing, all samples were below the cleanup standard of 9.2 pCi/g, applicable at that time, and, therefore, required no remediation.[3]

- **2003 Boeing Supplemental Area IV Survey**. In June 2003, additional sampling was conducted in grid blocks S19 and T19 neighboring the former Building 4654. Samples nearest the former Building 4654 area had Cs-137 levels ranging from non-detect to 0.43 pCi/g, which was below the sitewide release limit of 9.2 pCi/g. One sample above the release limit was noted near Building 4133 and is discussed in Section 2.15.[4,5]

- **2005 Release for Unrestricted Use**. On February 1, 2005, the DOE stated that Building 4654 met DOE and California Department of Health Services approved soil cleanup limits and was reportedly suitable for release for unrestricted use according to DOE at the time.[6]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Location: None.

Aerial Photographs: Building 4654 is first identified as a possible open storage (OS) area on a 1965 aerial photograph. The OS area is located south of a fill area (FA), identified as FA-5 by the U.S. Environmental Protection Agency's (EPA) aerial photographic analysis, containing light-toned material. In 1967, the OS area is fenced and it is located on an access road that circles rock outcroppings before running along the west side of a processing area (PA) identified

[1] Dahl, Fraley, C., *Building T654 Supplemental Final Radiological Survey Report, SSWS-AR-0011*, The Boeing Company, January 20, 1999, pgs. 3-6.
[2] U.S. Department of Energy, Oakland Operations Office, Environmental Restoration, *Draft Docket for the Release of Building 4654 at the Energy Technology Engineering Center, DOE/CD-ETEC-654, RD99-158*, May 1999.
[3] Boeing, *Site Environmental Report for Calendar Year 2002, DOE Operations at The Boeing Company Rocketdyne Propulsion & Power, RD02-148-01*, September 2003, pgs. 5-14–5-16.
[4] Boeing, *Site Environmental Report for Calendar Year 2003, DOE Operations at The Boeing Company Rocketdyne Propulsion & Power, RD02-148-01*, September 2004, p. 5-14.
[5] Internal Correspondence from McGinnis, E.R. to Sujata, B.D., The Boeing Company, *Re: Grid S19/T19 Interim Soil Remediation*, November 19, 2003.
[6] Correspondence from Lopez, M., U.S. Department of Energy National Nuclear Security Administration Service Center, to Lee, Majelle, The Boeing Company, Re: *Release of Building 4654*, dated February 1, 2005.

as PA-2 by the EPA's aerial photographic analysis. In 1972, Building 4654 is noted as a possible OS area. In 1978, the area is noted as containing five or six rectangular objects. Building 4133 and another OS area are identified to the north of the Building 4654 area. A possible pipeline is identified to the east. In 1980, probable heavy equipment is identified in the Building 4654 area and an aboveground pipeline running east-west is noted to the north. No other features are identified in the Building 4654 area after 1980.[1]

Radionuclides of Concern: The primary radionuclides of concern for Building 4654 are uranium and mixed fission and activation products.[2] All radionuclides of concern listed are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: A June 2009 Resource Conservation and Recovery Act Facility Investigation Report notes that surface water flows both east and west from Building 4654; however, these two drainage paths eventually converge into an east-west trending pathway north of Building 4654 and the RMHF. This drainage pathway flows to Outfall 003 before exiting the Area IV boundary.[3]

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4654 area is Class 1, due to the building design, its former use, radiological incidents, and previous investigations.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the Building 4654 area. As discussed above, there were several radiological incidents at Building 4654 and documented evidence of radiological releases. In addition, previous characterization studies for the Building 4654 area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4654 area. This includes the following Building 4654 areas and appurtenances:

- The former tube and trench area of the Building 4654 footprint. The common trench structure housed eight storage tubes for fuel elements, one of which was damaged during demolition activities. The storage tubes were dug 25 feet into the rock surface. Residual contamination may be present in the area. Because Building 4654 was open to the environment, the potential for surface water to seep into the storage tubes and possibly

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[1] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2,* U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[2] Vitkus, T.J., *Verification Survey of the Interim Storage Facility (T654), Santa Susana Field Laboratory, Rockwell International, Ventura County, California*, *ORISE 97-1900*, Oak Ridge Institute for Science and Education, November 1997, p. 7.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, Figure 2-7B.

corrode the steel pipes exists. This building design increases the potential for contaminated water to leak into the subsurface below the storage tubes. Samples coinciding with storage tube locations should be collected 1 to 3 feet below the bottom of the tube to investigate this potential.

- Areas outside the former northeast fence line and along the east side of the former fence line where radiological contamination was noted to be found. Incident report A0079 notes that contamination had spread outside the ISF fence line. These areas should be reexamined for residual contamination.

- Open storage areas noted in aerial photographs. These storage areas may have contained radioactive waste and without protection from weathering the storage containers could have released contamination to the surrounding area. These areas should be reexamined for residual contamination.

- Surface drainage areas around the Building 4654 area. Radiological incident A0014 notes that contamination spread outside the Building 4654 in part due to drainage from rain storms. The natural surface drainages in the area should be examined further. Any releases of radioactive materials would have followed drainage pathways from the building and could leave residual contamination.

- Access road coming in and out of Building 4654. The access roads could have allowed for tracking of contamination across facilities. These roads should be examined for residual contamination.

2.17 Building 4028 Area

Site Description: The Building 4028 area comprises Building 4028, Electrical and Mechanical Equipment Pad 4811, and the land surrounding these sites located on an access road north off of B Street. Building 4028 was a U.S. Department of Energy (DOE)-owned facility constructed in 1960 as the Shield Test Reactor (STR), also referred to as the Systems for Nuclear Auxiliary Power (SNAP) Shield Test Experiment (STE) and the Shield Test Facility (STF).[1,2,3] Figures 2.17a through 2.17r provide a recent photograph, site plan, historical photographs, and building-specific drawings.

Building Features: Building 4028 was originally constructed as a 40 foot square by 14 feet high Butler-type building with a steel frame, gable roof, insulated metal siding, continuous concrete footings, and a concrete floor slab. It was built on top of an approximately 200-square-foot concrete test vault with an approximately 20-foot ceiling. Building 4028 included below-ground structures that were not directly below the main building. These structures were recessed into a sloped area, but were not entirely underground. Equipment Pad 4811 was located adjacent to Building 4028 and held support equipment, including the cooling tower, heat exchanger, and

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[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962-November 1992.
[2] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. K-1.
[3] Department of Energy, *Real Property and Site Development Planning FY 1988-FY 1992*, January 1988.

high-efficiency particulate air (HEPA) exhaust system and stack. The building contained a reactor room, reactor core tank, test vault, cooling system, control room, laboratory, office, and change room.[1,2,3,4,5]

[redacted][6,7] [redacted][8,9,10,1,2]

[1] Cabrera Services, *Final Final Status Survey Report: Final Status Survey Post Historical Site Assessment Sites, Block 1, Santa Susana Field Laboratory, Ventura County, California*, March 2007, p. 2.
[2] Ureda, B.F., *STIR Facility Decontamination and Disposition Final Report, AI-ERDA-13168*, Rockwell International, August 26, 1976, p. 10.
[3] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962-November 1992.
[4] *Certification of the Radiological Condition of Building 028 at the Energy Technology Engineering Center Near Chatsworth, California*, Federal Register Vol. 62, No. 65, April 4, 1997, pgs. 16144-16146.
[5] Ashley, R.L., Atomics International, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.
[6] Golliher, K.G. and K.G. Randen, *Capabilities of the 1Mw Shield Text and Irradiation Reactor, NAA-SR-11528*, Atomics International, November 10, 1965, pgs. 10-11.
[7] Golliher, K.G., *STIR Fuel Element Removal and Shipment – Nuclear Safety Analysis, NSA-652-240-002*, Atomics International, May 16, 1973, p. 5.
[8] Ureda, B.F., *STIR Facility Decontamination and Disposition Final Report, AI-ERDA-13168*, Rockwell International, August 26, 1976, pgs. A-2 – A-3.
[9] Ashley, R.L., Atomics International, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.
[10] Ashley, R.L., Atomics International, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.

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[redacted][3]

In 1964, the STR was modified to become the Shield Test and Irradiation Reactor (STIR). A new reactor core was installed as well as a new cooling system and additional shielding required for operating at 1 megawatt of power. The new shielding included a 12-inch concrete lid for the reactor tank, a 4-foot thick water tank on rails to shield against radiation through the test vault roll-up door, and an improved "donut" shield for the fission plate. A standard fuel element for the STIR consisted of 10 fuel plates of 93.2 percent enriched uranium clad in aluminum. Each fuel element contained approximately 154 to 165 grams of U-235. The normal operational core loading was a 4 by 5 array of fuel elements. The reactor was controlled by four boron carbide (B_4C) control rods with drive mechanisms mounted at the top of the reactor tank. A storage rack for seven fuel elements was located on the tank wall approximately 4 feet from the bottom.[4,5]
According to a 1976 report, reactor cooling for the STIR was provided by a 50-kilowatt refrigeration unit and a 1-megawatt cooling tower. The 50-kilowatt refrigeration unit consisted of a freon-to-water heat exchanger in the reactor room, an airblast heat exchanger outside the reactor room, and the associated pump and plumbing. The 1-megawatt cooling tower system consisted of the cooling tower and pumps, a heat exchanger on the roof of the test vault, and a water purification system. The water purification system and a primary side circulating pump were located in a trench outside the reactor room. A 1,000-gallon distilled water make-up tank was located south of Building 4028.[6]

The 50-kilowatt cooling system became known as the auxiliary cooling system when the STR was modified in 1964. It was retained for low power operations and for cooling the reactor pool during periods when the reactor was not being used to minimize corrosion and evaporation losses. The 50-kilowatt cooling system primary side was always circulating at 40 gallons per minute, even when the reactor was shut down. This loop also supplied the fission plate cooling water. For the 1 megawatt cooling system, the outlet pipe to the cooling system was located 2 feet below the surface of the water in the reactor pool and extended through the wall of the reactor room below ground level. The primary system piping was laid in a concrete-lined trench covered with removable grating below ground level to minimize the effects of radioactive nitrogen-16 (N-16) in the coolant. A fence also enclosed the trench, in addition to the cooling tower and heat exchanger, so that dose rates at the fence line were within acceptable limits,

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[1] Johnson, R.P. et al., *SNAP Shield Test Experiment Preliminary Operations Manual, NAA-SR-5897*, Atomics International, May 8, 1961, p. 13.
[2] Internal Correspondence from Durand, R.E. and Royden, H.N. to Ashley, R.L., Atomics International, *Re: Report of Subcommittee Survey of STIR – August 15, 1967*, August 30, 1967.
[3] Johnson, R.P. et al., *SNAP Shield Test Experiment Preliminary Operations Manual, NAA-SR-5897*, Atomics International, May 8, 1961, pgs. 15-17.
[4] Randen, K.G. and K.G. Golliher, *Startup and Operation of the One-Megawatt Shield Text and Irradiation Reactor, NAA_SR-11175*, Atomics International, March 25, 1966, p.9.
[5] Randen, K.G. et al., *Hazards Summary Report The Shield Text and Irradiation Reactor Modifications for One Megawatt Operation, NAA-SR-MEMO-9129*, Atomics International, December 15, 1963, pgs. 11, 15, 21, 29.
[6] Ureda, B.F., *STIR Facility Decontamination and Disposition Final Report, AI-ERDA-13168*, Rockwell International, August 26, 1976, p. A-3.

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according to a 1963 Atomics International report. The report does not state what the acceptable limits were in 1963. The primary coolant in the 1-megawatt cooling system was circulated at 600 gallons per minute through a heat exchanger located on the roof of the test vault and was returned to the bottom of the reactor pool. Part of the return flow was directed through a jet diffuser located 2 feet above the reactor core. The piping and heat exchanger tubes were aluminum and the pump and flow indicators were stainless steel to minimize corrosion. The secondary loop of the 1-megawatt cooling system took water from the heat exchanger through a one-cell induced draft counter-flow cooling tower. The tower was approximately a 12-foot cube structure located on test vault roof. The secondary loop was automatically controlled using the primary coolant inlet temperature as a controlling mode.[1,2]

The 450-foot square laboratory area was used to house experimental instrumentation. A fume hood containing its own absolute filtering system and a radioactive sink draining to a portable container for liquid waste disposal were provided in the laboratory for the handling of radioactive materials.[3,4,5] The laboratory was modified and extended 12 feet to the south sometime in or after 1965 (see Figure 2.17m). The laboratory also housed a fuel storage vault in the northeast corner of the room.[6]

The office, control room, change room, and men's restroom were not normally considered radiation areas, unless the combination of reactor, fission plate, and shield were arranged in such a way to produce radiation levels above 2.5 millirems per hour (mrem/hr).[7] The 23- by 20-foot control room was adjacent to the north wall of the reactor room and included a window to allow observation of the reactor room operations. The reactor console and instrumentation were located in one area of the control room, while the instrumentation required for shielding measurements were located in a separate area within the control room.[8]

A 1961 Atomics International manual, states that the atmosphere in the reactor room and shield test vault was maintained at a negative pressure to ensure that any air leakages would be directed toward potentially radioactive areas. The rooms were provided with separate air inlets, each of which were equipped with fixed louvers, renewable media filters, and manual air volume dampers. The control room air was replaced twice each hour with outdoor fresh air. Air from the laboratory was exhausted from the room by way of the fume hood when the hood door was open and through a bypass damper when the hood door was closed. A high efficiency prefilter

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[1] Randen, K.G. et al., *Hazards Summary Report The Shield Text and Irradiation Reactor Modifications for One Megawatt Operation, NAA-SR-MEMO-9129*, Atomics International, December 15, 1963, pgs. 44-46, 72.
[2] Randen, K.G. and Golliher, K.G., *Startup and Operation of the One-Megawatt Shield Test and Irradiation Reactor, NAA-SR-11175*, Atomics International, March 25, 1966, p. 10.
[3] Golliher, K.G. and K.G. Randen, *Capabilities of the 1Mw Shield Text and Irradiation Reactor, NAA-SR-11528*, Atomics International, November 10, 1965, pgs. 10-11.
[4] Ashley, R.L., Atomics International, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.
[5] Johnson, R.P. et al., *SNAP Shield Test Experiment Preliminary Operations Manual, NAA-SR-5897*, Atomics International, May 8, 1961, pgs. 4-5.
[6] Pascolla, A.L., *Building 028 and STIR Facility Decontamination and Decommissioning, 028-AR-0001*, Rockwell International, March 18, 1996, p.9.
[7] Golliher, K.G., *Shield Text and Irradiation Reactor Operations Manual, NAA-SR-MEMO-12606*, Atomics International, September 1, 1968, p. 6-12.
[8] Ashley, R.L., Atomics International, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.

installed in the fume hood would capture most of the gross air particulate matter as it entered the exhaust system. All air exhausted from Building 4028 through the ventilation system passed through a succession of progressively finer media particulate air filters. All filters were reportedly fire and moisture resistant and were to be changed when the accumulated particulate caused excessive pressure drops. The filters were to be routinely monitored and would also be changed if the dose rate at the filter surface approached 100 mrem/hr. All air which left the exhaust system was released through the building ventilation stack. According to the 1961 manual, under normal operation the gaseous or particulate airborne radioactive effluent released at the stack would not exceed the maximum permissible levels indicated by the Chicago Operations Office Atomic Energy Commission Manual at that time.[1] The 1961 manual does not state what the maximum permissible level was at the time.

According to 1962, 1966, and 1976 reports, exhausted air from the reactor room, test vault, and laboratory hood passed through a particulate air filter bank with prefilters and absolute filters before being released through the building's 30-foot ventilation stack.[2,3,4] Gas samples from the building exhaust stack were pumped through a shielded chamber containing a Geiger tube and preamplifier. A log count rate meter and strip chart recorder located in the control room provided a signal if activity exceeded a preset level. A similar system was used to monitor the secondary coolant to detect possible leaks in the heat exchanger. The stack gas monitoring system required daily calibration and replacement of the primary filter as necessary. Complete servicing of the count rate meter and strip chart recorder was required on a quarterly basis. During routine servicing, precautions were taken as the stack gas monitoring system filter was changed. All particulates were filtered from the air stream and could be radioactive. Handling or disposal of the filter was to be performed as if the filter was contaminated.[5,6,7]

A 1961 Atomics International manual notes that no major radioactive waste system was associated with the STE, but provisions were made for handling low-level liquid wastes from the laboratory, change room, and reactor room. According to the manual, the service sink in the change room and the change room shower were drained to the central sewage system, which had a provision for monitoring and handling low levels of radioactive liquid waste. Additionally, the floors of the reactor room drained into the annulus around the reactor tank and may be removed from the shield test vault. No water connections were provided for wash down of either area because the quantities of radioactive liquid waste from the building would be small.[8]

[1] Johnson, R.P. et al., *SNAP Shield Test Experiment Preliminary Operations Manual, NAA-SR-5897*, Atomics International, May 8, 1961, pgs. 6-9.
[2] Ureda, B.F., *STIR Facility Decontamination and Disposition Final Report, AI-ERDA-13168*, Rockwell International, August 26, 1976, p. A-3.
[3] Ashley, R.L., Atomics International, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.
[4] Health and Safety Division, Chicago Operations Office, Reactor Safety Survey Report, Shield Test and Irradiation Reactor (STIR), Atomics International, February 16-17, 1966, p. 5.
[5] Randen, K.G. et al., *Hazards Summary Report The Shield Test and Irradiation Reactor Modifications for One Megawatt Operation*, NAA-SR-MEMO-9129, Atomics International, December 15, 1963, p. 62.
[6] Johnson, R.P. et al., *SNAP Shield Test Experiment Preliminary Operations Manual, NAA-SR-5897*, Atomics International, May 8, 1961, pgs. 41, 116.
[7] Health and Safety Division, Chicago Operations Office, Reactor Safety Survey Report, Shield Test and Irradiation Reactor (STIR), Atomics International, February 16-17, 1966, p. 5.
[8] Johnson, R.P. et al., *SNAP Shield Test Experiment Preliminary Operations Manual, NAA-SR-5897*, Atomics International, May 8, 1961, p. 41.

A 1968 STIR operations manual notes that the sink and shower in the change room were connected to the sanitary sewer system and thus the discharge of radioactive materials into either was prohibited.[1] This appears to differ from what the 1961 Atomics International manual states above.

An undated facility information document, notes that there was no radioactive liquid holdup tanks at Building 4028.[2] However, a 1965 document on changes that need to be made in the STIR operations manual states that the radioactive waste sink in the laboratory fume hood drained to a 20-gallon holdup tank.[3]

A 1966 reactor safety survey report states that radioactive wastes generated at the STIR consisted of solid wastes only. According to the report, ice cream cartons containing low-level waste were picked up by the Radioactive Materials Handling Facility (RMHF) approximately once a week. Radioactive wastes of larger sizes and/or higher radiation levels were put in 55-gallon drums, but the report notes that this material averages no more than one drum every 6 to 9 months.[4]

During the late 1970s and early 1980s, Building 4028 was used for uranium oxide (UO_2) experiments. The former shield test vault, known as the basement or room B101 during this time, housed experimental equipment such as the 5.5-foot by 5-foot by 6-foot arc melting vacuum furnace and associated appurtenances. Additional equipment included the vacuum equipment, associated electrical power systems, and a ventilation system. The furnace and vacuum systems were contaminated with approximately 22 kilograms (kg) of normal UO_2 at the end of operations. The former laboratory area, known as room 102A during this time, was a fuel storage vault from 1977 to 1988 that housed approximately 300 kg of normal and depleted uranium that was surplus at the end of 1988. A fume hood and laboratory equipment were also located in this room.[5,6]

A water retention pond was originally constructed in the early to mid-1960s to contain surface runoff north of Building 4028. A 1969 plot plan shows a 3-inch drain line leading from the southwest corner of Building 4028 into a ditch that directed flow to the pond. The pond was converted for Radioactive Materials Handling Facility (RMHF) use (now referred to as RMHF 4614 Holdup Pond) by removing the Building 4028 piping and constructing a drainage channel between the pond and the RMHF. A 2007 report states that the water retention pond was constructed in the mid-1960s and was likely modified around 1976 when the remaining reactor at Building 4028 was decommissioned and removed. However, a 2009 report states the water

[1] Golliher, K.G., *Shield Text and Irradiation Reactor Operations Manual, NAA-SR-MEMO-12606*, Atomics International, September 1, 1968, p. 6-12.
[2] Unknown Author, *Facility Information, Building # 028*, Unknown Date, BNA01247350.
[3] Unknown Author, *Changes in STIR Operations Manual*, October 15, 1965, BNA 02011149.
[4] Health and Safety Division, Chicago Operations Office, Reactor Safety Survey Report, Shield Test and Irradiation Reactor (STIR), Atomics International, February 16-17, 1966, p. 8.
[5] Klein, A., *Building T028 Decontamination and Demolition Final Report, N001T1000322*, Rockwell International, June 6, 1990, pgs. 3-6.
[6] Pascolla, A.L., *Building 028 and STIR Facility Decontamination and Decommissioning, 028-AR-0001*, Rockwell International, March 18, 1996, p.9.

retention pond was modified in approximately 1961 to also receive surface water runoff from the RMHF. [1,2,3,4]

Former Use(s): Building 4028 was originally constructed to house the STR, which was a water-cooled, zirconium-hydride moderated reactor that operated at a 50-kilowatt capacity between 1961 and 1964. The STR was used to perform tests on space reactor shields using a fission plate driven by neutrons from the thermal column of the swimming pool-type reactor. Four rods were reported to have controlled the reactor, three of which used B_4C as a poison, and the other was a "grey" regulating rod composed of stainless steel. The control rod system was activated by electromagnetic clutches designed for fail-safe operation.[5,6,7]

According to a 1962 description of the experimental program within Building 4028, operations began with a reactor fission-plate testing program that consisted of obtaining the physical parameters necessary to prove the safety of the reactor system. Measurements obtained during this testing program included: [8]

- Reactor criticality
- Reactivity worth of fuel rods and core components
- Core and reflector void reactivity measurements
- Isothermal temperature coefficients
- Reactor and thermal column flux traverse
- Reactor power calibration
- Power coefficient measurements
- Fission plate flux mapping
- Fission plate power calibration

Following the reactor fission-plate testing program, Building 4028 was used for the radiation evaluation of shield materials. This consisted of exposing slabs of shielding materials to be used in the SNAP 2, 8, and 10A programs to the fission spectrum from the fission plate and measuring their attenuation characteristics for various energies of neutrons. The parameters studied included the energy and angular neutron distribution as a function of shield thickness.[9]

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[1] Atomics International, Drawing No. 303-GEN-C40 Sheet No. 6, *Santa Susana Facility Plot Plan*, February 17, 1969.
[2] Cabrera Services, *Final Characterization and Final Status Survey Report: Radioactive Materials Handling Facility Holdup Pond (Site 4614),* March 2007, pgs. 2, 9.
[3] Internal Correspondence from Moore, J.D. to Remley, M.E., Rockwell International, *Re: Quarterly Review of the RMDF (T022) for Radiation Safety, First Calendar Quarter, 1985*, May 29, 1985.
[4] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures,* June 2009, p. 2-7.
[5] U.S. Department of Energy, *Shield Text Experiments*, Energy Technology Engineering Center (ETEC) Website, http://www.etec.engery.gov/History/Major-Operations/Shield-Text.html, accessed April 30, 2010, p.1.
[6] Pascolla, A.L., *Building 028 and STIR Facility Decontamination and Decommissioning, 028-AR-0001*, Rockwell International, March 18, 1996, p.4.
[7] Ashley, R.L., Atomics International, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.
[8] Ashley, R.L., Atomics International, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.
[9] Ashley, R.L., Atomics International, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.

As noted above, one of the first experiments carried out by the STR was a calibration of the fission plate used in the shield test experiments. It was found that the maximum power output of the fission plate was only one sixth of the desired value. While this did not hamper the STR experiments, it was determined that an increase in power would be desirable to improve the statistical accuracy in the experiments and extend the range of measurements possible. Therefore, the decision was made to increase the power of the second core from 50 kilowatts to 1 megawatt.[1]

The STR was modified in 1964 to become the STIR. It operated at a 1-megawatt capacity from 1964 to 1972. The STIR was fueled with Materials Test Reactor (MTR) plate-type fuel elements as opposed to the SNAP fuel elements used in the STR. The MTR was built in Idaho and its fuel assembly body consisted of a group of 18 curved fuel plates brazed to two grooved side plates. The MTR fuel plates consist of cores of uranium-aluminum alloy clad entirely with aluminum. The STIR was used for reactor physics experiments, studies in radiation damage to electronic and instrumentation components, and neutron radiography.[2,3,4,5]

Once testing with the STIR was finished, the fuel elements were removed and the pool water was drained in June 1973. The actual dismantling of STIR began on September 24, 1975 and was completed March 26, 1976. This included the removal of the core tank, the activated concrete structures surrounding the core tank, the thermal column, the reactor shield, the test vault carriage, the water cooling systems, the water shield door, and the partially dismantled exhaust system. These components and structures were shipped to Beatty, Nevada for land burial. [6,7,8]

In 1977, Building 4028 was operated again as the Liquid Metal Fast Breeder Reactor (LMFBR) Fuel Safety Building, or Arc Melt Facility, to investigate the behavior of molten UO_2 relative to simulated reactor accidents. These tests were conducted at the minimum scale necessary to simulate post-accident heat removal conditions and focused on flooring and structural materials. Normal and depleted uranium was processed and melted under controlled conditions. These experiments resulted in recontamination of Building 4028 in areas used for the preparation and melting of UO_2. Tests continued intermittently into 1981.[9,10,1,2]

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[1] Randen, K.G. et al., *Hazards Summary Report The Shield Test and Irradiation Reactor Modifications for One Megawatt Operation*, NAA-SR-MEMO-9129, Atomics International, December 15, 1963, p. 11.
[2] U.S. Department of Energy, *Shield Text Experiments*, Energy Technology Engineering Center (ETEC) Website, http://www.etec.engery.gov/History/Major-Operations/Shield-Text.html, accessed April 30, 2010, p.1.
[3] Pascolla, A.L., *Building 028 and STIR Facility Decontamination and Decommissioning, 028-AR-0001*, Rockwell International, March 18, 1996, p.4.
[4] Oldenkamp, R.D. et. al., Rockwell International Document No N001ER000017, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, January 16, 1990.
[5] Smith et al., *Production of Fuel Assemblies for the Materials Texting Reactor Mock-Up Critical Experiments*, Oak Ridge National Laboratory, April 9, 1951, p. 9.
[6] Ureda, B.F., *STIR Facility Decontamination and Disposition Final Report, AI-ERDA-13168*, Rockwell International, August 26, 1976, p. 9.
[7] U.S. Department of Energy, *Draft Docket No. ETEC-028*, March 26, 1996.
[8] Pascolla, A.L., Rockwell International Document No. 028-AR-0001, *Final Report, Building 028 and STIR Facility Decontamination and Decommissioning*, March 18, 1996.
[9] Oliver, B.M., *Final Decontamination and Radiological Survey of Building T 028, N704SRR990033*, Rockwell International, February 21, 1991, pgs.14-15.
[10] Correspondence from Evans, J.T., Rockwell International, to Long, M.E., Department of Energy, *Re: Strategic Facility Initiative*, March 23, 1987.

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[1] Correspondence from Tuttle, R.J., Rockwell International, to Vaille, R., U.S. Environmental Protection Agency, *Re: Identification and Description of Areas Involved with Radioactive Materials at SSFL Area IV*, October 2, 1989.
[2] Department of Energy, *Real Property and Site Development Planning FY 1988-FY 1992*, January 1988.
[3] Gunderjahn, C.A. and Campbell, D.C., *Operation of the Arc Furnace in Building 028, Santa Susana*, Rockwell International, September 7, 1978.

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[redacted]

[redacted]

[redacted][1]

[redacted]

[redacted]

[redacted]

Additionally, the 1978 operations document notes that no spread of radioactive contamination has occurred beyond the immediate vicinity of the arc melt furnace. The UO_2 forms large and heavy aerosol particles that quickly fall out. The air monitor has never detected excessive airborne contamination. Plastic sheets are placed on the floor and personnel wear protective clothing to prevent the spread of contamination. Occasionally, it was necessary to clean up excess UO_2 deposits in the furnace. Personnel would don protective clothing, including filter or air supply masks, and clean out the furnace with small shovels.[2]

Finally, the 1978 operations document notes that several improvements were scheduled for Building 4028. A recirculating cooling water system was to replace the once through system that provided poor quality water. The recirculating system would reduce or eliminate corrosion and scale buildup in the crucible cooling channels. An improved radioactive exhaust system was also required to increase flow velocity and reliability. Permanent exhaust ducting was to be installed on the furnace tank.[3]

Internal Rockwell letters from September 1983 and 1984 describe annual HEPA filter efficiency testing at Building 4028. According to the 1983 letter, the test on the main radioactive exhaust system filter bank that was recently rebuilt by outside contractor exhibited 99.92 percent efficiency. The test the following year showed 99.95 percent efficiency.[4,5]

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[1] Gunderjahn, C.A. and Campbell, D.C., *Operation of the Arc Furnace in Building 028, Santa Susana*, Rockwell International, September 7, 1978.
[2] Gunderjahn, C.A. and Campbell, D.C., *Operation of the Arc Furnace in Building 028, Santa Susana*, Rockwell International, September 7, 1978.
[3] Gunderjahn, C.A. and Campbell, D.C., *Operation of the Arc Furnace in Building 028, Santa Susana*, Rockwell International, September 7, 1978.
[4] Internal Correspondence from Vetter, M.B. to Moore, J.D., Rockwell International, *Re: DOS Hepa Filter Test, Bldg. 028, ESG-SSFL*, September 20, 1983.
[5] Internal Correspondence from Vetter, M.B. to Moore, J.D., Rockwell International, *Re: Annual DOS Test of Bldg. 028, ESG-SSFL*, September 25, 1984.

A Building 4028 familiarization document attached to a 1987 letter notes that the facility had been used most recently for a uranium melting experiment for the reactor safety program and was radioactively contaminated in several areas, including the furnace and exhaust system in the basement, the uranium storage room, and the radioactive exhaust system. The document states that the building had a radioactive HEPA filer exhaust system that remained in operation at all times. Depleted and normal uranium were stored in cans and encapsulated in clad rods in the former laboratory area known as room 102A and this room was considered contaminated. Normal and depleted UO_2 remained in the furnace and exhaust system following the end of experimentation. According to the document, the furnace and vacuum system needed additional funding and disassembly to recover the uranium. The furnace was sealed shut and contained high internal radioactive contamination. The area outside the furnace was noted as currently clean, but a potential area of contamination. The familiarization document noted that several areas required periodic surveillance in Building 4028. The radioactive exhaust system required operational checks, filter testing, and preventative maintenance. A sump located at the east end of the basement, known as room B101 and formerly the shield test vault, required monitoring for infiltration of groundwater. According to the document, water fills up in the sump and the water level needed to be checked. If the water level approached the top of the sump, a water sample was to be obtained. If the water was clean, it was pumped to the RMHF 4614 Holdup Pond, also known as the T028 pond. If the water was contaminated, RMHF personnel were to be contacted for pickup.[1]

A decision to terminate operations was made in 1984. In 1986, the transformer that provided power for the testing equipment items was removed as part of an environmental project to eliminate polychlorinated biphenyl (PCB)-contaminated items. Building 4028 remained inactive and under periodic surveillance until 1988 when cleanup and decontamination began. A January 1988 condition report on the building indicated that in 1988 the general condition of the structure was poor as a result of the facility's inactive status. In April 1989, the above-grade portion of the building was demolished leaving the concrete floor and below-grade test vault in place.[2,3,4,5]

Information from Interviewees: A number of former employees were interviewed about their experience at the Santa Susana Field Laboratory (SSFL). Four remembered Building 4028. Excerpts from their interviews are included below.

Interviewee 107 worked for Atomics International from 1961 to 1973 as an engineer at the SNAP 2, SNAP 10/10A, S8ER, and STIR programs. The following excerpts were pulled from the interview.

> *"Most of my work at Canoga Park involved the Shield Test Facility and Shield Test and Irradiation Reactor (STIR) in Building 28.*[6] *The Shield Test reactor was*

[1] Unknown Author, *Building T028 Familiarization*, Unknown Date, BNA03532987.
[2] Oliver, B.M., *Final Decontamination and Radiological Survey of Building T 028, N704SRR990033,* Rockwell International, February 21, 1991, pgs.14-15.
[3] Correspondence from Evans, J.T., Rockwell International, to Long, M.E., Department of Energy, *Re: Strategic Facility Initiative*, March 23, 1987.
[4] Correspondence from Tuttle, R.J., Rockwell International, to Vaille, R., U.S. Environmental Protection Agency, *Re: Identification and Description of Areas Involved with Radioactive Materials at SSFL Area IV*, October 2, 1989.
[5] Department of Energy, *Real Property and Site Development Planning FY 1988-FY 1992*, January 1988.
[6] The Building 4028 STIR was located at the Santa Susana Field Laboratory and not at the Canoga Park facility.

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a 50 KW reactor. It was shut down and converted to a 1 MW reactor, which became the STIR. The STIR was used to conduct irradiation tests for the Jet Propulsion Laboratory. Samples for this testing were handled quickly as the half-life of isotopes involved was just minutes. Under the STIR program, I conducted studies on shielding, neutron activation, and neutron radiography. Neutron radiography was my primary research in the early 1970s. I worked on neutron radiography of electronic explosive devices for the Saturn and Apollo space programs, including Apollo 7 through Apollo 17. An issue of the North American Rockwell Corporation journal Skyline shows examples of how neutron radiography can be used in non-destructive examination. The radiograph of a motorcycle was my son's motorcycle. The radiography left the motorcycle slightly irradiated and an AI health physicist noted I could not take the motorcycle home right away.

The only incident I am aware of during my time at Santa Susana is the use of approximately two parts per million of potassium dichromate in the STIR cooling tower. Potassium dichromate was used to minimize corrosion, but the state of California came in as the regulator and stated it could no longer be used. A phosphate compound was used to replace the dichromate compound.

I wrote the safety analysis report and worked on the engineering of fuel element removal and shipment from the STIR facility. When fuel elements had to be replaced, the used fuel elements were placed in a storage rack inside the reactor vessel. New, unused fuel elements were taken from the storage vault in the building and placed in the reactor.

STIR was owned by AEC (now DOE) and used for neutron radiography. When General Electric built its own neutron radiography facility, AI decided not to compete with them and abandon the STIR for the L-88 reactor. The L-88 reactor was also used for neutron radiography and was the first reactor of its kind.

Documentation from experiments and testing, including rolls from recorders, were packaged quarterly and sent to Rockwell International storage facilities that were originally in downtown Los Angeles, and moved later to Newport Beach. The Newport Beach facility also contained documents from the Nixon library. Nearly 10 years of records from the STIR facility would have been sent to one of these locations.

In the late 1960s, I recall one day at the STIR facility when we were told to "shut her down" because of what was interpreted as being air emissions from the building stack. We never asked questions when told to shut down a reactor, so we did what we were told to do. However, the instrumentation and records on the facility were all normal. The readings that had set off the alarms were consistent with a bomb, not with normal operations of the reactor. About a half hour later, it was discovered that the Chinese had detonated a nuclear weapon and fallout in the atmosphere had been mistakenly attributed to the STIR facility. Weapons *testing fallout was not a big deal to us, but this instance got our attention because we had to shut down the STIR as a result.*

Water from the STIR cooling tower would drain into a holding reservoir [presumably the RMHF 4614 Holdup Pond, originally built as a retention pond for Building 4028] at the edge of the asphalt driveway leading into Building 28. The reservoir would accumulate cooling tower water as well as rainwater. A sump pump located at the northwest corner of the test vault accessway [near the location of RMHF 4614 Holdup Pond] was used to pump the water over to Rocketdyne. After the water was pumped to Rocketdyne, AI had no control over it. Rocketdyne conducted regular sampling of the water and then released it to the Los Angeles River. AI was essentially a guest of Rocketdyne's at the site and Rocketdyne could tell AI what to do. Presumably, if there were any issues with the water from AI, Rocketdyne would have discussed it with AI.

During a shielding study test, the intensity of the radiation was so great that a temporary perimeter, similar to the caution tape used by police, had to be established outside the regular building perimeter.

My last chore at AI was packaging up and shipping lithium hydride and tungsten slabs to Oak Ridge National Laboratory as part of an AEC consolidation effort. The slabs were approximately 8 square feet in size and ranged from 1 inch to 10 inches thick. They were used in shielding studies related to a project that aimed to send a person and reactor into space together. The AEC began centralizing operations and eliminating duplication. This involved moving operations to Oak Ridge, which had a reactor the same size as STIR.

Most of my SSFL exposure was from neutron radiography using indium plates that were 16 inches by 20 inches by 1/16 inch thick. The plates would become activated and because of how we held the plates, I received facial exposure. I wore safety glasses and a dosimeter that kept daily records of my exposure. During shielding studies, the reactor room would sometimes become so hot we had to wait a few months for the radiation to subside so that acceptable exposure limits were met. This happened several times, but as a result, we never had any abnormal exposures. Objects used for shielding studies were 5 feet square of various thicknesses. Materials studied included lithium hydride, depleted uranium, lead, and tungsten.

Lab activities at AI used radiological sources and chemicals handled under a hood. Radioisotopes for calibration units were stored in the floor vault and when the STIR facility was decommissioned the calibration sources were sent to DeSoto, but I am not sure how they were ultimately disposed." [1]

Interviewee 277 started working at SSFL in May 1975 as a technician in Building 006 for Atomic International's Sodium & Component Technology Group. The interviewee was

[1] Interview No. 107 conducted by DOE and EPA on July 6, 2010.

transferred 2 to 3 years later to work at the RMHF. The following excerpts were pulled from the interview.

> *"After working for 2 or 3 years at Building 006, I was transferred to RST's department at the radioactive materials disposal facility (RMDF).*
>
> *Once we had a spill of water at the RMHF when a tech left the water running and the fill tank with radioactive water in it overflowed onto the asphalt. It was handled immediately like the charge of the light brigade. I was called in at night in the rain to help vacuum the water off the asphalt that drained to the pond at the bottom of the hill. The pond did overflow into the canyon in heavy rains. The pond is no longer there – it was dug out. The pond was actually built for Building 28 – there was a drainage line direct from Building 28 to the pond. Now drainage water is pumped into a Baker tank, to 17th Street and then to Silvernale Reservoir and to outfall 18, I think."* [1]

Holding a Masters degree in Health Science with a concentration in Environmental and Occupational Health, Interviewee 269 worked at SSFL from 1992 to 2007 for Rockwell International's Rocketdyne division in the Environmental, Health, and Safety group doing permit work and performing a variety of environmental-related projects for the company. The following excerpts were pulled from the interview.

> *"Building 28 housed the STIR, the Shield Test Irradiation Reactor Facility, but we did not find tritium there. We did not find tritium at the SRE, which may be because the SRE had a large amount of shielding."* [2]

Interviewee 3 was an Atomics International employee from 1963 to 1999. The interviewee started as a fork lift operator and was promoted to be in charge of five test facilities. The following excerpts were pulled from the interview.

> *"Building 28 was the neutron flux generator reactor. I was a fork lift operator working at that building. They had to create a frame with lead shielding to put between me and the items I removed with the fork lift from Building 28. That was a neat building. They did things with mummies, motorcycles, and .45 caliber pistols. You could take a picture of a .45-caliber pistol and you could see the spring inside the gun, the bullets inside the clip, and the powder inside the bullets. They did a lot of mummies and stuff for colleges and universities. Rather than disturb the outer packaging of the mummy, they could look inside it. They even did a dinosaur head in Building 100. I moved things within the building because everything associated with the reactor was heavy."* [3]

Radiological Incident Reports: There have been several incidents associated with Building 4028 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing. Summaries of only the

[1] Interview No. 277 conducted by DOE in 2010.
[2] Interview No. 269 conducted by DOE in 2010.
[3] Interview No. 3 conducted by DOE and EPA on March 16, 2010.

incident reports that resulted or may have resulted in releases to the environment are provided following the table, when available. Summaries of all available incident reports are provided in Attachment A.

Building 4028 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0278	3/5/1965	Irradiation Tub		High Airborne Activity During Sample Removal After In-core Irradiation.
A0280	5/8/1965	Irradiation Tub		High Airborne Activity During Sample Removal After In-core Irradiation.
A0279	6/17/1965	Irradiation Tub		Extremity Exposure From Handling Irradiated Bag Sealed With Green Tape.
A0437	8/6/1965	STIR Office	U235	Unmarked Irradiated Fission Foil Moved In Private Car To Clean Office.
A0055	6/2/1975	RMDF & Adjacent	Mixed Fission Product	Nine Spills Have Been Identified @ RMDF Complex.
A0065	1/10/1978	Furnace Area	U	A Small Uranium Fire In An Arc Melting Furnace.
A0077/A0232	1/17/1979	Floc Tower Area	Mixed Fission Product	R/A Water From Flocculation Tower Contaminated Drainage Ditch And Pond.
	1/30/1979	Pond	Mixed Fission Product	Increased R/A In Runoff Water From RMDF.
A0087	7/24/1981	Yard	U	Contaminated Crucible Stored Outside Exposed To Element.
A0096	1/20/1982	Pond		Stuck Float Switch Pumped Pond Dry Increasing Background To Cause Alarm.

- On March 5, 1965, the constant air monitor located in the reactor room alarmed during the removal of an irradiated sample from the north irradiation facility tube referred to as a “glory hole.” The removal operation consisted of “hand hauling” a length of plastic coated electronic hoop-up wire, from which the sample was suspended, to a position where the sampled would be allowed to “cool.” Following the alarm, all personnel in the area were evacuated to the reactor control room and office. High volume air samples and smear surveys were taken from the reactor room and the reactor control room. The operations personnel were requested to seal the “glory hole” opening with plastic to prevent further airborne contamination to leak into the area. Based on available data contained within the incident report, the “glory hole” was sealed approximately an hour and a half after the alarm sounded.

  The incident report summarized that surveys of personnel involved in the incident and indicated no contamination in excess of the background of the instrument, or 30 disintegrations per minute (dpm) beta and gamma. There were four 10-minute high volume air samples taken in the reactor room, including a sample taken at the “glory hole” (Sample No. 3). The measurements ranged from 1.0 x 10^{-7} microcuries per cubic centimeter (µC/cc) at the "glory hole" to 5.8 x 10^{-10} µC/cc, which was approximately 30 minutes after the "glory hole" had been sealed with plastic. A high volume air sample taken in the reactor control room approximately 30 minutes after the incident indicated a gross beta-gamma activity of 1.7x10^{-9} µC/cc upon immediate analysis.

The results of the smear surveys obtained from the reactor room and other areas traversed by personnel did not indicate any contamination in excess of 30 dpm gross beta-gamma, with the exception of the reactor room, which ranged from 40 to 402 dpm gross beta-gamma activity.

The incident report summarized that "as indicated by the high volume air sample obtained in the reactor control room, the building environmental air flow patterns permit the penetration of radioactive airborne contamination into areas from which it should be prohibited." It was recommended that a precise air flow pattern of Building 4028 be examined to correct any deficiencies within the building (A0278).[1]

- On April 8, 1965, a special bioassay request was made for an employee as a result of the "emission of radioactive particulates from the irradiation thimble ('glory hole') during removal of sample from thimble." The incident report did not indicate how the emission of radioactive particulates occurred, but indicated that the "radioelements" involved in the bioassay included possible "hydrocarbons plus other activation products." According to the document, nasal swipes of the employee indicated a gross beta-gamma activity of 1 x 10^3 dpm. An air sample was reported to have measured 5.5 x 10^{-9} µC/cc. No additional information regarding this incident or the employee was included in the referenced document (A0280).[2]

- On August 6, 1965, an unmarked fission foil containing less than 0.5 grams of U-235 was left on a desk in the office area of Building 4028 after being hand-carried from Building 4009 to Building 4028 by an employee in his car. The outside of the container was contaminated to a maximum of 12,000 dpm per 100 square centimeters (dpm/100 cm^2). The U-235 foil had been previously irradiated at Building 4028 in April 1965. The gasket under the top did not provide a seal for the can because the threads of some of the screws holding the top on were stripped. The can was placed in safe storage and the desk was decontaminated to less than 30 dpm/100 cm^2 beta gamma. The maximum removal contamination on the desk was found to be 4,500 dpm/100 cm^2 beta gamma. The employee who transferred the can in his car was surveyed and his car was surveyed and no significant contamination was found (A0437).[3]

- An October 17, 1975, internal letter discusses nine significant radioactive spill areas and numerous "spot areas" at the RMHF complex. Figures 2.7e and 2.10b present a map of these areas. The activity associated with the spills ranged from 0.5 to 3,500 millirads per hour (mrad/hr). The spills were assumed to have occurred between 1972 and 1975 and to

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[1] Owen, R.K., Rough Draft Internal Letter Re: *High Level Radioactive Airborne Concentrations Incident at Building-028 (STIR), March 5, 1965*, Undated.
[2] Owen, R.K., Atomics International Internal Correspondence, *Subject: Special Bioassay Request*, April 9, 1965.
[3] Tschaeche, A.N., Atomics International Internal Correspondence, *Re: Incident Report, Santa Susana Bldg. 028, August 6, 1965*, August 30, 1965.

have followed the course of water. The letter noted that the rainy season was approaching and a spill area on the bank above Building 4028 would "assuredly spread and create considerably more radioactive waste." The figure appears to show this area to have had an activity of 210 mrad/hr adjacent to the stairway northwest of Building 4028 and 35 mrad/hr adjacent to the stairway at the northeast corner of Building 4028. Two more suspect areas, presumably around Building 4028, were to be surveyed as they became accessible; however, the available documents do not provide information on these areas (A0055).[1]

- A November 18, 1975 Rockwell letter follows up on the October 17, 1975 letter discussed above and describes the current status of the RMHF complex. It describes a contaminated area extending along the fence west of the RMHF complex between Building 4028 and the RMHF perimeter fence. This area of contamination appears to be the same area described above in the October 17, 1975 letter. Contamination of dirt and asphalt was thought to be the result of contaminated barrels stored at the west end of the RMHF complex. The barrels may or may not have contained contaminated material. They may have become contaminated due to drainage from an upstream source. Presumably, one or more of the contaminated barrels filled with rain water and tipped over, or by some other means, possibly corrosion, spread contamination down the hill to the south for approximately 100 feet by several feet wide.[2]

- On January 10, 1978, there was a small uranium fire at Building 4028. According to the incident report, the health physicist entered the test area to take a low volume air sample and take several spot smears on the floor and high ledges to determine if airborne activity had been present. The incident report states that "when both the air sample and smear were attempted to be counted, several problems were encountered with the counting system in the area." The report did not elaborate on the problems encountered, but indicated that alpha contamination of 4 to 7 counts per minute (cpm) appeared to be located on the "planchette slide holder." The research team has been unable to determine exactly what this "planchett slide holder" is or where it was located.

  Subsequent investigation found contamination of approximately 60 dpm/100 cm^2 alpha on the lip edge of the arc-melt furnace. This area was decontaminated by personnel assigned to the building. The incident report stated that the constant air-monitor in the area was not operating at the time of the incident, but did not provide detailed information on the actual incident, including the duration and extent of the fire (A0065).[3]

  A 1978 letter report provides some additional information on the fire. According to the report, before the pyrophoric nature of UO_2 was known, "a small amount of UO_2 fell out on the plastic covering the floor while opening the door." Presumably, this means the UO_2 fell out of the furnace door and onto the floor of the former shield test vault room. The door was closed and the fire was extinguished by argon flow from a hose. No spread

[1] Badger, F.H., Rockwell International Internal Letter, *Re: Radioactive Spills in RMDF*, October 17, 1975.
[2] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.
[3] Owens, D.E., Rockwell International Internal Letter, *Subject: Emergency Response-Uranium Fire at T028*, March 28, 1978.

of contamination resulted. To prevent reoccurrence, metal trays were installed under the doors and the trays were covered with calcium carbonate to catch the UO_2 and slow down the oxidation process.[1]

- On January 30, 1979, a water sample from the Building 4028 retention pond located to the west of the building showed an unusual increase in the concentration of radioactivity within the pond. The Building 4028 retention pond was also known as the RMHF 4614 Holdup Pond. Accordingly, this incident is discussed in detail in Section 2.18, below.

- A July 24, 1981, handwritten report indicates that radioactive material was being stored on the pad northwest of Building 4028. According to the report, a copper crucible for melting depleted uranium was stored in a wooden box, but the box lid had been removed. A survey of the upper sides of the crucible indicated contamination of less than 50,000 cpm. The report indicated that the box, and a similar adjoining box, was badly weathered with the plastic wrap on the crucible "all but gone."

  The report stated that drainage from the storage area and Building 4028 was directly to Simi Valley. The document indicated there to be violations of existing regulations and policies and the author requested immediate attention. The document did not provide additional information on the duration of these storage activities, and additional information regarding the fate of the crucible and wooden box could not be located in available documents (A0087).[2]

- On January 20, 1982, the water monitor in the Building 4028 Pond alarmed during heavy rain. The Building 4028 retention pond was also known as the RMHF 4614 Holdup Pond. Accordingly, this incident is discussed in detail in Section 2.18, below.

Current Use: Building 4028 above-grade structures were demolished in 1989.[3] On December 21, 1995, the California Department of Health Services (DHS) concurred with the release of Building 4028 for unrestricted use.[4] On April 2, 1997, DOE approved the release of Building 4028 without radiological restrictions.[5] On April 4, 1997, DOE published a notice in the Federal Register certifying the radiologic condition of Building 4028.[6] On April 21, 1997, DOE officially notified Boeing that Building 4028 was immediately available for unrestricted non-

[1] Gunderjahn, C.A. and Campbell, D.C., *Operation of the Arc Furnace in Building 028, Santa Susana,* Rockwell International, September 7, 1978.
[2] Author Illegible, Handwritten Correspondence, *Subject: Storage Area Northwest of T028*, July 24, 1981.
[3] Klein, A., *Building T028 Decontamination and Demolition Final Report, N001T1000322,* Rockwell International, June 6, 1990, pgs. 9-10.
[4] Correspondence from Wong, G., California Department of Health Services, to Rutherford, P.D., Rockwell International Corporation, *Re: Rocketdyne's Letter Dated July 8, 1995 With Attachments Concerning the Release of Buildings T029, T028, and OCY*, dated December 21, 1995.
[5] Internal Memorandum from Robison, S.A., U.S. Department of Energy (DOE) Office of Northwestern Area Programs, Environmental Restoration, to Liddle R., DOE Oakland Operations Office, *Re: Release of Decontaminated Building 028 without Radiological Restrictions at the Energy Technology Engineering Center*, dated April 2, 1997.
[6] *Certification of the Radiological Condition of Building 028 at the Energy Technology Engineering Center Near Chatsworth, California*, Federal Register Vol. 62, No. 65, April 4, 1997, pgs. 16144-16146.

radiologic use.[1] However, documents indicate that as early as January 9, 1997, Boeing issued the specifications for the removal of the Building 4028 foundation to contractors. According to the specification, all utilities to the building had been disconnected.[2] Below-ground structures and the remainder of Building 4028 were removed in 1998.[3,4] Figure 2.17q is a photograph of the excavation of Building 4028 below-ground structures.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s):

- **1963 Atomics International Reactor Safeguard Review Panel**. The Compact Reactors Committee (Reactor Safeguards Review Panel) met on December 31, 1963 for a survey of the STIR. This survey brought out the fact that there was a diversity of opinion at Atomics International concerning the formats of the operation records (e.g., log books) in use at the various facilities. At each facility a format was adopted which was most suitable for the needs of that facility. This diversity also existed regarding the philosophy and content of these records. Although the Committee acknowledged the advantages of individual choice, the policy presented a problem to the outside reviewer, because of the lack of familiarity with each individual facility. The Committee agreed that serious effort should be made to standardize such records to facilitate external reviews and guarantee that the records were adequate for their purpose. To the objection of a project representative that one format might not be appropriate for all types of reactors, the Committee suggested that a format could be devised that would include items covering all types, and each individual facility could then indicate deletion of those items considered to be non-applicable. The Committee also agreed that there was a deficiency in the number and character of entries in log books. Insufficient information and/or insufficient details were provided in the log books, which would be problematic if an investigation of an incident were necessary.[5]

- **1975 Rockwell Characterization Survey**. A November 18, 1975 internal letter notes that a contaminated area extends down the hillside from the southwest end of the RMHF complex perimeter, north of Building 4028. The contaminated area was approximately 100 feet long by several feet wide. The letter states that brush was cleared along both sides of the fence and down the hill to the north and west of Building 4028. A radiological survey of the area was performed. Approximately 30 cubic feet of dirt and rocks were removed from the upper part of the hill before work was halted due to funding and other issues. Prior to stopping work, a buried "conduit" was exposed. The letter recommends that funding be made available quickly to dispose of this "conduit," a potential source of contamination. It also states that the contaminated area requires

[1] Correspondence from Liddle, R.H., U.S. Department of Energy, Environmental Restoration Division, to Gabler, Mark, Boeing North American, Inc., Energy Technology Engineering Center, *Re: Release of Facilities for Unrestricted Non-Radiologic Use*, dated April 21, 1997.
[2] Gerritsen, W.J., Boeing North America, *Specification for Removal of the Building 4028 Foundation at the Santa Susana Field Laboratory*, January 9, 1997.
[3] Lafflam, Steve, Letter *Re: Building Demolition and Disposal at SSFL*, April 11, 2000.
[4] Rockwell International, Building *4028 Demolition Photo, Photograph Number ETEC-9/22/97-395366*, September 22, 1997.
[5] Internal Correspondence from Compact Reactors Committee to Balent, R., North American Aviation, *Re: STIR Survey – Recommendation and Minutes of Meeting of December 31, 1963*, January 31, 1964.

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further removal of brush to more fully delineate the contamination.[1] The research team is unable to identify the type of buried conduit discovered in this survey or its exact location.

- **1976 Rockwell Radiological Survey**. In 1975 and 1976, Rockwell International conducted decontamination and decommissioning (D&D) of Building 4028 as STIR operations had ceased in the building. Prior to dismantling the facility, Atomics International conducted a survey of the facility and determined that radiation sources were "essentially confined to the reactor vessel internals and surrounding materials, thermal column, and test carriage." During the course of D&D activities, Atomics International performed radiological monitoring and surveying of the operation that included smear surveys, portable instrument surveys, air sampling, and radioanalyses of water, soil, and concrete. Surveys of the graphite logs within the thermal column found radiation levels ranging from 15 mrad/hr at the ends exposed to the test vault to 50 mrad/hr at the ends nearest to the reactor. Six thousand pounds of graphite logs were removed from the thermal column and placed in shipping containers to be sent to the RMHF for subsequent shipment to Beatty, Nevada for burial. The thermal column wall had a radiation level of 500 mrad/hr in the center and 200 mrad/hr at the edges.[2]

  Additional areas of elevated radiation included the test vault area, the "donut," the thermal column walls, the reactor cavity floor, and the lower reactor concrete wall. Activation of the reactor concrete ranged from 14.0 picocuries per gram (pCi/g) beta to 18.6 pCi/g beta. Analysis of concrete cores at 0 to 1 inches of core segment depth ranged from 12.1 pCi/g beta at the cavity wall to 4,904.1 pCi/g beta at the floor of the reactor enclosure. Atomics International had determined that the mean background for Building 4028 was 16.8 pCi/g. To remove the activated concrete, an air-driven, hydraulically positioned Hoe-Ram was used to break out the activated concrete. Water was sprayed on the rubble to decrease the amount of airborne dust. Contaminated water from the concrete coring and Hoe-Ram operations was evaporated; however the report does not indicate where this evaporation occurred.[3]

  Atomics International placed the concrete rubble into boxes that were sent to the RMHF for shipment to an offsite burial location. Atomics International removed the entire floor area of the reactor enclosure and the concrete pad directly below the floor. In addition, the concrete structure that supported the thermal column shielding and extended under the floor area was removed to a depth of 1.5 feet. Excavation of the floor area extended to a depth of 3 feet below the original floor level at the rear of the reactor cavity and 4.5 feet at the front. The maximum specific activity of concrete samples taken from the concrete remaining in the wall and below the floor measured 19.0 pCi/g beta. The removal of the concrete walls and floor exposed the surrounding fill soil, which was sampled for radiation levels. Twenty-five samples taken from the exposed soil

[1] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.
[2] Ureda, B.F., *STIR Facility Decontamination and Disposition Final Report*, *AI-ERDA-13168*, Rockwell International, August 26, 1976, pgs. 19, 30.
[3] Ureda, B.F., *STIR Facility Decontamination and Disposition Final Report*, *AI-ERDA-13168*, Rockwell International, August 26, 1976, pgs. 30, 37- 43.

surrounding the reactor cavity measured between 14.4 and 30.8 pCi/g beta. According to Atomics International, the natural background radioactivity levels of soil in the area surrounding the SSFL were historically measured from 20 to 30 pCi/g beta. It should be noted that lesser readings have been used by Atomics International, Rockwell, and Boeing as a guide for onsite background levels. Nevertheless, Atomics International determined that the soil surrounding the concrete was at background radioactivity levels.[1]

The reactor cavity was backfilled with dirt and non-radioactive rubble and the opening in the test vault was sealed with a 6-inch thick concrete-steel reinforced wall. The reactor cavity opening in the reactor room was paved with concrete. Other pits and trenches deemed unsafe were filled and paved, including a storage vault in the laboratory room, the shield door rail excavations, and the pipe pits near the reactor cavity. A final radiological survey of Building 4028 and the fenced area surrounding the building was conducted following D&D activities. One hundred measurements were taken with a 7 mg/cm^2 absorber detector in the interior of the building and the measurements ranged from 0.02 to 0.07 mrad/hr above background (background was stated by Rockwell to have been between 0.03 and 0.04 mrad/hr). Eighty measurements taken within the fenced area surrounding the building ranged from 0.02 to 0.08 mrad/hr above background (background was stated by Rockwell to have been between 0.02 and 0.04 mrad/hr). Atomics International summarized that the survey showed Building 4028 had been decontaminated to levels as low as practicable below the 1976 limits for future unrestricted use shown in the table below.[2,3]

1976 Contamination Limits for Decontamination and Disposal of Building 4028

Emitters	Total	Removable
Beta-Gamma	0.1 mrad/hr at 1 cm with 7 mg/cm^2 absorber	100 dpm/100 cm^2
Alpha	100 dpm/100 cm^2	20 dpm/100 cm^2

- **1981 Rockwell Environmental Survey**. In 1981, a preliminary survey was conducted to support RMHF decommissioning. Low levels of fixed and removable contamination were found in portions of the RMHF asphalt and in the soil beneath the asphalt paving. Localized areas of contamination were also discovered in the soil outside the north, west, and south fence perimeters. Thirty-seven locations were identified for sample collection with a micro-R meter. Samples were taken at the surface and at 12 inches below the surface (subsurface) to determine the extent of contamination. Surface soil sample activities ranged from 21.25 to 1,142.92 pCi/g. The soil activity at 12 inches deep ranged from 19.86 to 104.00 pCi/g. Sample results in the drainage north of Building 4028 are described in the table below. Boeing-stated background levels ranged from 20 to 30 pCi/g gross beta activity. Soil and asphalt sampling and radiological surveys identified

1 Ureda, B.F., *STIR Facility Decontamination and Disposition Final Report, AI-ERDA-13168*, Rockwell International, August 26, 1976, pgs. 43-47.
2 Ureda, B.F., *STIR Facility Decontamination and Disposition Final Report, AI-ERDA-13168*, Rockwell International, August 26, 1976, pgs. 9, 55, 58.
3 Internal Correspondence from Johnson L., Rockwell International, to Heine, W.F., *Re: Final Radiation Survey – Building T-028*, dated May 10, 1976.

eight areas with elevated radiological activity at the RMHF, including an area north of Building 4028. See Figure 2.1u for a more specific depiction of the sampling locations and Plate 1 for the location of contaminated areas.[1,2,3]

1981 Soil Sample Analysis Results

Sample Location	Surface Activity (pCi/g)	Subsurface Activity (pCi/g)
North of Building 4028	220.95	104.00
North of Building 4028	50.15	30.23
Northeast of Building 4028	84.82	51.15
East of Building 4028	44.97	36.79

- **1988 Rockwell Radiological Survey**. In July 1988, Rockwell International began D&D efforts again for Building 4028 after UO_2 experiments had ceased in the building. Surplus UO_2 was packaged for disposal and consisted of 278,671 grams of normal UO_2 and 22,405 grams of depleted UO_2. In August 1988, equipment, piping, hardware, and electrical components from room 102A and B101 were packaged for disposal. Additionally, the concrete floor of room 101A was scabbled and the walls dusted. From August through October 1988, the radioactive filter system and furnace were decontaminated, removed, and disposed.[4,5]

  Removal of the radioactive duct-work began in the attic and continued through the room 102A fuel storage vault, the change room, and the rest room. The removal effort ceased while the furnace was being removed as it was necessary to repair and have the radioactive filter system operational for the furnace cleanup and removal. Following the removal of the furnace, the remaining ventilation ducting was removed in October 1988. From October through November of 1988, the HEPA filter components and stack were removed from the building exterior, the sump was pumped out, and furnace power transformer removed.[6]

  The furnace removal began with the flushing of the vacuum pump. Decontamination, monitoring, appurtenance removal and sealing of the arc furnace was completed in October 1988. During this process, an oily substance was discovered to be leaking from the filter box. The oil was solidified with Petroset and the surfaces were wiped. The furnace was then placed on a pallet and the exterior of the furnace was cleaned. According to the 1996 facility D&D report, the furnace was loaded with "LSA" waste

[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-3.
[2] Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, pgs. 24-29.
[3] Internal Correspondence from Peko, D. to McCurnin, W.R., Rockwell International, *Re: Radioactive Materials Disposal Facility Assessment Plan*, May 22, 1990.
[4] Klein, A., *Building T028 Decontamination and Demolition Final Report, N001T1000322*, Rockwell International, June 6, 1990, pgs. 8-10.
[5] Pascolla, A.L., *Building 028 and STIR Facility Decontamination and Decommissioning, 028-AR-0001*, Rockwell International, March 18, 1996, pgs. 15-17.
[6] Pascolla, A.L., Rockwell International Document No. 028-AR-0001, *Final Report, Building 028 and STIR Facility Decontamination and Decommissioning*, March 18, 1996, pgs. 16-17.

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and diatomaceous earth, sealed and prepared for shipment to Hanford, Washington, for burial as radioactive waste.[1]

All radioactive waste from the facility D&D was reported to have been sent to the RMHF for packaging and subsequent shipment to Hanford, Washington, or Beatty, Nevada, for land burial. A total of 1,500 cubic feet of radioactive waste was removed. Contaminated water from the concrete coring and Hoe-Ram operations was evaporated at the RMHF.[2]

Rockwell International performed a final radiological survey in November 1988 and determined that all above-ground structures were found fit to be disposed as "conventional" waste, presumably non-radioactive waste. Building demolition occurred from April to July 1989. According to Rockwell, below-grade structures met the 1988 criteria for release with unrestricted use and were left in place.[3,4] Additionally, a site water runoff analysis, completed in September 1988, determined there to be no detectable activity from Building 4028 runoff.[5] Rockwell International performed a final radiological survey in 1991.[6,7]

- **1988 Rockwell Water Runoff Analysis**. On September 15, 1988, a site water runoff analysis was conducted as part of D&D efforts. No detectable activity was found by Rockwell.[8,9]

- **1991 Rockwell Final Decontamination and Radiological Survey.** In February 1991, Rockwell International presented the results and statistical analysis of the final radiological survey data for Building 4028 that were conducted prior to building demolition in 1989. According to Rockwell's report summary, the data indicated small levels of residual radioactive contamination just above background in isolated areas of the facility. Total alpha/beta measurements made in 67 grid locations in Building 4028 rooms 102, 102A and B101 showed test statistic values of 36.2 and 1,148 dpm/100 cm^2, respectively. Both of these values were below the acceptance limit for surface contamination of 5,000 dpm/100 cm^2 that was reportedly effective at that time. The removable alpha/beta measurements made in the same grid locations showed test statistic values of 33.3 and 89.9 dpm/100 cm^2, respectively. Removable alpha/beta measurements

[1] Pascolla, A.L., Rockwell International Document No. 028-AR-0001, *Final Report, Building 028 and STIR Facility Decontamination and Decommissioning*, March 18, 1996, p. 16.
[2] Pascolla, A.L., Rockwell International Document No. 028-AR-0001, *Final Report, Building 028 and STIR Facility Decontamination and Decommissioning*, March 18, 1996, p. 18.
[3] Klein, A., *Building T028 Decontamination and Demolition Final Report, N001T1000322*, Rockwell International, June 6, 1990, pgs. 8-10.
[4] Pascolla, A.L., Building 028 and STIR Facility Decontamination and Decommissioning, 028-AR-0001, Rockwell International, March 18, 1996, pgs. 15-17.
[5] Pascolla, A.L., Rockwell International Document No. 028-AR-0001, *Final Report, Building 028 and STIR Facility Decontamination and Decommissioning*, March 18, 1996.
[6] Oldenkamp, R.D. et. al., Rockwell International Document No N001ER000017, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, January 16, 1990.
[7] U.S. Department of Energy, *Draft Docket No. ETEC-028*, March 26, 1996.
[8] Klein, A., *Building T028 Decontamination and Demolition Final Report, N001T1000322*, Rockwell International, June 6, 1990, pgs. 8-10.
[9] Pascolla, A.L., Building 028 and STIR Facility Decontamination and Decommissioning, 028-AR-0001, Rockwell International, March 18, 1996, pgs. 15-17.

taken on various remaining structures located at Building 4028 showed test statistic values of 6.2 and 31.8 dpm/100 cm^2. All the removable alpha/beta values were below the Rockwell acceptance limit for removable contamination of 1,000 dpm/100 cm^2.[1]

The ambient gamma exposure rates were observed to be slightly higher in the basement area (4.7 microroentgens per hour [µR/h]), but still below the Rockwell International-reported allowable limits. The maximum acceptable contamination limits used for comparison are presented in the table below. The background gamma exposure rate for Building 4028 was determined by Rockwell International to be 17.9 µR/h.[2] EPA does not necessarily agree with these background or maximum acceptable contamination limits.

Rockwell's 1991 Maximum Acceptable Contamination Limits

Parameter	Limit
Total surface alpha/beta activity	5,000 dpm/100 cm2
Removable surface alpha/beta activity	1,000 dpm/100 cm2
Ambient gamma exposure rate (at 1 meter)	5 µR/h above background* 10 µR/h above background**

* Limit applicable for outside areas or building interiors with standard slab floor above-grade construction.
** Limit applicable for areas such as concrete shielded vaults.

- **1992 ORISE Verification Survey**. In June 1992, the Oak Ridge Institute for Science and Education (ORISE) conducted a verification survey of Building 4028, including the above-grade pad, building vault, and stairwell. The survey included surface scans and smear samples for alpha, beta, and gamma activity, soil samples, and document review. According to ORISE's report, the primary contaminant within Building 4028 was uranium in natural and depleted isotopic abundances. Samples and data were submitted to ORISE's laboratory in Oak Ridge, Tennessee for analysis. The report indicated that soil samples were analyzed by gamma spectrometry for cesium-137 (Cs-137) and uranium, and were analyzed by wet chemistry methods for strontium-90 (Sr-90). Surface scans of the above-ground concrete slab, below-grade vault, and the stairwell did not identify any locations of elevated direct radiation. The average surface activity levels were < 83 dpm/100 cm^2 for alpha and ranged from < 860 to 1,200 dpm/100 cm^2 for beta. Individual direct measurements ranged from < 83 to 89 dpm/100 cm^2 for alpha and < 860 to 1,400 dpm/100 cm^2 for beta. Removable activity levels were < 12 dpm/100 cm^2 for gross alpha and < 15 to 25 dpm/100 cm^2 for gross beta. ORISE's measurements and sampling data were within DOE guidelines in 1992, which are presented in the table below. According to the ORISE report, Building 4028 met the release requirements for unrestricted use.[3]

[1] Oliver, B.M., *Final Decontamination and Radiological Survey of Building T 028, N704SRR990033,* Rockwell International, February 21, 1991, pgs.14-15.
[2] Oliver, B.M., *Final Decontamination and Radiological Survey of Building T 028, N704SRR990033,* Rockwell International, February 21, 1991, pgs.14-15.
[3] Vitkus, T.J., *Verification Survey of the Old Conservation Yard, Building T064 Side Yard, and Building T028, Santa Susana Field Laboratory, Rockwell International, Ventura County, California,* Oak Ridge Institute for Science and Education, October 1993, pgs. 5-11.

Surface Contamination Guidelines from DOE Order 5400.5 (1990 and 1993)

Allowable Total Residual Surface Contamination (dpm/100 cm²)			
Radionuclides	**Average**	**Maximum**	**Removable**
U-Natural, U-235, U-238, and associated decay products	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000β-γ	15,000β-γ	1,000β-γ
External Gamma Radiation			
The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h.			

Source: U.S. Department of Energy Order 5400.5, Radiation Protection of the Public and the Environment, February 8, 1990, p. IV-6, and Change 2, January 1993.

- **1995 California DHS Verification Survey**. On September 14, 1995, a verification survey for Building 4028 was performed by the California DHS. The survey included a visual site inspection that confirmed that the above-ground structure of Building 4028 had been removed. The report indicated that the basement area had been stripped of all equipment and fixtures. DHS conducted background measurements approximately 50 yards from the remaining structure outside the basement room. The Ludlum M-19 Rate meter provided a reading of 8 μR/h outside the basement area, and an Eberline ESP-2 with a Ludlum 44-9 G-M pancake probe provided a background reading of 50 cpm.

  DHS conducted a scan of the main floor, which gave readings ranging from 8 μR/h to 39 μR/h. DHS attributed the range of the readings to the proximity of the RMHF. DHS also made contact readings at nine locations in the basement area and took wipe samples of the floor and walls surrounding the area previously occupied by the uranium melting facility. The contact readings ranged from 42 to 64 cpm, and the wipe sample readings ranged from 51 to 56 cpm. DHS summarized that the survey results were less than twice background for the basement structure and were higher than the established background for the surrounding area. These higher levels were attributed, however, to the proximity of Building 4028 to the RMHF.

  DHS also concluded that the surface scans and wipe sample results were below limits for release for unrestricted use. These levels were derived from DECON-1 (Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use) and were 5,000 dpm/100 cm^2 alpha and beta-gamma for surface readings and 1,000 dpm/100 cm^2 alpha and beta-gamma for removable activity.[1]

- **1995 California DHS Release to Unrestricted Use**. On December 21, 1995, the California DHS concurred with the release of Building 4028 for unrestricted use.[2]

[1] Lupo, R., Verification Survey of Building T028, California Department of Health Services, September 14, 1995.
[2] Correspondence from Wong, G., California Department of Health Services, to Rutherford, P.D., Rockwell International Corporation, *Re: Rocketdyne's Letter Dated July 8, 1995 With Attachments Concerning the Release of Buildings T029, T028, and OCY*, dated December 21, 1995.

- **1996 Rocketdyne Area IV Radiological Characterization Survey.** During the 1996 Area IV Radiological Characterization Survey, soil samples were collected and analyzed as part of the Area IV radiological characterization. Randomly selected, two soil samples were taken in the vicinity of Building 4028 (samples 95-0107 and 95-0108). Sample 95-0107 was located northwest of the paved area north of Building 4025 and was reported to have had elevated levels of Cs-137 at 0.51 pCi/g. Sample 95-0108 was located southwest of the RMHF 4614 Holdup Pond and had Cs-137 levels of 0.43 pCi/g. These activities were reported by Rocketdyne to be below regulatory cleanup standards and "mostly within the range of U.S. background." The report indicated that no remediation was required.[1]

- **1997 DOE Release to Unrestricted Use**. On April 2, 1997, DOE approved the release of Building 4028 without radiological restrictions.[2] On April 4, 1997, DOE published a notice in the Federal Register certifying the radiologic condition of Building 4028.[3] On April 21, 1997, the DOE officially notified Boeing that Building 4028 was immediately available for unrestricted non-radiologic use.[4]

- **2002 EPA Technical Support and Field Oversight Document Review.** In December 2002, U.S. Environmental Protection Agency (EPA) contractor, Tetra Tech, provided its findings of an independent evaluation of the processes used by Rocketdyne to assess the radiological status of a number of buildings at the SSFL, including Building 4028. The findings were presented to EPA and concluded that Building 4028 had been adequately surveyed and the surveys were sufficiently documented. No further survey action was recommended for Building 4028. The only recommendation Tetra Tech provided was to implement MARSSIM for all future radiological surveys at the SSFL.[5]

- **2003 RMHF South Fence Characterization**. In 2003, an extensive characterization was performed on soils outside the RMHF south fence. According to a 2003 Boeing site environmental report, this area had historically contained small amounts of Cs-137. More than 40 soil samples were taken and analyzed for man-made gamma emitters. Cs-137 was detected in most samples and averaged 27 pCi/g, ranging from nondetectable to 124 pCi/g in isolated spots. The approved soil release criteria for Cs-137 was 9.2 pCi/g.[6] Contaminated soils were excavated. According to a 2009 Resource Conservation and

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[1] Rocketdyne, Report No. A4CM-ZR-0011, *Area IV Radiological Characterization Survey Final Report*, August 15, 1996.
[2] Internal Memorandum from Robison, S.A., U.S. Department of Energy (DOE) Office of Northwestern Area Programs, Environmental Restoration, to Liddle R., DOE Oakland Operations Office, *Re: Release of Decontaminated Building 028 without Radiological Restrictions at the Energy Technology Engineering Center*, dated April 2, 1997.
[3] *Certification of the Radiological Condition of Building 028 at the Energy Technology Engineering Center Near Chatsworth, California*, Federal Register Vol. 62, No. 65, April 4, 1997, pgs. 16144-16146.
[4] Correspondence from Liddle, R.H., U.S. Department of Energy, Environmental Restoration Division, to Gabler, Mark, Boeing North American, Inc., Energy Technology Engineering Center, *Re: Release of Facilities for Unrestricted Non-Radiologic Use*, dated April 21, 1997.
[5] Tetra Tech EM, Inc., *Zone III EPA Region 9, Final Rocketdyne Technical Support and Field Oversight Document Review for Buildings T-012, T-023, T-028, T-029, and T-363*, December 20, 2002.
[6] Boeing, *Site Environmental Report for Calendar Year 2003, DOE Operations at The Boeing Company Rocketdyne Propulsion & Power, RD02-148-01*, September 2004, p. 5-13.

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Recovery Act Facility Investigation report, three small shallow excavations were performed south of the RMHF perimeter fence to mitigate the elevated mixed fission products (primarily Cs-137) detected in soils during the south fence characterization. One of the small excavations was near the northeast corner of the Building 4028 area. The excavations measured 125 feet by 13 feet, 5 feet by 7 feet, and 7 feet by 12 feet. Excavation depths were approximately 0.5 feet deep, with approximately 130 cubic yards of soil removed.[1,2] After removal of the contaminated soil, six more soil samples were taken from the area and the average Cs-137 concentration was lowered to 3.75 pCi/g, ranging from 1.65 to 7.08 pCi/g. These samples were below the Boeing-stated approved release criteria of 9.2 pCi/g, applicable at that time. Since the RMHF complex is still operating, a final cleanup survey will be performed after RMHF closure.[3]

- **2006 Boeing Radiological Survey**. In November and December 2006, Boeing performed a final status survey for five sites at the SSFL, including Building 4028. This survey included a gross gamma walkover survey, surface soil sampling, subsurface soil sampling, and exposure rate measurements. According to Boeing, none of the samples reported radionuclide concentrations above their respective derived concentration guideline levels (DCGLs) in 2006. Building 4028 was recommended for unrestricted release.[4] The DCGLs established by Boeing were derived, radionuclide-specific activity concentrations within a survey unit corresponding to the release criterion and were based on the most "restrictive" standards between the Boeing DCGL and the 2006 EPA preliminary remediation goals (PRG) 10-4 Risk Level, as indicated in the table below.[5] EPA does not necessarily agree that these standards were appropriate or effective at that time.

Boeing's DCGLs for Radionuclides of Concern

Constituent	Residential Soil Concentration (pCi/g)	
	Boeing DCGL [1]	EPA PRG 10^{-4} Risk Level [2]
Americium-241	**5.44** [3]	187
Cobalt-60	**1.94**	4
Cesium-134	**3.33**	16
Cesium-137	9.2	**6**
Europium-152	4.5	**4**
Europium-154	**4.1**	5
Tritium	31,900	**228**
Manganese-54	**6.1**	69
Plutonium-238	**37.2**	297
Plutonium-239	**33.9**	259

[1] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California*, June 2009, p. 3-13.
[2] The research team could not verify this information from the source cited in the 2009 Resource Conservation and Recovery Act Facility Investigation report.
[3] Boeing, *Site Environmental Report for Calendar Year 2003, DOE Operations at The Boeing Company Rocketdyne Propulsion & Power, RD02-148-01*, September 2004, p. 5-13.
[4] Cabrera Services, Final Final Status Survey Report: Final Status Survey Post Historical Site Assessment Sites, Block 1, Santa Susana Field Laboratory, Ventura County, California, March 2007, pgs 18-20, 31, 39.
[5] Cabrera Services, Inc., *Final Status Survey Report: Final Status Survey Post Historical Site Assessment Sites, Block 1*, March 2007.

Boeing's DCGLs for Radionuclides of Concern (concluded)

Constituent	Residential Soil Concentration (pCi/g)	
	Boeing DCGL [1]	EPA PRG 10^{-4} Risk Level [2]
Plutonium-240	**33.9**	-
Plutonium-241	**230**	40,600
Strontium-90	36	**23**
Thorium-228	**5**	15
Thorium-232	**5**	**5**
Uranium-234	**30**	401
Uranium-235	30	**20**
Uranium-238	**35**	74

[1] Boeing, Approved Sitewide Release Criteria for Remediation of Radiological Facilities at the SSFL, 1998
[2] Source: Based on EPA preliminary remediation goals (PRGs) for residential soil at a 10-4 risk level. OSWER 9355.01-83A. "Distribution of OSWER Radionuclide Preliminary Remediation Goals (PRGs) Superfund Electronic Calculator." February 7, 2002. http://epa-prgs.ornl.gov/radionuclides. Data retrieved October 26, 2006.
[3] More restrictive standard for each constituent is bolded.

- **2008 ORISE Verification Survey**. In February 2008, ORISE performed a verification survey of Building 4028 to confirm Boeing's final status survey results. Surface scans, soil sampling, and a document review was conducted in two survey units comprising the former Building 4028 footprint. Radionuclide concentrations in soil samples were directly compared with Cs-137 and europium-152 (Eu-152) release limits of 4.7 pCi/g for Cs-137 and 2.8 pCi/g for Eu-152. Radionuclide concentrations in soil samples within the survey area group for Building 4028 ranged from "-0.04" to 0.08 pCi/g for Cs-137 and -0.06 to 0.03 pCi/g for Eu-152. Gamma radiation surface scans did not identify any locations of elevated direct radiation. Based on the results, ORISE determined that the verification results confirmed Boeing's conclusions regarding the final radiological status of Building 4028 and that the release limits have been satisfied.[1]

Radiological Use Authorizations: During the course of building operations from 1960 through 1975, the use of radioactive materials in Building 4028 was exempt from California licensing requirements as a U.S. Energy Research and Development Administration (ERDA)-owned facility.[2] Following the end of ERDA-sponsored operations in Building 4028, the following radiological use authorizations have been assigned to Building 4028:

- Use Authorization 95, issued July 8, 1975, authorized the decontamination and disposition of the STIR, which involved low-level contamination and activities distributed around the reactor tank. The authorization expired July 8, 1976.[3]

[1] Vitkus, T.J., *Verification Survey of the Building 4059 Site (Phase B); Post Historical Site Assessment Sites, Block 1; and Radioactive Materials Handling Facility Holdup Pond (Site 4614), Santa Susana Field Laboratory, The Boeing Company, Ventura County, California*, Oak Ridge Institute for Science and Education, June 2008, pgs. 1-11.
[2] Atomics International, Document PP-704-990-002, *Decontamination and Disposition of Facilities Program Plan*, January 23, 1975.
[3] Tuttle, R.J., *Authorization for Use of Radioactive Materials or Radiation Producing Devices*, Authorization No. 95, Issue Date, July 8, 1975, Expiration Date: July 8, 1976.

- Use Authorization 108 was initially issued on June 22, 1977 for the use and storage of UO_2 at Building 4028.[1] Use Authorization 108D, issued June 22, 1981, authorized the use and storage of 600 kilograms of normal or depleted UO_2 for the UO_2 melting operations in Building 4028. Normal and depleted UO_2 was used in the form of declad pellets, powder, and mixed batches from previous melting experiments. The use authorization was reissued each year with the quantity allowed for use and storage dropping to 300 kilograms in 1985. The last use authorization was issued June 22, 1988 and expired on September 22, 1989. On September 20, 1989 the retirement of Use Authorization 108 was requested as all uranium was removed from Building 4028 and the facility had been demolished with the exception of the vault area.[2,3,4]

Former Radiological Burial or Disposal Locations: None found.

Aerial Photographs: Building 4028 is first identified on a 1965 aerial photograph. In 1967, a drainage pathway is identified south of Building 4028. The drainage path identified in EPA's aerial photographic analysis for 1967 is directed to the southwest. The EPA aerial photographic analysis does not consistently present drainage paths in the area, and this drainage changed over time and with demolition of Building 4028. In 1980, an open storage (OS) area, identified as OS-13 by the EPA's aerial photographic analysis, is located west of Building 4028. OS-13 contains possible stains. In 1988, a smoke stack is identified at Building 4028. Building 4028 is last identified on a 1995 aerial photograph.[5]

Radionuclides of Concern: The primary contaminant within Building 4028 is natural and depleted uranium (U-234, U-235, and U-238).[6] A 1 Ci plutonium beryllium (Pu-Be) source was used with initial criticality and low power experiments and N-16 was found in the reactor coolant. Radioactive polonium-210 (Po-210) would also be present in the coolant if a break should occur in the aluminum plate covering the bismuth window separating the thermal column from the reactor core.[7] Other radionuclides of concern include isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241), americium-241 (Am-241), Cs-137, cobalt-60 (Co-60), europium isotopes (Eu-152, Eu-154), tritium (H-3), and Sr-90.[8] All radionuclides of concern listed with the exception of N-16 (due to a short half-life) are included in the EPA October 2010 Field

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[1] *Radioactive Material Authorizations*, Rockwell International, BNA02647573.
[2] Internal Correspondence from Burgess, D.D. to Isotope Committee Chairman, Rockwell International, *Re: Application for Renewal of Authorization for Use of Radioactive Materials No. 108C*, June 8, 1981.
[3] Nagel, W.E., Authorization for Use of Radioactive Materials or Radiation Producing Devices, Authorization Nos. 108D, 108E, 108F, 108H, 108K, Rockwell International, June 22, 1981 through June 22, 1988.
[4] Internal Correspondence from Schmidt, F.G. to Moore, J.D., Rockwell International, *Re: Retirement of User Authorization No. 108 – Uranium Melt Facility T028*, September 20, 1989.
[5] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.
[6] Vitkus, T.J., *Verification Survey of the Old Conservation Yard, Building T064 Side Yard, and Building T028, Santa Susana Field Laboratory, Rockwell International, Ventura County, California,* Oak Ridge Institute for Science and Education, October 1993, p. 6.
[7] Randen, et al., *Hazards Summary Report The Shield Test and Irradiation Reactor Modifications for One Megawatt Operation, NAA-SR-9129,* Atomics International, December 15, 1963, pgs. 29, 70, 93.
[8] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Methodology*, May 2005, p. 2-9.

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Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of radiological contaminants of concern.

Drainage Pathways: Water runoff is primarily to the west near Building 4028.[1,2] There are two storm drains (upper and lower) at the former location of Building 4028. Stormwater runoff that enters these drains comes from a drainage north of Building 4024, which received surface water runoff from the areas east of Building 4024, the asphalt area around Building 4024, and from the slope between the RMHF and nearby rock outcrops. Prior to 2006, the Building 4028 culvert drained to a pipeline and surface water was conveyed to the RMHF catch basin (RMHF 4614 Holdup Pond). After the RMHF 4614 Holdup Pond was removed in 2006, surface water flow was redirected away from the storm drains and now drains around the former RMHF 4614 Holdup Pond and converges with the drainage than runs north of the RMHF and enters the Meier Canyon drainage monitored by Outfall 003.[3]

An October 1998 email notes that Boeing received bids for erosion control work at the Building 4028 area in October 1997 and that the outcome of the work was not likely to have been successfully achieved or sufficiently durable. The email goes on to discuss development of a new bid to provide an effective solution for the "erosion and drainage problem at the B028 site."[4]

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4028 area is Class 1, due to its former use as a nuclear reactor, radiological incidents, and previous investigations.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the Building 4028 area. As discussed above, there were several radiological incidents at Building 4028 and documented evidence of radiological releases. Previous characterization studies for the Building 4028 area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the Building 4028 area. This includes the following Building 4028 areas and appurtenances:

- Former reactor, test vault, and fuel storage locations in the west portion of the Building 4028 site. Leaks in the reactor and shield cooling lines may have left residual contamination in the area.

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[1] Pascolla, A.L., *Building 028 and STIR Facility Decontamination and Decommissioning, 028-AR-0001*, Rockwell International, March 18, 1996, p. 4.
[2] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, pgs. 2-4, Figure 2-7B.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-7.
[4] Email from Gutierrez, A., Newtech Resources, to Trippeda, D.M., Boeing, *Re: B1028 Site Hill Erosion Control Project*, October 16, 1998.

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- Former radioactive sink for liquid waste disposal in the east portion of the Building 4028 footprint. The known radioactive sink may have left residual contamination in the area.

- Former holding reservoir [RMHF 4614 Holdup Pond] located at the edge of the asphalt driveway leading to the Building 4028 footprint that accumulated cooling tower water and rainwater. If radioactive materials were released or accumulated in the holding reservoir, residual contamination may be present.

- Former trench outside the reactor room that contained the water purification system and a primary side circulating pump as part of the cooling tower system. The trench could provide a drainage area for surface water and could collect any residual contamination.

- Former sump pump located at the northwest corner of the Building 4028 test vault accessway [RMHF 4614 Holdup Pond pump] that pumped water from the holding reservoir to Rocketdyne. If radioactive materials were released or accumulated in water, residual contamination may be present.

- Former spill areas on the bank above the former Building 4028 area noted in a 1975 letter. These known areas of contamination were thought to have followed drainage pathways down the bank. Residual contamination may be present.

- Open storage area (OS-13) west of Building 4028 depicted in a 1980 aerial photograph. Possible stains were noted in this area. If radioactive materials were released from OS-13, residual contamination may exist.

- Drainage areas north and south of Building 4028. Aerial photographs and other documents note stormwater drainage pathways on the north and south sides of the building. Residual contamination may exist in these drainages.

2.18 RMHF Holdup Pond/Catch Basin 4614 Area

Site Description: The Radioactive Material Handling Facility (RMHF) 4614 Holdup Pond/Catch Basin Site area, formerly the Radioactive Material Disposal Facility (RMDF) 4614 Site area, comprises RMHF 4614 Holdup Pond/Catch Basin and the drainage channel that terminates at the pond from the west side of the RMHF complex. The RMHF 4614 Holdup Pond/Catch Basin is often referred to as the Building 4028 Pond or 4028 Pond, and has also been referred to as the RD-621 pond. For purposes of this section, Site 4614 will be referred to as the RMHF 4614 Holdup Pond. The RMHF 4614 Holdup Pond was originally constructed in the early to mid-1960s as a holdup pond for Building 4028.[1,2] Figures 2.18a through 2.18h provide a recent photograph, site plan, historical photographs, and building-specific drawings.

Building Features: The former RMHF 4614 Holdup Pond comprised an approximately 25- by 25-foot pond sealed with coated asphalt with a depth of approximately 4 feet and a capacity of

[1] Cabrera Services, *Final Characterization and Final Status Survey Report: Radioactive Materials Handling Facility Holdup Pond (Site 4614)*, March 2007, p. 2.
[2] Internal Email from Rutherford, P. to Marshall, R., The Boeing Company, *Re: Radioactive Material Handling Facility (RMHF) Catch Basin Alarms, Santa Susana Field Laboratory*, February 13, 2003.

approximately 30,000 gallons. The coated asphalt was designed to prevent the seepage of water into the environment. The pond was equipped with two parallel centrifugal pumps that pumped effluent from the pond through a 6-inch discharge line that emptied into a catch basin at the southwest corner of Building 4025, just north of B Street. From here the effluent entered an open drainage ditch and into the 17th Street Drainage that directed flow to the Santa Susana Field Laboratory (SSFL) 3,000,000-gallon Silvernale retention pond.[1,2,3,4]

The pond was also equipped with three level switches. Two of these switches started each of the pumps and a third switch triggered a remote trouble light at the control center. The pond also had a dissolved radioactivity probe that had a local buzzer that tripped the same remote trouble light. According to a 1991 incident report, guards posted at the control center were responsible for responding to the trouble light in the event it was activated.[5] The two float switches were set to leave approximately 2 feet of water in the pond at all times, as this amount of water shielded the probe from the fixed contamination at the bottom of the pond (see Radiological Incident Reports A0077 and A0232 below).[6] Any fixed contamination remaining in the RMHF 4614 Holdup Pond asphalt was dug up in 2006 during decontamination and decommissioning (D&D) activities.[7,8]
According to a 1969 plot plan and a 2009 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report, the RMHF 4614 Holdup Pond received surface water from Building 4028 and Building 4024 via asphalt-paved drainages. Surface water from the RMHF operational area was conveyed to the RMHF 4614 Holdup Pond by an asphalt-paved swale along the northern site boundary and asphalt paved drainage from the western end of the RMHF complex. Based on the 1969 plot plan, drainage also appears to have been received from paved areas to the north of Building 4010, as well as paved areas south of Building 4028. The 1969 plot plan also shows a 3-inch drain line leading from the southwest corner of Building 4028 into a ditch that directed flow to the RMHF 4614 Holdup Pond.[9,10]

Former Use(s): The RMHF 4614 Holdup Pond was originally constructed in the early to mid-1960s as a water retention pond for Building 4028, which housed the shield test reactor (STR) and the shield test and irradiation reactor (STIR). It was converted for RMHF use by removing the Building 4028 piping and constructing a drainage channel between the pond and the RMHF.

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[1] Adler, K.L. and P.S. Olson, Rockwell International Document No N001T1000262, *CERCLA Program Phase I Installation Assessment for DOE Facilities at SSFL*, April 25, 1986.
[2] Atomics International, Drawing No. 303-GEN-C40 Sheet No. 6, *Santa Susana Facility Plot Plan*, February 17, 1969.
[3] Bassat, S. and P. Holten, Occurrence Report RD-91-3-RMDF-91-2, February 28, 1991.
[4] Richards, C. and K. Murray, Rockwell International Document No. GEN-ZR-0019, *Safety Analysis Document for RMDF Operations*, September 9, 1992.
[5] Bassat, S. and P. Holten, Occurrence Report RD-91-3-RMDF-91-2, February 28, 1991.
[6] Bradburry, S.M., Rockwell International Internal Letter, *Subject: Radiological Safety Incident Report T028 Hold-Up Pond*, January 22, 1982.
[7] Cabrera Services, *Final Characterization and Final Status Survey Report: Radioactive Materials Handling Facility Holdup Pond (Site 4614)*, March 2007, pgs. 2, 9.
[8] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, pgs. 12-13.
[9] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[10] Atomics International, Drawing No. 303-GEN-C40 Sheet No. 6, *Santa Susana Facility Plot Plan*, February 17, 1969.

A 2007 final status survey report states that the Building 4028 water retention pond was likely modified around 1976 when the remaining reactor at Building 4028 was decommissioned and removed; however, 1969 plot plans show the drainage channel from the RMHF to already be present. In addition, the 2009 RFI report states the water retention pond was modified in approximately 1961 to receive surface water runoff from the RMHF.[1,2]

As indicated above, the pond had a capacity of approximately 30,000 gallons and was monitored for possible radiological contamination. The pond and drainage channel were lined with asphalt until the fall of 2006, when the asphalt was removed as part of D&D operations. In addition to the asphalt, concrete, soil, and 60 feet of asbestos-containing piping were removed from the RMHF 4614 Holdup Pond area. The holdup pond was replaced with a 1,500-gallon polyurethane stormwater aboveground storage tank in 2006. The tank receives runoff from the RMHF via a drainage pipe. Stormwater runoff is collected and then pumped from the aboveground storage tank to a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[3,4,5,6,7]

The RMHF 4614 Holdup Pond was monitored and alarmed by a sodium iodine gamma exposure meter. Any alarms result in the immediate sampling of water. According to a 2005 historical site assessment (HSA), all alarms in the previous 14 years were false alarms caused by power supply and telephone line problems during wet weather. Reportedly, no activity has been detected in the water. Water pumped from this pond into the SSFL water reclamation system was ultimately sampled according to the National Pollutant Discharge Elimination System permit.[8] In a 1988 site visit, RMHF staff indicated that the pond was monitored regularly, especially in the rainy season. The pond was monitored at least monthly by the Rockwell health and safety department. Furthermore, the pond was checked weekly during the winter and daily during periods of rain. Rockwell RMHF staff indicated that radioactive contamination of the pond from the storage of solid materials in the RMHF yard was remote.[9]

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[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[2] Atomics International, Drawing No. 303-GEN-C40 Sheet No. 6, *Santa Susana Facility Plot Plan*, February 17, 1969.
[3] Internal Correspondence from Moore, J.D. to Remley, M.E., Rockwell International, *Re: Quarterly Review of the RMDF (T022) for Radiation Safety, First Calendar Quarter, 1985*, May 29, 1985.
[4] Cabrera Services, *Final Characterization and Final Status Survey Report: Radioactive Materials Handling Facility Holdup Pond (Site 4614)*, March 2007, pgs. 2, 9.
[5] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, pgs. 12-13.
[6] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures and Volume II – RFI Site Reports Appendix C*, June 2009, pgs. 2-6–2-7, C.2-5.
[7] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-5.
[8] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-25.
[9] Lavagnino, G., *ETEC Meeting and Site Visit*, U.S. Department of Energy, August 17, 1988.

During the dry season when the pond dried up, the sediment was reported to have been removed from the lined pond and analyzed for contamination prior to being disposed as radioactive waste. According to the 2005 HSA, low levels (e.g. 34 pCi/g in 2003) of cesium-137 (Cs-137) were frequently found.[1] It is important to note that the research team did not locate any sampling data from the sediment removed from the RMHF 4614 Holdup pond.

Information from Interviewees: A number of former employees were interviewed about their experience at the SSFL. Three remembered the RMHF 4614 Holdup Pond. Excerpts from their interviews are included below.

Interviewee 254 worked at the SSFL from 1957 to 1989 and became the Engineer in Charge at the RMDF, now known as the RMHF. The following excerpts were pulled from the interview.

> *"In 1977 or 1978 we had a lot of rain and the holdup ponds were overflowing. I would get a phone call in the middle of the night that a pond alarm was going off. This meant the water level of the pond was getting too high. I would have to go up to the hill in the middle of the night and we had to catch any excess water from the holding pond. We had to catch everything because the HPs [health physicists] had to monitor it to see if it was clean. Even though it was presumably clean, it was rain from the sky, the fact that it fell in areas where radiological or chemical material was used meant we had to monitor the water. If it was clean it could go to the Rocketdyne holdup pond."*

> *"The RMDF had a 10,000 to 20,000 gallon holdup pond down to the west, past Building 75. That pond had alarms and radiation monitors on it. During the rains, we had to store all the excess water in 55-gallon drums so the HPs could monitor it. We had a lot of drums that had to be stored in an outdoor storage area at the RMDF complex so they could be verified as clean before being released. One whole parking lot was full of drums of rainwater."*[2]

Interviewee 419 retired from Rockwell International/Boeing as the Division Director for Environment, Health and Safety. The interviewee was a member of the Environmental Health and Safety group for 22 years. The following excerpts were pulled from the interview.

> *"The parking lot at the RMDF drained to the RMDF pond, which was also radiologically monitored. There was a cleanup on the RMDF slope between the parking lot and the end of the property. It entailed cleanup of the parking lot, slope, and an adjacent leach field. After the cleanup was completed, asphalt was put in place to seal any remaining contamination in place during the RMDF leach field clean up. The spill was the result of a large plastic carboy that failed."*[3]

Interviewee 277 started working at SSFL in May 1975 as a technician in Building 006 for Atomic International's Sodium & Component Technology Group. The interviewee was transferred 2 to 3 years later to work at the RMHF. The pond mentioned in the interview is the RMHF 4614 Holdup Pond. The following excerpts were pulled from the interview.

[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California*, *Volume 2 – Area IV Site Summaries*, May 2005, p. I-26.
[2] Interview No. 254 conducted by DOE and EPA on July 20, 2010.
[3] Interview No. 419 conducted by DOE in 2010.

> *"After working for 2 or 3 years at Building 006, I was transferred to RST's department at the radioactive materials disposal facility (RMDF).*
> *Once we had a spill of water at the RMHF when a tech left the water running and the fill tank with radioactive water in it overflowed onto the asphalt. It was handled immediately like the charge of the light brigade. I was called in at night in the rain to help vacuum the water off the asphalt that drained to the pond at the bottom of the hill. The pond did overflow into the canyon in heavy rains. The pond is no longer there – it was dug out. The pond was actually built for Building 28 – there was a drainage line direct from Building 28 to the pond. Now drainage water is pumped into a Baker tank, to 17th Street and then to Silvernale Reservoir and to outfall 18, I think."* [1]

Radiological Incident Reports: There have been several incidents associated with RMHF 4614 Holdup Pond that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing. Summaries of only the incident reports that resulted or may have resulted in releases to the environment are provided following the table, when available. Summaries of all available incident reports are provided in Attachment A.

RMHF Holdup Pond 4614 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0077/A0232	1/17/1979	Floc Tower Area	Mixed Fission Product	R/A Water From Floculation Tower Contaminated Drainage Ditch And Pond.
	1/30/1979	Pond	Mixed Fission Product	Increased R/A In Runoff Water From RMDF.
A0080	1/9/1980	RMDF & Drainage	Mixed Fission Product	Water Hose Broke Overfilling R/A Waste Tank And Drained To 28 Pond.
A0096	1/20/1982	Pond		Stuck Float Switch Pumped Pond Dry Increasing Background To Cause Alarm.
A0265	2/27/1991	Pond		Water Overflowed Pond When Check Valve Stuck During Rain Storm.

- On January 30, 1979, a water sample from the RMHF 4614 Holdup Pond (note the incident report refers to the pond as the Building 4028 retention pond) showed an unusual increase in the concentration of radioactivity within the pond. According to the incident report, the probable source was an accidental release of less than 0.4 millicuries (mCi) of strontium-90 (Sr-90) and Cs-137 from a contaminated paving area near the flocculation tower at RMHF.

  The source of contamination as described in the incident report is vague; however, the incident report indicated that between January 17 and January 23, 1979, a hose used for

[1] Interview No. 277 conducted by DOE in 2010.

Redacted

the transfer of radioactive solutions to the packaging room from the flocculation tower was wrapped with plastic and placed in a plastic bag on the ground surface. This area had also been the previous location of a catch tray used for containing liquids that may have spilled from 55-gallon drums. According to the incident report, the tray may have leaked contaminated water onto the paving. In addition, water contaminated with radioactive material from the flocculation tower process was “accidentally” rinsed into the RMHF 4614 Holdup Pond between January 17 and January 23, 1979. Based on the information contained within the incident report it is unclear whether the source of contamination is from the transfer hose that had been wrapped and placed in a plastic bag or the catch tray.

According to the incident report, the release of 0.4 mCi of Sr-90 and Cs-137 collected in the RMHF 4614 Holdup Pond and increased the concentration of radioactivity in the pond water to a maximum observed value of 8×10^{-6} microcuries per milliliter (µCi/mL). The surface of the silt at the inlet of the pond was observed to be approximately 2,000 picocuries per gram (pCi/g). No increase in silt activity was reported to have been detected downstream of the pond.

Heavy rainfall immediately following the detection of the high radioactive concentrations forced the pumping of the RMHF 4614 Holdup Pond to a surface drainage channel leading to the Rocketdyne Pond R2A, which is discharged during heavy rains to Bell Canyon. This latter discharge resulted in offsite release of water from the Rocketdyne retention pond. Radioactivity levels in water released from the R2A Pond to Bell Canyon were reportedly no different from natural background levels; however no information is provided concerning how much sediment may have transported to the R2A pond during this event. The incident report indicates there was repeated sampling of the R2A pond; however the results of those sampling activities were not included in the incident report. Radioactivity levels in water at a distance halfway to the Rocketdyne pond at 17th and G Streets were “observed to be slightly detectable above background.”

Following the detection of radioactivity in the RMHF 4614 Holdup Pond water and the pumping of that water during heavy rainfall to the Rocketdyne pond, the incident report indicated that personnel used asphalt sealant to cover the contaminated paving. However, additional rains fell following the application of the sealant and washed it loose. Personnel then reportedly applied water-setting cement, followed by another application of the asphalt sealant during clear weather. Following the application of the sealant, runoff from the RMHF carried “significantly more activity” to the RMHF 4614 Holdup Pond “due to scavenging of surface contamination by the sealant and suspension of the sealant in rainwater runoff.”

Analysis of the silt samples from the pond before and after the application of the sealant indicated that much of the sealant was “plated out” in the top layer of silt at the inlet of the RMHF 4614 Holdup Pond. The incident report did not indicate what remediation, if any, occurred at the RMHF 4614 Holdup Pond to remove contamination from silt.

According to the incident report, contamination surveys were conducted on January 30 and 31, 1979, and February 1 and 2, 1979, to determine the distribution of activity

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downstream from the RMHF complex. The incident report indicated that on January 30, 1979, activity was detected at 17th and B Streets at levels of 2,000 counts per minute (cpm) associated with vegetation in the culvert at that location. The incident report stated that this activity "may have accumulated from radioactivity in water that had been previously pumped from the pond." Surveys of the RMHF complex area measured 25,000 cpm with hot spots of 35,000 cpm at the flocculation tower pad and runoff ditch. Following the application of the asphalt sealant on January 31, 1979, the levels were reduced to 20 to 50 percent of the original values, and there was "no detectable activity downstream of 17th and B Streets" (A0077, A0232).[1,2]

- On January 9, 1980, a water hose broke and caused the 5,000-gallon radioactive water tank to overflow. An estimated 100 gallons of liquid containing 0.01 µCi of mixed fission products drained to the RMHF Holdup Pond 4614. A report of property damage or loss indicated that the spill resulted in the contamination of approximately 2,500 square feet of asphalt paving, and an accumulation of approximately 3,000 gallons of contaminated liquid. This incident is discussed in detail in Section 2.1, above (A0080).[3] This spill is depicted on Plate 1.

- On January 20, 1982, the water monitor in the RMHF 4614 Holdup Pond alarmed during heavy rain. It was found that the pumps were still running and had pumped the pond down to approximately six inches of water. According to the incident report, the float switches were set to leave approximately 2 feet of water in the pond, as this amount of water shielded the detector head from the fixed contamination in the bottom of the pond. The incident report summarized that the float switches malfunctioned and did not turn the pumps off as designed. The incident report did not report whether any contaminated waters were pumped out of the pond as a result of the water having been pumped so low (A0096).[4]

- On February 27, 1991, the radiation/high water monitor in the RMHF 4614 Holdup Pond alarmed during a heavy rainstorms. According to the incident report, the discharge pumps could not keep up with the incoming rainwater and some over-flow of the water occurred. Water samples were collected from the inlet, discharge, over-flow points and main SSFL pond outlet. The report indicated that no radioactive discharge occurred. It was determined that a partially stuck check-valve in the pump intake line caused the over-flow. The incident report indicated the vegetation debris was removed from the pond the following day; however, the incident report did not indicate how much debris, or whether the debris was checked for contamination (A0265).[5]

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[1] Gardner, F.W. Rockwell International Internal Correspondence, *Re: Release of Radioactivity from RMDF – January 1979*, February 23, 1979.
[2] Gardner, F.W., Rockwell International Internal Letter, *Subject: Radiological Safety Incident Report RMDF*, February 26, 1979.
[3] Bradbury, S.M., Rockwell International Internal Correspondence, *Re: Radiological Safety Incident Report, RMDF, January 9, 1980*, April 9, 1980.
[4] Bradburry, S.M., Rockwell International Internal Letter, *Subject: Radiological Safety Incident Report T028 Hold-Up Pond*, January 22, 1982.
[5] Ervin, Guy, et al., Occurrence Report, March 18, 1992.

Current Use: Use of the RMHF 4614 Holdup Pond was discontinued in 2006 and the pond was excavated. Approximately 260 cubic feet of soil was removed 10 feet north of the RMHF 4614 Holdup Pond due to elevated Cs-137 sampling results (see below) and approximately 80 cubic feet of soil was removed during excavation of the drainage channel. Neither area was graded or backfilled following the removals. The drainage channel and pond were replaced in 2006 with a 1,500-gallon polyurethane stormwater aboveground storage tank. The tank receives runoff from the RMHF via a drainage pipe. Stormwater runoff is collected and then pumped from the aboveground storage tank to a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage. [1,2,3,4]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this site is as follows:

- **1979 Release Cleanup**. In 1979, contamination resulting from the operation of the flocculation tower north of Building 4021 was identified in the asphalt drainage channel and fixed in place by the application of a bituminous coating. The coating was initially intended as a temporary fix as it is vulnerable to weathering. It has been frequently replaced to prevent contaminant migration. Contaminated runoff water and sludge were also removed from the RMHF 4614 Holdup Pond. The pond surfaces were scrubbed, but low-level contamination remained. This low-level contamination was fixed in place with an asphalt sealer. Low levels of contamination have been identified periodically in the sediments that accumulate in the pond. These sediments are removed during the dry season.[5,6] The sources cited do not provide information on how the sediments were disposed.

- **1981 Rockwell Environmental Survey**. In 1981, a preliminary survey was conducted to support RMHF decommissioning. Low levels of fixed and removable contamination were found in portions of the RMHF asphalt and in the soil beneath the asphalt paving. Localized areas of contamination were also discovered in the soil outside the north, west, and south fence perimeters. Thirty-seven locations were identified for sample collection with a micro-R meter. Samples were taken at the surface and at 12 inches below the surface (subsurface) to determine the extent of contamination. Surface soil sample activities ranged from 21.25 to 1,142.92 picocuries per gram (pCi/g). The soil activity at 12 inches deep ranged from 19.86 to 104.00 pCi/g. Sample results surrounding the RMHF 4614 Holdup Pond are described in the table below. Boeing-stated background levels

[1] Cabrera Services, *Final Characterization and Final Status Survey Report: Radioactive Materials Handling Facility Holdup Pond (Site 4614),* March 2007, p. 2.
[2] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, pgs. 12-13.
[3] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, pgs. 2-6, 3-8.
[4] *Site Environmental Report for Calendar Year 2008, DOE Operations at The Boeing Company, Santa Susana Field Laboratory, Area IV,* The Boeing Company, September 2009, p. 2-4.
[5] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, p. 13.
[6] Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, p. 30.

ranged from 20 to 30 pCi/g gross beta activity. Many of the soil samples listed below indicated elevated readings even when compared with the Boeing's background range. Soil and asphalt sampling and radiological surveys identified eight areas with elevated radiological activity at the RMHF. See Figure 2.1u for a more specific depiction of the sampling locations and Plate 1 for the location of contaminated areas.[1,2,3]

1981 Soil Sample Analysis Results

Sample Location	Surface Activity (pCi/g)	Subsurface Activity (pCi/g)
North side of RMHF 4614 Holdup Pond Channel	38.78	47.17
North side of RMHF 4614 Holdup Pond Channel	44.57	34.42
North side of RMHF 4614 Holdup Pond Channel	35.00	32.63
North side of RMHF 4614 Holdup Pond	64.16	28.04
North side of RMHF 4614 Holdup Pond	30.63	31.42
RMHF 4614 Holdup Pond	40.78	31.42
South side of RMHF 4614 Holdup Pond Channel	40.20	32.43
South side of RMHF 4614 Holdup Pond Channel	45.37	30.81
South side of RMHF 4614 Holdup Pond Channel	37.60	19.86

- **1991 Progress Report**. A project progress report for August 1991 noted that the surface water from the RMHF 4614 Holdup Pond was drained and the pond was refurbished. The sludge collected from the bottom of the pond contained Cs-137 in amounts ranging from 34 to 69 pCi/g. Traces of cobalt-60 (Co-60) were detected at 2 pCi/g. Natural potassium (K-40) was found at "typical levels" (22 pCi/g). After draining, the pond bottom was dried and vacuumed. Fixed contamination ranged from 1,800 to 3,000 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) beta-gamma (U.S. Department of Energy [DOE] Order 5400.5 lists a maximum beta-gamma level of 15,000 dpm/100 cm^2). Smears indicated no detectable contamination above background levels prior to application of the new asphalt sealing compound.[4]

- **2006 Boeing Final Status Survey**. In November and December of 2006, Boeing performed a characterization and final status survey for RMHF Holdup Pond 4614 area. An initial gamma walkover survey of the entire accessible area was conducted. The

[1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-3.
[2] Pendleberry, S.L., *ETEC RMDF Decontamination and Decommissioning (D&D) Project Management Plan, RMDF-AN-0001*, Energy Technology Engineering Center, February 10, 1993, pgs. 24-29.
[3] Internal Correspondence from Peko, D. to McCurnin, W.R., Rockwell International, *Re: Radioactive Materials Disposal Facility Assessment Plan*, May 22, 1990.
[4] Gaylord, G., *Energy Technology Engineering Center Project Progress Report, Accounting Period for August 1991*, Attachment I-2, p.2.

walkover survey found elevated gross gamma activity in two areas, at the top of the drainage channel and north of the former holdup pond. Surface soil sample results ranged from 1.1 to 9.0 pCi/g of Cs-137. Several of the samples exceeded the modified derived concentration guideline level (DCGL), or project action level, for Cs-137 (4.7 pCi/g). As a result of this initial characterization, Boeing removed 346 cubic feet of soil from the RMHF Holdup Pond 4614 area. The majority of the soil was removed from the area north of the former holdup pond. A smaller amount was removed from the top of the drainage channel. Following the removal action, Boeing repeated the gamma walkover survey and soil sampling as a part of the final status survey. The gross gamma walkover survey data was used to generate additional biased soil sample locations. Forty six surface soil samples and two subsurface soil samples (at 1 foot below ground surface) were collected and analyzed. None of the samples exceeded the project action levels of 4.7 pCi/g. Final status survey results did not show the presence of contamination and the site was recommended for release for unrestricted use.[1]

- **2008 ORISE Verification Survey**. In February 2008, the Oak Ridge Institute for Science and Education (ORISE) performed an independent verification survey of the RMHF Holdup Pond 4614 as part of a larger survey unit. ORISE conducted gamma scanning and surface soil sampling at the site. Gamma scan counts ranged from 4,500 to 7,800 cpm with variability consistent with local topography and geology. No locations of elevated direct radiation were identified. Soil samples were analyzed for Cs-137 and europium-152 (Eu-152). Concentrations for Cs-137 ranged from "-0.04" to 0.08 pCi/g. Concentrations for Eu-152 ranged from "-0.06" to 0.03 pCi/g. These results were less than the modified DCGLs for Cs-137 (4.7 pCi/g) and Eu-152 (2.8 pCi/g). ORISE confirmed Boeing's conclusions in the final status survey and noted DOE and California Department of Health Services radiological release limits were satisfied.[2]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Location: According to a 2007 final characterization and status survey, the RMHF 4614 Holdup Pond was originally constructed in the mid-1960s for Building 4028, which housed the STR and STIR. The 2007 survey states that there were no radiological incidents associated with Building 4028 that may have affected the holdup pond; however, the building and pond were connected via piping. The holdup pond was later converted for RMHF use by constructing a drainage channel between the pond and the RMHF. In the fall of 2006, the holdup pond was replaced with a 1,500-gallon polyurethane stormwater aboveground storage tank. The tank receives runoff from the RMHF via a drainage pipe. Stormwater runoff is collected and then pumped from the aboveground storage tank to a pipeline that discharges to a lined drainage ditch along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[3,1,2,3]

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[1] Cabrera Services, *Final Characterization and Final Status Survey Report: Radioactive Materials Handling Facility Holdup Pond (Site 4614)*, March 2007, pgs. 1, 13-15, 37, 39.
[2] Vitkus, T.J., *Verification Survey of the Building 4059 Site (Phase B); Post Historical Site Assessment Sites, Block 1; and Radioactive Materials Handling Facility Holdup Pond (Site 4614), Santa Susana Field Laboratory, The Boeing Company, Ventura County, California*, Oak Ridge Institute for Science and Education, June 2008, pgs. 1-11.
[3] Cabrera Services, *Final Characterization and Final Status Survey Report: Radioactive Materials Handling Facility Holdup Pond (Site 4614)*, March 2007, pgs. 2, 9.

A 2008 waste debris survey identified four debris areas around the RMHF 4614 Holdup Pond area. The smallest area, estimated at less than 100 square feet, was a soil pile with intermixed asphalt debris. The next larger debris area was estimated at 753 square feet and contained a soil pile with intermixed concrete and asphalt debris. A larger debris area, estimated at 1,805 square feet, contained soil piles intermixed with asphalt, concrete, metal pipes, and scrap metal. Finally, the largest debris area, estimated at 10,087 square feet, was described as debris in and around an open excavation that appeared to be the former RMHF 4614 Holdup Pond location. Debris included concrete, asphalt, metal pipes, and fence posts.[4]

The 2008 waste debris survey also identified five debris areas in the western portion of HSA-7. Three areas were estimated at less than 100 square feet in size. The other two areas were estimated at 2,458 and 2,866 square feet. Debris included two crushed 5-gallon metal containers; one empty, crushed 55-gallon drum; empty spray paint cans; one empty paint can; ceramic insulators with filaments attached; scrap metal; and soil piles intermixed with asphalt and concrete.[5]

A large soil disturbance area located west of the RMHF 4614 Holdup Pond is noted in Atomics International aerial photographs from 1965, 1969, and 1976. According to a 2009 Resource Conservation and Recovery Act Facility Investigation report, this area was observed to contain soil piles and hummocks in a 2008 site survey.[6,7,8]

Aerial Photographs: The RMHF 4614 Holdup Pond is first identified on a 1965 aerial photograph as a liquid-filled impoundment (IM), denoted IM-4 by the U.S. Environmental Protection Agency's (EPA's) aerial photographic analysis. A partially-vegetated fill area (FA), identified as FA-8 by the EPA's aerial photographic analysis, is noted to the north and a large are of disturbed ground is located to the west. A possible aboveground pipeline connecting the western end of the RMHF site to IM-4 is noted. In 1967, an aboveground pipeline is identified at the south side of IM-4. In 1972, the possible aboveground pipeline from the RMHF site to IM-4 identified in 1965 is identified as a drainage channel/pipeline. In 1978, two drainage channels are identified flowing into IM-4. Drainage from the RMHF site flows west into IM-4 and drainage from the south flows north into IM-4. In 1980, the two drainage channels remain and an aboveground pipeline is identified from the south of IM-4, but the impoundment is described as dry. An access road connects Building 4075 to a partially-vegetated area with a ground scar.

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[1] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, pgs. 12-13.

[2] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.

[3] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-5.

[4] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Appendix F: Group 7 2008 Waste Debris Survey Results*, June 2009.

[5] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Appendix F: Group 7 2008 Waste Debris Survey Results*, June 2009.

[6] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I, Text, Tables, and Figures*, June 2009, p. 3-13.

[7] Atomics International, *Photograph Number SS-182*, March 30, 1965, HDMSM000000273.

[8] Atomics International, *Photograph Number S-294*, April 24, 1969, HDMSM000000264.

This road runs in an east-west direction along the north side of IM-4. An open storage (OS) area, identified as OS-13 by the EPA's aerial photographic analysis, containing possible stains is located southwest of IM-4. In 1983, OS-13 contains possible horizontal tanks and possible stains. The drainage and access road from the RMHF site are again identified and IM-4 possibly contains liquid. In 1988 and 1995, IM-4 contains liquid and drainage from the RMHF site continues in the direction of IM-4. In 2005, IM-4 is identified as possibly containing liquid.[1]

Radionuclides of Concern: Radionuclides of concern for RMHF Holdup Pond 4614 include: natural and enriched uranium (U-234, U-235, U-238), plutonium isotopes (Pu-238, Pu-239, Pu-240, Pu-241), americium-241 (Am-241), cesium isotopes (Cs-134, Cs-137), Co-60, europium isotopes (Eu-152, Eu-154), manganese-54 (Mn-54), Sr-90, and thorium isotopes (Th-228, Th-232).[2] All radionuclides of concern listed are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The mean RMHF elevation is approximately 1,850 feet above sea level and is greater than the immediate surrounding area.[3] The pavement surrounding the RMHF buildings slopes away from the buildings to facilitate water runoff.[4] Surface water within the RMHF fenced area generally flows from east to west across the site to a storm drain culvert along the western perimeter of the site. Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF catch basin (RMHF 4614 Holdup Pond).[5] The RMHF 4614 Holdup Pond had a capacity of approximately 30,000 gallons and was used to contain stormwater runoff and any accidental releases.[6] It was sealed with coated asphalt to prevent leakage and equipped with a radiation monitor connected to an alarm system to warn if any radioactive contamination enters the pond.[7]

A 1977 storm drain plan shows that the RMHF 4614 Holdup Pond received surface flow from the RMHF complex, a small stretch of land south of the RMHF perimeter fence, from a pathway north of former Building 4010, and from Building 4028. The plan also indicates that drainage from the Building 4614 Holdup Pond was redirected south to 17th Street.[8] See Figure 2.18e for this storm drain plan.

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[1] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.

[2] Cabrera Services, *Final Characterization and Final Status Survey Report: Radioactive Materials Handling Facility Holdup Pond (Site 4614)*, March 2007, pgs. 9-10.

[3] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.

[4] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, *Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF)*, September 14, 1990.

[5] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.

[6] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF)*, October 2006, p. 3-2.

[7] Science Applications International Corporation, *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, May 1994, pgs. 7-14 – 7-15.

[8] Rockwell International Drawing, *Santa Susana Facility Area Plan, Storm Drain Master East, 303-GEN-C93*, September 1977.

The RMHF 4614 Holdup Pond and drainage channel were removed in 2006. The culvert now drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane stormwater aboveground storage tank. After the water is tested for radionuclides, it was pumped from the aboveground storage tank to B Street where it entered a pipeline that discharges to a lined drainage along 17th Street. Drainage follows 17th Street to G Street and then continues through lined and unlined channels to the 17th Street Drainage.[1,2] The 17th Street Drainage was sampled by EPA under the Soil Field Sampling Plan Addendum for Subarea 5B.
Surface drainage for the undeveloped portion of HSA-7, west of RMHF Holdup Pond 4614, flows to a north-trending drainage leading offsite onto the Brandeis-Bardin Campus property where the drainage converges with a drainage from HSA-8 and then converges with drainage from Outfall 003.[3]

Radiological Contamination Potential: The preliminary MARSSIM classification for the RMHF 4614 Holdup Pond area is Class 1, due to its former use as a drainage area for radioactive facilities, radiological incidents, and previous investigations.

Recommended Locations for Sediment/Soil Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the RMHF 4614 Holdup Pond area. As discussed above, there were a couple of radiological incidents involving the RMHF 4614 Holdup Pond and documented evidence of radiological releases. Previous characterization studies for the RMHF 4614 Holdup Pond area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the RMHF 4614 Holdup Pond area. This includes the following RMHF 4614 Holdup Pond areas and appurtenances:

- Drainage channel between the RMHF facilities and the holdup pond/tank, with a specific emphasis at the top of the channel where previous investigation found elevated gamma. This channel provided a pathway for the migration of radioactive materials. It is possible that residual contamination exists in this channel.

- Former RMHF 4614 Holdup Pond that was used for Building 4028, a reactor building, and the RMHF. Known low-level contamination was fixed in place using asphalt sealer before the pond was excavated in 2006. Residual contamination may exist in the former pond area.

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[1] MWH, *Group 7-Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-6.
[2] Correspondence from Chell, M., MWH, to Trippeda, D., Boeing, *Re: Conversation with Dan Trippeda Regarding RMHF Catch Basin*, February 23, 2009.
[3] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Text, Tables, and Figures*, June 2009, p. 2-4.

- Area north of the RMHF Holdup Pond 4614 that was excavated in 2006 because of elevated gross gamma levels. Although this area was excavated, residual contamination may still exist in the area.

- The 1,500-gallon stormwater aboveground storage tank and drainage pipe placed in service in 2006. This new system of stormwater collection still provides pathways for contaminant pooling and should be surveyed for residual contamination.

- Soil disturbance area located west of the RMHF 4614 Holdup Pond noted in Atomics International aerial photographs from 1965, 1969, and 1976. This area was noted to contain soil piles in 2008 and should be further investigated for residual contamination.

- Waste debris areas identified in a 2008 survey. Four debris areas were noted around the RMHF 4614 Holdup Pond and five debris areas were noted in the western portion of HSA-7. These areas should be further investigated for residual contamination.

2.19 Southern California Edison Substation

Site Description: The Southern California Edison (SCE) substation area is located at the east end of C Street, near the eastern boundary of Area IV. The SCE substation was constructed in about 1956.[1] Plate 1 depicts the HSA-3 subarea.

Building Features: The SCE substation, known as the Chatsworth Substation, covers 0.887 acres of Area IV land and comprises a small rectangular building, transformers, switching equipment, protection and control equipment, and a fenced area of land surrounding these facilities. Figure 2.19a presents a plot plan of the site, and Figure 2.19b shows an aerial photograph of the site taken in 1963.

Former Use(s): The SCE Company delivers power to the Santa Susana Field Laboratory (SSFL) from the Valencia (Pardee) substation on two overhead high-voltage transmission lines. Incoming 66 kilovolts (kV) service enters the SSFL at its western boundary and continues northeasterly over a 50-foot-wide easement to the SCE substation area. From this substation, power is stepped down to a 16-kV substation in Area I, and is also provided to Black and Bell Canyons (privately owned areas outside of the SSFL). The 16-kV substation was connected to two other substations on the SSFL where the 16-kV lines were stepped down to 4,160 volts, which were, in turn, connected to other substations throughout the site.[2,3,4]

In June 1982, a soils engineering contractor visited the substation site and found that the southern one-fifth portion of the site was covered with a thin layer of gravel, and was used as a parking

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[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[2] Ashley, R. L., *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, Atomics International Report No. NAA-SR-7300, May 25, 1962, p. II-55.
[3] NASA letter from C. J. Scolese, Acting Administrator, to the Honorable Nancy Pelosi, Speaker of the House of Representatives, Re: *NASA's Intention to Declare SSFL Property as Excess*, April 10, 2009, p. 2.
[4] ETEC, *Technical Site Description of the Engineering Technology Engineering Center*, ETEC Report No. GEN-AT-0027, Revision B, June 30, 1993, pp. b-8 – b-9.

area. Machinery was located in the central portion of the site, and the northern one-third portion was covered with weeds. Two buried corrugated metal pipes were also located on the site.[1]

Information from Interviewees: None to date.

Radiological Incident Reports: None found.

Current Use: The SCE substation continues to provide power to the remaining facilities on the SSFL.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): Details of a radiological investigation at this site are as follows:

- **1994 and 1995 Rockwell Characterization Study**. In 1994 and 1995, Rockwell conducted a radiological characterization study in Area IV that included the boundary of the SCE substation. However, access inside the fence of the SCE substation was not permitted at that time. The purpose of the study was to locate and characterize previously unknown areas of elevated radioactivity in Area IV. Survey methods included an ambient gamma survey, a walk-about gamma survey, and soil sampling and analysis. Rockwell's average local background at the SCE fence was estimated to be 15.6 microroentgens per hour (µR/h). Rockwell's acceptable limit was less than 5 µR/h above background. Survey results were below Rockwell's acceptance limits.[2]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: None found.

Aerial Photographs: Aerial photographs show undeveloped land until a 1957 photograph in which a small rectangular building and transformers are observed that are identified as the SCE substation. A possible vertical tank is identified in the 1957 photograph. The area does not change in photographs from 1959, 1960, 1965, 1967, 1972, and 1978. A possible vertical tank is observed in all of the photographs up until 2009. In the 1980, 1983, 1988, and 1995 photographs, a drainage channel is observed south of the fence in the southwest region of the site. This channel is not visible in the 2005 and 2009 photographs.[3]

Radionuclides of Concern: The research team did not find evidence that radioactive materials were used or stored within the SCE substation area. However, the site borders the Old Salvage Yard and it is not apparent that a full radiologic characterization of the area has been conducted. Possible radionuclides include uranium isotopes (U-238, U-234, U-235, U-238), plutonium isotopes (Pu-239, Pu-240, Pu-241, Pu-242), americium-241 (Am-241), thorium isotopes (Th-228, Th-232), H-3, sodium isotopes (Na-22, Na-24), chromium-51 (Cr-51), manganese-54 (Mn-54), iron-59 (Fe-59), cobalt-60 (Co-60), krypton-85 (Kr-85), strontium isotopes (Sr-89, Sr-90),

[1] Letter from J. A. Vidal, Robert Stone & Associates, Inc., to L. S. Breese, Rockwell International Corporation, Re: *Foundation Investigation*, June 23, 1982, pp. 1-2.
[2] Rutherford, P., *Area IV Radiological Characterization Survey Final Report*, ETEC Report No. A4CM-ZR-0011, August 15, 1995, pp. 21-24, Figure B-181.
[3] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

antimony-125 (Sb-125), iodine isotopes (I-129, I-131), cesium isotopes (Cs-134, Cs-137), cerium-141 (Ce-141), barium (lanthanum)-140 (Ba (La)-140), niobium-95 (Nb-95), ruthenium isotopes (Ru-103, Ru-106), xenon isotopes (Xe-133, Xe-135), promethium-147 (Pm-147), samarium-151 (Sm-151).[1,2,3] All radionuclides of concern listed with the exception of Na-22, Na-24, Cr-51, Mn-54, Fe-59, Kr-85, Sr-89, I-131, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm-147 and Sm-151 are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. The radionuclides omitted from the sampling plan have very short half-lives except for Sm-151 for which no analytical method is available. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Based on general site topography, the SCE substation is located south of a drainage divide that forces surface water from the SCE substation to flow south into a natural drainage channel on the south side of E Street. This channel connects to the Area II ponds. The overflow from these ponds is into Bell Canyon and thence to the Los Angeles River.[4]

Radiological Contamination Potential: The preliminary MARSSIM classification for the SCE substation area is Class 2, because of its location adjacent to the Old Salvage Yard.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 provides a convenient reference for the following recommendations.

The previous characterization study for the SCE substation area was focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. If access to the site is not granted for safety reasons, additional characterization is recommended along the fence boundary. This includes the following SCE substation areas:

- The flat and low-lying areas along the fence-line of the SCE substation. Radionuclides originating from the Old Salvage Yard may have migrated to these areas via surface water flow or airborne releases.

2.20 Northern Buffer Zone – Northeast Area

Site Description: The Northern Buffer Zone (NBZ) – Northeast (NE) area comprises land and drainage channels located north of Area IV extending west to east between the Sodium Reactor Experiment (SRE) complex and Area I. The NBZ is also commonly referred to as the Northern Undeveloped Land (NUL). The southeastern border of the NBZ-NE adjoins both the HSA-3 and HSA-6 subareas. Plate 1 depicts the NBZ-NE subarea. Figure 2.20 shows an oblique

[1] Hart, R. S., *Distribution of Fission Product Contamination in the SRE*, Atomics International Report No. NAA-SR-6890, March 1, 1962, pp. 8-27.
[2] Kinzer, J. and Crawford, A. C., *SRE First Core Fuel*, Atomics International Technical Data Record No. 5301, May 16, 1960, pp. 1-7.
[3] Letter from Heine, W. F., Atomics International, to Proctor, J. F., E. I. du Pont de Nemours & Company, re: *Fission Product and Fissile Content of SRE Fuel*, July 2, 1975.
[4] Stelle, A. M., *SRE Activity Requirement No. 27, D & D of Building 143 Retention Pond and Sanitary Sewer*, Rockwell International Report No. N704ACR990024, September 14, 1981, p. 6.

photograph of the Santa Susana Field Laboratory (SSFL) site; the approximate location of the NBZ-NE area is depicted on the left side of the photograph.

Building Features: There were and are no buildings in the NBZ-NE subarea. This area has never been used for industrial purposes. Located downhill from the SSFL, the NBZ-NE is a naturally vegetated area containing drainage channels; it may also contain artesian wells and natural springs.

Former Use(s): In February 1997, Boeing made an offer to the Brandeis-Bardin Institute to purchase 175 acres along the boundary between the SSFL and the Institute at a fair market value to be determined by a mutually agreed upon independent appraiser, assuming that the land was not contaminated.[1] In May 1997, the Thousand Oaks Star newspaper announced that the Brandeis-Bardin Institute had settled its lawsuit against Rocketdyne. Details of the settlement were confidential.[2] Rockwell purchased the 175 acres, to form the NBZ, from the adjoining Brandeis-Bardin Institute, which had owned the land since 1947.[3] The Brandeis-Bardin Institute is a Jewish educational center that is also used for camping, hiking, and horseback riding.[4] The Institute recently changed its name to the American Jewish University Brandeis-Bardin Campus. Some surface water from the SSFL is transported downhill to the NBZ-NE, the Brandeis-Bardin campus, and thence to surrounding populated areas. Rockwell purchased this land because radioactive and chemical contamination originating from the SSFL had been found on the property by environmental contractors in the early 1990s. The NBZ-NE area covers approximately half of the 175 total acres of the NBZ.

Surface water and process wastewater from all buildings within the SRE complex drained into the SRE pond. A drainage channel commencing at the SRE pond carried surface water from the pond through the NBZ-NE region prior to 1959. The pond's compacted earth dam was damaged by storm flow in 1958. In 1959, as a result of complaints from downstream property owners, a pumped sump was constructed to pump water from the pond via overland pipe to a channel connecting to the Area II ponds.[5] However, radiologically contaminated water from the SRE complex may have been carried along the drainage channel during severe storm events after 1959. The location of the drainage channel from the SRE pond is shown on Plate 1.

Information from Interviewees: A number of former employees were interviewed about their experience at the SSFL. One remembered a release in the NBZ-NE. Excerpts from this interview are included below.

In 1968, Interviewee 195 worked on "the hill" at Building 355 (the Sodium Component Test Installation). The following excerpts were pulled from that interview.

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[1] Letter from S. Lafflam, Boeing North American, Inc., to A. Mars, Brandeis-Bardin Institute, Re: *Boeing North American Offer to Purchase 175 Acres of Institute Property*, February 20, 1997.
[2] Johnson, B., "Brandeis-Bardin settles Rocketdyne suit," in *Thousand Oaks Star*, May 23, 1997, p. 1.
[3] Agency for Toxic Substances and Disease Registry, *Draft Preliminary Site Evaluation, Santa Susana Field Laboratory*, Atlanta, GA, December 3, 1999, pp. 2-5.
[4] U.S. Environmental Protection Agency, *EPA Update – The U.S. EPA Announces Results of Rocketdyne's Off-Site Sampling Program of the Santa Susana Field Laboratory*, July 1995, p. 1.
[5] Stelle, A. M., *SRE Activity Requirement No. 27, D & D of Building 143 Retention Pond and Sanitary Sewer*, Rockwell International Report No. N704ACR990024, September 14, 1981, p. 6.

"I hope someone has talked about the spill that ran downhill from the SRE to Brandeis. Brandeis sued and the company bought the land to shut them up."

"I know they are trying to clean it up—I bet it is cleaner than my backyard except for where the SRE is and down the hill from there." [1]

Radiological Incident Reports: None found.

Current Use: The NBZ-NE subarea serves as a buffer zone between the SSFL and Brandeis-Bardin land.[2]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this site is as follows:

- **1991 Brandeis-Bardin Institute Sampling**. In 1991, Joel I. Cehn, CHP, a consultant to the Brandeis-Bardin Institute collected soil, vegetation, and surface water samples and had them analyzed for tritium (H-3) and other radionuclides. Mr. Cehn identified no radionuclides above what he regarded as background concentrations in the NBZ-NE area.[3]

- **1991 Rockwell Multi-Media Sampling**. In 1992, Rockwell contracted with McLaren/Hart Environmental Engineering Corporation (McLaren/Hart) to conduct a multi-media sampling program to determine whether chemicals and/or radionuclides had migrated from the SSFL or had been deposited on Brandeis-Bardin Institute and/or Santa Monica Mountains Conservancy land.[4]

  McLaren/Hart collected 18 soil samples from background areas and 118 soil/sediment samples from the Brandeis-Bardin and Santa Monica Mountains study areas. All soil/sediment samples were analyzed for 75 naturally occurring and man-made radionuclides using gamma scanning technology as well as H-3, plutonium isotopes (Pu-238 and Pu-239), iodine-129 (I-129), and strontium-90 (Sr-90). Surface water samples were also collected and analyzed together with two groundwater samples. McLaren/Hart collected four sediment samples downstream from the SRE in the run-off creek bed immediately north of and below the NBZ-NE/HSA-6 property boundary. A U.S. Environmental Protection Agency (EPA) radiological survey of this creek bed recorded 13 to 16 microroentgens per hour (μR/h). Cs-137 was detected in two sediment samples near the NBZ-NE/HSA-6 boundary at 0.30 ± 0.05 and 0.24 ± 0.06 picocuries per gram (pCi/g) dry. Sr-90 was detected in the same two sediment samples at 0.08 ± 0.02 and 0.09 ± 0.02 pCi/g (dry). McLaren/Hart also collected five sediment samples from the

[1] Interview No. 195 conducted by DOE in 2010.
[2] Stelle, A. M., *SRE Activity Requirement No. 27, D & D of Building 143 Retention Pond and Sanitary Sewer,* Rockwell International Report No. N704ACR990024, September 14, 1981, p. 6.
[3] *Cehn, J. I., Results of Environmental Radiation Survey at Brandeis-Bardin Institute, Brandeis, California*, July 1991, pp. 2, 6, 8, 12.
[4] McLaren/Hart Environmental Engineering Corporation, *Multi-Media Sampling Report for the Brandeis-Bardin Institute and the Santa Monica Conservancy, Volume I*, Project No. 29403-012, March 10, 1993, pp. 9-65 – 9-93, 11-11 – 11-16.

creek bed from the second most eastern drainage channel north of Area II. Pu-238 was detected in one sediment sample at 0.22 ± 0.07 pCi/g (dry), but when the statistical "t-test" was run on the Pu-238 data, results were not different from McLaren/Hart's background level for Pu-238.[3]

- **1994 Rockwell Soil and Water Sampling**. In 1994, Rockwell contracted with McLaren/Hart to conduct additional soil and water sampling on Brandeis-Bardin Institute and Santa Monica Mountains Conservancy land. One of nine tasks was to determine whether the cesium-137 (Cs-137) and Sr-90 concentrations reported in the SRE watershed in 1992 were statistically different from background. Another of the nine tasks was to determine whether the Pu-238 concentration detected in the second most eastern drainage channel north of Area II in 1992 was statistically different from background.[1]

  McLaren/Hart collected five additional sediment samples and statistically compared the results to background. An EPA radiological survey of the drainage channel on NBZ-NE land downstream from the SRE pond recorded 16 to 17 µR/h. According to McLaren/Hart, Cs-137 was detected in three sediment samples from this channel at concentrations of between 0.045 and 0.056 pCi/g (dry). These were significantly lower than the concentrations detected in 1992, and, according to McLaren/Hart, were consistent with background sampling results for Cs-137. Sr-90 was detected at 0.12 ± 0.08 pCi/g (dry) and 0.061 ± 0.041 pCi/g (dry). These results were consistent with Sr-90 concentrations detected in 1992, and were consistent with background sampling results for Sr-90 as determined by McLaren/Hart.[1]

  McLaren/Hart collected six additional sediment samples in the second most eastern drainage channel north of Area II and statistically compared the results to background. These additional samples were collected both upstream and downstream of the 1992 sampling location. An EPA radiological survey of the drainage channel on NBZ-NE land downstream from Area II recorded 16 to 17 µR/h. Isotopic plutonium was below detection limits in all six sediment samples. The 1994 study results did not confirm the 1992 detection of Pu-238.[1]

- **2007 Boeing, NASA, DOE Offsite Sampling**. In 2007, pursuant to Section 3.4.9 of the Consent Order for Corrective Action, Docket No. P3-07-08-003, Boeing, the National Aeronautics and Space Administration (NASA), and the U.S. Department of Energy (DOE) contracted with Montgomery Watson Harza (MWH) to evaluate offsite sampling data collected by Boeing, NASA, and DOE around the SSFL. MWH concluded that the offsite soil/sediment data were sufficient and no data gaps were identified except in areas of ongoing work in the northeast and in the northern drainage area on Santa Monica Mountains Conservancy land.[2]

[1] McLaren/Hart Environmental Engineering Corporation, *Additional Soil and Water Sampling, The Brandeis-Bardin Institute and Santa Monica Mountains Conservancy*, Project No. 03.0600829.013, January 19, 1995, pp. 7-14 – 15, 8-4 – 86, 9-3.
[2] Montgomery Watson Harza, *Offsite Data Evaluation Report, Santa Susana Field Laboratory, Ventura County, California*, Arcadia, California, December 2007, pp. ES-1 – ES-4, 3-19 – 3-23.

- **2008 Boeing, NASA, DOE Waste Debris Survey**. In February 2008, Boeing, NASA, and DOE contracted with CH2MHILL and MWH to conduct a survey of waste debris on the SSFL and outside the boundary. In the NBZ-NE area, a truck tire was partially buried in the drainage channel from the SRE pond. Also, a 12- by 18-inch diameter rusted container, partially buried, was found in the drainage channel located north of the Southern California Edison (SCE) substation. South of this drainage channel, debris, including pieces of transite pipe, tile, metal strapping, sheet metal, a drum lid, and crushed light bulbs, were observed.[1] The debris locations are shown on Plate 1.

- **2009 and 2010 Boeing Waste Debris Removal**. During 2009 and 2010, Boeing contracted with CH2MHILL to remove debris from the SSFL. By request from the California Department of Toxic Substances Control (DTSC), only debris that could be accessed with minimum disruption to soil was removed. If debris was located within a soil pile, only the debris readily accessible at the surface was removed, and the soil pile was left intact. It appears from CH2MHILL's draft report that almost all of the debris identified in the NBZ-NE area in 2008 was left in place in 2009 and 2010.[2]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: A drainage channel in the NBZ-NE area carried radiologically contaminated surface water from the SRE pond prior to 1959. Radiologically contaminated water from the SRE complex may also have been carried along the drainage channel during severe storm events after 1959.

Aerial Photographs: Aerial photographs show undeveloped land throughout the period from 1952 through 2009. In the 1957 photograph, an unpaved access road located north of the SCE substation, is observed extending from the boundary of Area IV in a northeasterly direction. A drainage channel extending in a northeasterly direction from the SRE pond is also observed together with two additional drainage channels from the northeast region of Area IV, extending in a northwesterly direction. These features are also seen in the 1959, and approximately 1960 photographs. In the 1965 photograph, possible solid waste is observed north of the Area IV boundary, northwest of the SCE substation. In the 1967 and 1972 photographs, probable debris is observed in this same location and light toned objects are observed on the Area IV boundary. In the 1978 photograph a ground scar is observed in this same location. The ground scar is no longer visible in the 1980, 1983 and 1988 photographs. In the 1995 photograph, an unpaved access road is again observed in the same location as that seen in the 1957, 1959, and 1960 photographs. Mounded material and probable debris are seen at the end of this road. The access road without mounded material and probable debris are observed in the 2005 and 2009 photographs.[3]

Radionuclides of Concern: The NBZ-NE area received surface water drainage from the SRE pond up until 1959 and from the SRE pond during storm events after 1959. Radiologically

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[1] CH2MHILL and Montgomery Watson Harza, *Draft Report, Waste Debris Survey, Santa Susana Field laboratory, Ventura County, California*, March 2008, pp. 1, Figures 1, G-1, Table G-1.
[2] CH2MHILL, *Draft Site-Wide Debris Removal and Documentation Summary, Santa Susana Field Laboratory, Ventura County, California*, October 12, 2010, pp. 1, 4, Figure 7.
[3] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

Redacted

contaminated water is known to have flowed into the SRE pond and out into the NBZ-NE area. Possible radionuclides include uranium isotopes (U-238, U-234, U-235, U-238), plutonium isotopes (Pu-239, Pu-240, Pu-241, Pu-242), americium-241 (Am-241), thorium isotopes (Th-228, Th-232), H-3, sodium isotopes (Na-22, Na-24), chromium-51 (Cr-51), manganese-54 (Mn-54), iron-59 (Fe-59), cobalt-60 (Co-60), krypton-85 (Kr-85), strontium isotopes (Sr-89, Sr-90), antimony-125 (Sb-125), iodine isotopes (I-129, I-131), cesium isotopes (Cs-134, Cs-137), cerium-141 (Ce-141), barium (lanthanum)-140 (Ba (La)-140), niobium-95 (Nb-95), ruthenium isotopes (Ru-103, Ru-106), xenon isotopes (Xe-133, Xe-135), promethium-147 (Pm-147), samarium-151 (Sm-151).[1,2,3] All radionuclides of concern listed with the exception of Na-22, Na-24, Cr-51, Mn-54, Fe-59, Kr-85, Sr-89, I-131, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm-147 and Sm-151 are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. The radionuclides omitted from the sampling plan have very short half-lives except for Sm-151 for which no analytical method is available. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Some surface water from the SSFL is transported downhill to the NBZ-NE, the Brandeis-Bardin campus, and thence to surrounding populated areas. Up until 1959, the NBZ-NE area received surface water drainage from the SRE pond. Surface water and process wastewater from all buildings within the SRE complex drained into the SRE pond. In 1958, the pond's compacted earth dam was damaged by storm flow, prompting construction of a pumped sump in 1959.[4]

In 1959, a 6-foot diameter overflow pipe and a pumped sump were installed at the confluence of the two main drainage channels upstream of the pond. Water was then pumped through a 4-inch diameter overland pipe to a channel connecting to the Area II ponds. The overflow from these ponds is into Bell Canyon and thence to the Los Angeles River.[5]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the NBZ-NE drainage channel emanating from the SRE pond is Class 1, because of the radiologically contaminated outflow from the SRE pond. The preliminary MARSSIM Classification for the other NBZ-NE areas is Class 3.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Previous characterization studies for the NBZ-NE area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by

[1] Hart, R. S., *Distribution of Fission Product Contamination in the SRE*, Atomics International Report No. NAA-SR-6890, March 1, 1962, pp. 8-27.
[2] Kinzer, J. and Crawford, A. C., *SRE First Core Fuel*, Atomics International Technical Data Record No. 5301, May 16, 1960, pp. 1-7.
[3] Letter from Heine, W. F., Atomics International, to Proctor, J. F., E. I. du Pont de Nemours & Company, re; *Fission Product and Fissile Content of SRE Fuel*, July 2, 1975.
[4] Stelle, A. M., *SRE Activity Requirement No. 27, D & D of Building 143 Retention Pond and Sanitary Sewer*, Rockwell International Report No. N704ACR990024, September 14, 1981, p. 6.
[5] Stelle, A. M., *SRE Activity Requirement No. 27, D & D of Building 143 Retention Pond and Sanitary Sewer*, Rockwell International Report No. N704ACR990024, September 14, 1981, p. 6.

the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the NBZ-NE area. This includes the following NBZ-NE areas:

- The bottom and sides of the drainage channel that commences at the SRE pond. Radionuclides originating from the SRE complex may have migrated to the channel via surface water flow, both prior to and after 1959.

- The locations of the partially buried truck tire in the drainage channel from the SRE pond; the 12- by 18-inch diameter partially buried rusted container in the drainage channel located north of the SCE substation; and the debris, including pieces of transite pipe, tile, metal strapping, sheet metal, a drum lid, and crushed light bulbs, observed south of the SCE substation drainage.

- The soil/sediment near any artesian wells and natural springs, if present. Radionuclides originating from Area IV may have been carried by groundwater to the NBZ-NE area ground surface through artesian wells and natural springs.

2.21 Northern Buffer Zone – Northwest Area

Site Description: The Northern Buffer Zone (NBZ) – Northwest (NW) area comprises land and drainage channels located north of Area IV extending west to east between the southwest corner of HSA-8 and the Sodium Reactor Experiment (SRE) complex. The NBZ is also commonly referred to as the Northern Undeveloped Land (NUL). The southeastern border of the NBZ-NW adjoins both the HSA-7 and HSA-8 subareas. Plate 1 depicts the NBZ-NW subarea. Figure 2.20 shows an oblique photograph of the Santa Susana Field Laboratory (SSFL) site; the approximate location of the NBZ-NW area is depicted on the left side of the photograph.

Building Features: There were and are no buildings on the NBZ-NW subarea. This area has never been used for industrial purposes. Located downhill from the SSFL, the NBZ-NW is a naturally vegetated area containing drainage channels; it may also contain artesian wells and natural springs.

Former Use(s): In February 1997, Boeing made an offer to the Brandeis-Bardin Institute to purchase 175 acres along the boundary between the SSFL and the Institute at a fair market value to be determined by a mutually agreed upon independent appraiser, assuming that the land was not contaminated.[1] In May 1997, the Thousand Oaks Star newspaper announced that the Brandeis-Bardin Institute had settled its lawsuit against Rocketdyne. Details of the settlement were confidential.[2] Rockwell purchased the 175 acres, to form the NBZ, from the adjoining Brandeis-Bardin Institute, which had owned the land since 1947.[3] The Brandeis-Bardin Institute is a Jewish educational center that is also used for camping, hiking, and horseback riding.[4] The

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[1] Letter from S. Lafflam, Boeing North American, Inc., to A. Mars, Brandeis-Bardin Institute, Re: *Boeing North American Offer to Purchase 175 Acres of Institute Property*, February 20, 1997.
[2] Johnson, B., “Brandeis-Bardin settles Rocketdyne suit,” in *Thousand Oaks Star*, May 23, 1997, p. 1.
[3] Agency for Toxic Substances and Disease Registry, *Draft Preliminary Site Evaluation*, *Santa Susana Field Laboratory*, Atlanta, GA, December 3, 1999, pp. 2-5.
[4] U.S. Environmental Protection Agency, *EPA Update – The U.S. EPA Announces Results of Rocketdyne's Off-Site Sampling Program of the Santa Susana Field Laboratory*, July 1995, p. 1.

Redacted

Institute recently changed its name to the American Jewish University Brandeis-Bardin Campus. Some surface water from the SSFL is transported downhill to the NBZ-NW, the Brandeis-Bardin campus, and thence to surrounding populated areas. Rockwell purchased this land because radioactive and chemical contamination originating from the SSFL had been found on the property by environmental contractors in the early 1990s. The NBZ-NW area covers approximately half of the 175 total acres of the NBZ.

Three drainage channels originating in HSA-8 carried surface water from the Sodium Disposal Facility (Site 4886), Building 4009, and the Empire State Atomic Development Associates (ESADA) area through the NBZ-NW region. The Sodium Disposal Facility contained upper and lower open-field ponds that were incompletely bermed. Contaminated water from these ponds spread to adjacent areas, with the natural drainage direction being to the north onto the NBZ-NW area. According to Rockwell, material was also dispersed onto surrounding land by explosions that extended to Building 4009.[1] Building 4009, which housed criticality test facilities, had a leach field used for the disposal of both sanitary and radioactive liquid wastes before the central sewage system was constructed in the early 1960s. A natural drainage channel was located west of the leach field. This ended at a rock outcrop, located approximately 150 feet north of the leach field. Surface water appears to infiltrate at this location and may resurface north of the outcrop where another channel carries it north through the NBZ-NW area.[2]

A drainage channel originating in HSA-5C also carried surface water from Building 4100, a criticality facility with a leach field, and the Site 4056 Landfill through the NBZ-NW area. Also, a channel located north of Systems for Nuclear Auxiliary Power reactor Building 4059 carried surface water through the NBZ-NW region. In addition, a drainage channel originating in HSA-7 carried surface water from the Radioactive Materials Handling Facility (RMHF) complex and other buildings through the NBZ-NW region. Drainage from these buildings is discussed earlier in this report. The locations of the drainage channels originating in HSA-5C, HSA-7, and HSA-8 are shown on Plate 1.

Information from Interviewees: None to date.

Radiological Incident Reports: None found.

Current Use: The NBZ-NW subarea serves as a buffer zone between the SSFL and Brandeis-Bardin land.[3]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this site is as follows:

- **1991 Brandeis-Bardin Institute Sampling.** In 1991, Joel I. Cehn, CHP, a consultant to the Brandeis-Bardin Institute collected soil, vegetation, and surface water samples and had them analyzed for tritium (H-3) and other radionuclides. Cesium-137 (Cs-137) was

[1] Chapman, J. A., *Radiological Survey of the Sodium Disposal Facility–Building T886,* ETEC Report No. GEN-ZR-0004, June 3, 1988, p. 16.

[2] MWH, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures,* September 2007, pp. 2-6 – 2-8.

detected in one soil sample (0.671 picocuries per gram [pCi/g]) in the creek bed below the RMHF.[1]

- **1992 Rockwell Multi-Media Sampling**. In 1992, Rockwell contracted with McLaren/Hart Environmental Engineering Corporation (McLaren/Hart) to conduct a multi-media sampling program to determine whether chemicals and/or radionuclides had migrated from the SSFL or had been deposited on Brandeis-Bardin Institute and/or Santa Monica Mountains Conservancy land. McLaren/Hart collected 18 soil samples from background areas and 118 soil/sediment samples from the Brandeis-Bardin and Santa Monica Mountains study areas. All soil/sediment samples were analyzed for 75 naturally occurring and man-made radionuclides using gamma scanning technology as well as H-3, plutonium isotopes (Pu-238, Pu-239), iodine-129 (I-129), and strontium-90 (Sr-90). Surface water samples were also collected and analyzed together with two groundwater samples.[2]
McLaren/Hart collected four sediment samples downstream from Building 4059 in the run-off creek bed immediately north of and below the NBZ-NW/HSA-7 property boundary. A U.S. Environmental Protection Agency (EPA) radiological survey of the creek bed recorded 14 to 17 microroentgens per hour (µR/h). Cs-137 was detected in one sediment sample at 0.23 ± 0.03 pCi/g (dry). Pu-238 was detected in one sediment sample at 0.19 ± 0.06 pCi/g (dry). H-3 was detected in two sediment samples at 10,800 ± 300 and 9,810 ± 330 picocuries per Liter (pCi/L).[3]

  McLaren/Hart collected six sediment samples downstream from the RMHF in the run-off creek bed immediately north of and below the NBZ-NW/Subarea-7 property boundary. An EPA radiological survey of the creek bed recorded 15 to 16 µR/h. According to McLaren/Hart, Cs-137 was detected in one sediment sample at 0.34 ± 0.04 pCi/g (dry). Sr-90 was detected in three of six sediment samples ranging between 0.08 ± 0.019 and 0.15 ± 0.02 pCi/g (dry). H-3 was detected in all six sediment samples ranging between < 200 to 1,500 ± 200 pCi/L.[3]

  McLaren/Hart collected nine sediment samples downstream from the Sodium Disposal facility in two run-off creek beds immediately north of and below the NBZ-NW/HSA-8 property boundary. An EPA radiological survey of the creek beds recorded 14 to 15 µR/h. According to McLaren/Hart, no radionuclides exceeded background levels.[1]

- **1994 Rockwell Soil and Water Sampling**. In 1994, Rockwell contracted with McLaren/Hart to conduct additional soil and water sampling on Brandeis-Bardin Institute and Santa Monica Mountains Conservancy land. Three of nine tasks were: 1) to further characterize Cs-137 and H-3 in the Building 4059 watershed to determine whether the Cs-137 and H-3 reported in the watershed in 1992 were greater than background, 2) to determine whether the Pu-238 reported in the Building 4059 watershed in 1992 was

[1] *Cehn, J. I., Results of Environmental Radiation Survey at Brandeis-Bardin Institute, Brandeis, California*, July 1991, pp. 2, 6, 8, 12.
[2] McLaren/Hart Environmental Engineering Corporation, *Multi-Media Sampling Report for the Brandeis-Bardin Institute and the Santa Monica Conservancy, Volume I*, Project No. 29403-012, March 10, 1993, pp. 9-65 – 9-86.
[3] McLaren/Hart Environmental Engineering Corporation, *Multi-Media Sampling Report for the Brandeis-Bardin Institute and the Santa Monica Conservancy, Volume I*, Project No. 29403-012, March 10, 1993, pp. 9-65 – 9-86.

statistically different from background, and 3) to determine whether the concentrations of Cs-137, Sr-90, and H-3 reported in the RMHF watershed in 1992 were greater than background.[1]

McLaren/Hart collected 16 additional sediment samples from the Building 4059 watershed and statistically compared the results to background. An EPA radiological survey of the creek bed recorded 18 µR/h. According to McLaren/Hart, Cs-137 results were consistent with those recorded in 1992, and were statistically different from background sampling results for Cs-137. H-3 results were also statistically different from background sampling results for H-3. Pu-238 and Pu-239 were below detection limits in all samples analyzed in 1994. The 1994 study results did not confirm the 1992 detection of Pu-238.[2]

McLaren/Hart collected five additional sediment samples from the RMHF watershed and statistically compared the results to background. An EPA radiological survey of the creek bed recorded 17 to 18 µR/h. According to McLaren/Hart, Cs-137 results were found to be not significantly different from background sampling results for Cs-137. Sr-90 results were found to be statistically different from background sampling results for Sr-90. H-3 results for the RMHF watershed samples collected in 1994 were not significantly different from background sampling results for H-3.[2]

- **2007 Boeing, NASA, DOE Offsite Sampling**. In 2007, pursuant to Section 3.4.9 of the Consent Order for Corrective Action, Docket No. P3-07-08-003, Boeing, the National Aeronautics and Space Administration (NASA), and the U.S. Department of Energy (DOE) contracted with MWH to evaluate offsite sampling data collected by Boeing, NASA, and DOE around the SSFL. MWH concluded that the offsite soil/sediment data were sufficient and no data gaps were identified except in areas of ongoing work in the northeast and in the northern drainage area on Santa Monica Mountains Conservancy land.[2]

- **2008 Boeing, NASA, DOE Waste Debris Survey**. In February 2008, Boeing, NASA, and DOE contracted with CH2MHILL and MWH to conduct a survey of waste debris on the SSFL and outside the boundary. Three debris piles were identified in the NBZ-NW area north of HSA-7. A small debris area, estimated at less than 100 square feet, was identified at the north end of the NBZ-NW area near the NBZ-NW/HSA-7 property boundary. This debris area contained an empty 0.5-gallon rectangular metal container, possibly a paint thinner can. Two other waste debris areas were identified in the NBZ-NW area along a dirt access road north of the RMHF 4614 Holdup Pond. One area was estimated at less than 100 square feet and the other area was estimated at 1,357 square feet. The smaller debris area contained a 55-gallon drum cut in half lengthwise and partially filled with soil. The larger debris area was a soil pile intermixed with asphalt, concrete, and metal debris. One debris area was identified in the NBZ-NW area north of

[1] McLaren/Hart Environmental Engineering Corporation, *Additional Soil and Water Sampling, The Brandeis-Bardin Institute and Santa Monica Mountains Conservancy*, Project No. 03.0600829.013, January 19, 1995, pp. 7-14 – 15, 8-4 – 86, 9-3.
[2] Montgomery Watson Harza, *Offsite Data Evaluation Report*, *Santa Susana Field Laboratory*, *Ventura County, California*, Arcadia, California, December 2007, pp. ES-1 – ES-4, 3-19 – 3-23.

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HSA-8 and included partially exposed intact well piping, a pump, and wiring in the vicinity of groundwater monitoring wells.[1]

- **2009 and 2010 Boeing Waste Debris Removal**. During 2009 and 2010, Boeing contracted with CH2MHILL to remove debris from the SSFL. By request from the California Department of Toxic Substances Control (DTSC), only debris that could be accessed with minimum disruption to soil was removed. If debris was located within a soil pile, only the debris readily accessible at the surface was removed, and the soil pile was left intact. It is appears from CH2MHILL's Draft Report that almost all of the debris identified in the NBZ-NW area in 2008 was left in place in 2009 and 2010.[2]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: Five drainage channels in the NBZ-NW area carried radiologically contaminated surface water from HSA-5C, HSA-7, and HSA-8 on Area IV.

Aerial Photographs: Aerial photographs show undeveloped land throughout the period from 1952 through 2009. In the 1952 photograph, an unpaved road is observed at the southern end of the NBZ-NW area, extending in a northwesterly direction. This unpaved road is also seen in the 1959, approximately 1960, 1965, 1967, 1978, 1980, 1983, and 1988 photographs. The unpaved road doubles in width in the 1995 photograph, but returns to its original width in the 2005 and 2009 photographs. In the 1959 photograph, disturbed ground is seen in HSA-7 that extends into the NBZ-NW area. This is also seen in the 1960 photograph, but to a much less extent in the 1965 photograph. The area is vegetated in the 1967, 1972, 1978, 1980, 1983, and 1988 photographs. In the 1995 photograph, an unpaved road is observed in the NBZ-NW area extending in a northeasterly direction just inside and roughly parallel to the NBZ-NW/HSA-7 boundary. In the 2005 and 2009 photographs, this unpaved road also extends in a southwesterly direction inside the NBZ-NW/HSA-7 boundary.[3]

In the 1957 photograph, one drainage channel is observed at the NBZ-NW/HSA-5C boundary, extending north through the NBZ-NW area. In the same 1957 photograph, one drainage channel is observed extending northwest from the NBZ-NW/HSA-7 boundary through the NBZ-NW area. In this same photograph, two drainage channels are observed at the NBZ-NW/HSA-8 boundary extending in a northeasterly direction through the NBZ-NW area. These drainage channels are also seen in the 1959, approximately 1960, 1965, 1967, 1972, 1978, 1980, 1983, 1988, 1995, 2005, and 2009 photographs. In the 1965 photograph, a strip of vegetation has been removed extending northeast from near the southeast corner of the NBZ-NW area. This is also observed in the 1967, 1972, 1978, 1980, 1983, 1988, 1995, 2005, and 2009 photographs. In the 1995 photograph an unpaved road is observed extending northeast from the northeast end of the de-vegetated area. In the 2005 and 2009 photographs, an additional unpaved road is seen in the de-vegetated area, aligned in a north-south direction.[1]

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[1] MWH Americas, Inc., *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Appendix F: Group 7 2008 Waste Debris Survey Results*, June 2009.
[2] CH2MHILL, *Draft Site-Wide Debris Removal and Documentation Summary, Santa Susana Field Laboratory, Ventura County, California*, October 12, 2010, pp. 1, 4, Figure 7.
[3] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

Radionuclides of Concern: The NBZ-NW area received surface water drainage from HSA-5C, HSA-7, and HSA-8 on Area IV. Radiologically contaminated water is known to have flowed from these areas. Possible radionuclides include uranium isotopes (U-238, U-234, U-235, U-238), plutonium isotopes (Pu-239, Pu-240, Pu-241, Pu-242), americium-241 (Am-241), thorium isotopes (Th-228, Th-232), H-3, sodium isotopes (Na-22, Na-24), chromium-51 (Cr-51), manganese-54 (Mn-54), iron-59 (Fe-59), cobalt-60 (Co-60), krypton-85 (Kr-85), strontium isotopes (Sr-89, Sr-90), antimony-125 (Sb-125), iodine isotopes (I-129, I-131), cesium isotopes (Cs-134, Cs-137), cerium-141 (Ce-141), barium (lanthanum)-140 (Ba (La)-140), niobium-95 (Nb-95), ruthenium isotopes (Ru-103, Ru-106), xenon isotopes (Xe-133, Xe-135), promethium-147 (Pm-147), samarium-151 (Sm-151).[1,2,3] All radionuclides of concern listed with the exception of Na-22, Na-24, Cr-51, Mn-54, Fe-59, Kr-85, Sr-89, I-131, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm-147 and Sm-151 are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. The radionuclides omitted from the sampling plan have very short half-lives except for Sm-151 for which no analytical method is available. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Some surface water from the SSFL is transported downhill to the NBZ-NW, the Brandeis-Bardin campus, and thence to surrounding populated areas. The NBZ-NW area received surface water drainage from HSA-5C, HSA-7, and HSA-8 in Area IV. Surface water from these subareas flows through the NBZ-NW and Brandeis-Bardin land through Meier Canyon and into Arroyo Simi and Simi Valley.[4]

Three drainage channels originating in HSA-8 carried surface water from the Sodium Disposal Facility (Site 4886), Building 4009, and the ESADA area through the NBZ-NW region. The Sodium Disposal Facility contained upper and lower open-field ponds that were incompletely bermed. Contaminated water from these ponds spread to adjacent areas, with the natural drainage direction being to the north onto the NBZ-NW area. According to Rockwell, material was also dispersed onto surrounding land by explosions that extended to Building 4009.[5] Building 4009, which housed criticality test facilities, had a leach field used for the disposal of both sanitary and radioactive liquid wastes before the central sewage system was constructed in the early 1960s. A natural drainage channel was located west of the leach field. This ended at a rock outcrop, located approximately 150 feet north of the leach field. Surface water appears to infiltrate at this location and may resurface north of the outcrop where another channel carries it north through the NBZ-NW area.[6]

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[1] Hart, R. S., *Distribution of Fission Product Contamination in the SRE*, Atomics International Report No. NAA-SR-6890, March 1, 1962, pp. 8-27.
[2] Kinzer, J. and Crawford, A. C., *SRE First Core Fuel*, Atomics International Technical Data Record No. 5301, May 16, 1960, pp. 1-7.
[3] Letter from Heine, W. F., Atomics International, to Proctor, J. F., E. I. du Pont de Nemours & Company, re; *Fission Product and Fissile Content of SRE Fuel*, July 2, 1975.
[4] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, pp. 2-7 – 2-8.
[5] Chapman, J. A., *Radiological Survey of the Sodium Disposal Facility–Building T886,* ETEC Report No. GEN-ZR-0004, June 3, 1988, p. 16.
[6] MWH, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures,* September 2007, pp. 2-6 – 2-8.

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A drainage channel originating in HSA-5C also carried surface water from Building 4100, a criticality facility with a leach field, and the Site 4056 Landfill through the NBZ-NW area. Also, a channel located north of SNAP reactor Building 4059 carried surface water through the NBZ-NW region. In addition, a drainage channel originating in HSA-7 carried surface water from the RMHF complex and other buildings through the NBZ-NW region. Drainage from these buildings is discussed earlier in this report.

Radiological Contamination Potential: The preliminary MARSSIM Classification for the five NBZ-NW drainage channels emanating from HSA-5C, HSA-7, and HSA-8 is Class 1, because of the radiologically contaminated outflow from the facilities in these subareas. The preliminary MARSSIM Classification for the other NBZ-NW areas is Class 3.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 provides a convenient reference for the following recommendations.

Previous characterization studies for the NBZ-NW area were focused on delineating the extent of contamination to standards that were applicable at the time and not to the standard required by the December 2010 Administrative Order on Consent. Therefore, additional characterization is recommended for the NBZ-NW area. This includes the following NBZ-NW areas:

- The bottom and sides of the drainage channel that originates in Subarea 5C, carrying surface water from Building 4100 and the Site 4056 landfill. Radionuclides originating from these buildings may have migrated to the channel via surface water flow.

- The bottom and sides of the drainage channel that originates north of SNAP reactor Building 4059. Radionuclides originating from these building may have migrated to the channel via surface water flow.

- The bottom and sides of the drainage channel that originates in HSA-7, carrying surface water from the RMHF complex and Building 4133. Radionuclides originating from these buildings may have migrated to the channel via surface water flow.

- The bottom and sides of the three drainage channels that originate in HSA-8, carrying surface water from Site 4886, Building 4009, and the ESADA area. Radionuclides originating from these facilities may have migrated to the channel via surface water flow.

- The soil/sediment near any artesian wells and natural springs, if present. Radionuclides originating from Area IV may have been carried by groundwater to the NBZ-NW area ground surface through artesian wells and natural springs.

3.0 RADIONUCLIDE LIST

3.1 U.S. Atomic Energy Commission Special Nuclear Material License

The first license issued by the U.S. Atomic Energy Commission (AEC) for the SSFL site was Special Nuclear Material License No. SNM-21. It was initially issued on April 6, 1956, for use at the Canoga Park site. License No. SNM-21 authorized Atomics International (AI) to receive and possess 50 grams of uranium, enriched in uranium-235 (U-235), for use in fission counter tubes. License No. SNM-21 was amended 79 times in its 40-year history to increase the number and type of nuclear materials that could be handled at the Canoga Park and SSFL sites. This license was terminated on September 27, 1996. In February 1975, the AEC became known as the Nuclear Regulatory Agency (NRC) and License No. SNM-21 became an NRC license. License No. SNM-21 applies to company owned, not federally owned facilities. This license does not apply to the HSA-7/3/NBZ subarea.

3.2 U.S. Atomic Energy Commission Critical Experiments Facility License

On October 3, 1960, the AEC authorized AI, under License No. CX-17, to possess and operate a separable-half type critical experiments facility at power levels not exceeding 200 watts (thermal) in Building 100 (now known as Building 4100). AI conducted this research under contract to the Southwest Atomic Energy Associates of Shreveport, Louisiana. The license permitted the possession "and use of special nuclear materials as follows:

- 25 kilograms of U-233 and 110 kilograms of U-235 as fuel for the reactor;
- 135 grams of U-233, 1,135 grams of U-235, and 135 grams of Pu-239 in foils and capsules for use in connection with operation of the reactor;
- 0.5 gram each of U-233, U-235, and Pu-239 in fission counters for use in connection with operation of the reactor; and
- 32 grams of Pu in encapsulated neutron sources for use in connection with operation of the reactor."

License No. CX-17 also permitted the possession "and use of source materials as follows:

- 656 kilograms of Th-232 for use in the core and buffer regions of the reactor;
- 700 grams of natural uranium in foils and capsules for use in connection with operation of the reactor; and
- 0.5 gram each of U-234, U-236, and U-238 in fission counters for use in connection with operation of the reactor."

License No. CX-17 also permitted the possession "and use of 0.5 gram of Np-237 in fission counters for use in connection with operation of the reactor and to possess, but not to separate such byproduct materials as may be produced by operation of the reactor."

License No. CX-17 was amended 10 times before it was terminated on October 6, 1980. It does not apply to the HSA-7/3/NBZ subarea.

3.3 California Department of Public Health Radioactive Material License

On September 11, 1963, the State of California, Department of Public Health issued Radioactive Material License No. 0015-59 to Atomics International. This license authorized the possession and use of a wide range of radioactive materials at the De Soto Avenue, Canoga Park, and SSFL sites as listed in Table 3.1, below.

Table 3.1
Radioactive Materials Covered by License No. 0015-59

Radioactive Material (element and mass number)	Chemical and/or Physical Form	Maximum Quantity that Licensee may Possess
Any byproduct material between atomic number 3 and 83	Any	7 curies of each byproduct material between atomic number 3 and 83
Antimony-124	Any	50 curies
Iridium-192	Any	70 curies
Cobalt-60	Sealed sources	10 sources not to exceed 400 curies each
Hydrogen-3	Any	550 curies
Polonium-210	Any	150 curies
Any byproduct material	Separated from irradiated thorium and uranium samples	250 microcuries total
Hydrogen-3	Titanium tritide foil (U.S. Nuclear Corporation)	500 millicuries
Hydrogen-3	Titanium tritide foil (U.S. Radium Corporation)	1 curie
Strontium-90	Sealed source (U.S. Nuclear Corporation Model 312)	5 microcuries
Radium-226	Any	2,000 milligrams
Radium-226	Sealed neutron sources	500 milligrams
Cobalt-60	Sealed source (U.S. Nuclear Corporation Model 338)	1 source not to exceed 5 curies
Cobalt-60	Sealed source (Isotopes Specialties Company Model 338)	1 source not to exceed 5 curies
Cerium-144	Sealed source (Isotopes Specialties Company Model 160)	50 microcuries
Iridium-192	Sealed source (Technical Operations Model A424-1)	1 source not to exceed 20 curies
Radium-226	Sealed sources (NRC Equipment Corporation)	Seven sources not to exceed 0.4 milligram each
Strontium-90	Sealed sources	Two sources of 3 millicuries each
Americium-241	Any	2 millicuries
Natural or depleted uranium	Any	20,000 pounds
Natural thorium	Any	700 pounds

This license covered the use and possession of radioactive materials outside the former ETEC boundary. It does not apply to the HSA-7/3/NBZ subareas. Up until December 1969, there had been 39 amendments to this license. The radioactive materials covered in the 39th amendment are listed in Table 3.2, below.

Table 3.2
Radioactive Materials Covered by License No. 0015-59, Amendment No. 39

Radioactive Material (element and mass number)	Chemical and/or Physical Form	Maximum Quantity that Licensee may Possess
Any radionuclide with atomic number 3 through 83	Any	25 curies for any one radionuclide
Antimony-124	Any	100 curies
Iridium-192	Any	100 curies
Cobalt-60	Sealed sources	10 sources not to exceed 400 curies each
Hydrogen-3	Any	10,000 curies
Polonium-210	Any	150 curies
Krypton-85	Any	100 curies
Neptunium-237	Any	100 microcuries
Radium-226	Any except as neutron sources	5 grams
Radium-226	Sealed neutron sources	500 milligrams
Cobalt-60	Sealed source (U.S. Nuclear Corporation Model 338)	1 source not to exceed 5 curies
Cobalt-60	Sealed source (Isotopes Specialties Company Model 338)	1 source not to exceed 5 curies
Cobalt-60	Sealed source (Lockheed Nuclear Products Dwg 442-1001)	25,000 +/- 2,500 curies in 12 sources
Iridium-192	Sealed source (Technical Operations Model A424-1)	4 sources not to exceed 100 curies each
Radium-226	Sealed sources (NRC Equipment Corporation)	Seven sources not to exceed 0.4 milligram each
Califonium-252	Sealed source (Oak Ridge)	2 sources not to exceed 550 microcuries each
Any radionuclide with atomic number 3 through 83	Any	Not to exceed 100 curies for any one radionuclide
Promethium-147	Promethium oxide	150,000 curies
Americium-241	Any	10 curies
Natural or depleted uranium	Any	20,000 pounds
Natural thorium	Any	1,000 pounds
Tantalum-182	Metal	500 curies
Natural or depleted uranium	Any	50,000 pounds
Mixed fission products (Hot Lab)	Any	10,000,000 curies
Any radionuclide with atomic number 3 through 83 (Hot Lab)	Any	100,000 curies for any one radionuclide

This license was amended 64 times up until August 2, 1979, when the license number was changed to No. 0015-70. This license number was changed a second time to No. 0015-19 on December 5, 1996. As of August 27, 2010, there had been 110 amendments to this license. This license applies to buildings outside of the ETEC boundary. It does not apply to the HSA-7/3/NBZ subareas.

3.4 Radionuclide List to be Used in Soil and Groundwater Sampling

From a review of historical documents and radioactive material licenses issued for the SSFL, all of the radionuclides selected for radiochemical analysis of soil samples are likely to have been used or generated on the SSFL. In the table below, certain radionuclides mentioned in source documents will not be analyzed. These have undergone radioactive decay in excess of 10 half-lives, such that they could no longer be present. These radionuclides include: Na-22, Fe-55, Sb-125, Cs-134, Ce-144, and Po-210. The September 23, 2010 Stakeholder Technical Meeting Action Items Memo describes the radionuclides contained in soil analytical suites, the sample analytical approach, and provides explanations for deleting certain radionuclides from analysis.

Table 3.3
Summary of Subarea HSA-7, HSA-3, and NBZ Sites
Potential Radiological Contaminants of Concern

Site No.	Use(s)	Current Status	Potential Radiological Contaminants of Concern	MARSSIM Class
4021	Radioactive Material Disposal Facility (RMDF) Waste Decontamination and Packaging ; Radioactive Material Handling Facility (RMHF) Waste Decontamination and Packaging	Standing	Am-241, Co-60, Cs-137, Eu-152, Eu-154, H-3, K-40, Ni-59, Ni-63, Pm-147, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Sr-90, Th-228, Th-232, U-234, U-235, and U-238.	1
4022	RMDF Vault Storage; RMHF Radioactive Vault Storage	Standing	Am-241, Co-60, Cs-137, Eu-152, Eu-154, H-3, K-40, Ni-59, Ni-63, Pm-147, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Sr-90, Th-228, Th-232, U-234, U-235, and U-238.	1
4028	Shield Test Irradiation Reactor (STIR) Facility; Liquid Metal Fast Breeder Reactor (LMFBR) Fuel Safety Building	Demolished	Am-241, Cs-137, Co-60, Eu-152, Eu-154, H-3, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, U-234, U-235, and U-238.	1
4034	RMDF Office Building; RMHF Office Building	Standing	Am-241, Co-60, Cs-137, Eu-152, Eu-154, H-3, K-40, Ni-59, Ni-63, Pm-147, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Sr-90, Th-228, Th-232, U-234, U-235, and U-238.	1
4044	RMDF Clean Shop; RMDF Support Lab; RMDH Support Lab	Standing	Am-241, Bi-210, Co-60, Cs-137, Eu-152, Eu-154, H-3, K-40, Ni-59, Ni-63, Pb-210, Pm-147, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Sr-90, Tc-99, Th-228, Th-232, U-234, U-235, and U-238.	1
4075	RMDF Contaminated Equipment Storage Building	Standing	Uranium, plutonium, thorium, mixed fission products. Isotopes of cobalt and europium.	1
4133	Hazardous Waste Treatment Facility; Hazardous Waste Management Facility	Standing	None identified.	1
4563	Building 4633 Storage Yard; Covered Storage Area Adjacent to Building 4075	Standing	Uranium, plutonium, thorium, and mixed fission products.	1
4614	RMDF Drainage Sump; RMHF Drainage Sump; RMHF Holdup Pond	Standing	Am-241, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Th-228, Th-232, U-234, U-235, and U-238.	1

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Table 3.3 (continued)
Summary of Subarea HSA-7, HSA-3, and NBZ Sites
Potential Radiological Contaminants of Concern

Site No.	Use(s)	Current Status	Potential Radiological Contaminants of Concern	MARSSIM Class
4621	RMDF Equipment Storage Building; RMHF Equipment Storage Building	Standing	Am-241, Bi-210, Co-60, Cs-137, Ir-192, Pb-210, Ra-226, Sr-90, Th-228, and Th-232.	1
4622	RMDF Counting Building	Demolished	None identified. It is presumed that waste handled at other RMHF complex buildings had the potential to be sampled and counted at Building 4622 and thus this building area should be surveyed for the same radionuclides of concern as the rest of the RMHF complex.	1
4654	Interim Storage Facility	Demolished	Uranium and mixed fission and activation products.	1
4658	RMDF Guard Shack; RMHF Guard Shack	Standing	None identified. However, this building was at the entry point for all incoming and outgoing fuel and waste shipments.	1
4663	RMDF Storage Area; RMHF Storage Area	Concrete Pad	Uranium, plutonium, thorium isotopes, and mixed fission products.	1
4664	RMHF Low-Level Waste Processing	Demolished	Uranium, plutonium, thorium isotopes, and mixed fission products.	1
4665	RMDF Oxidation Facility; RMHF Equipment Storage	Standing	Uranium, plutonium, thorium isotopes, and mixed fission products.	1
4688	Auxiliary Skid Shack; RMDF Storage Building; RMHF Storage Building	Standing	Uranium, plutonium, thorium isotopes, and mixed fission products.	1
N/A	RMHF Leach Field	Excavated	Am-241, Co-60, Cs-137, Eu-152, Eu-154, H-3, K-40, Ni-59, Ni-63, Pm-147, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Sr-90, Th-228, Th-232, U-234, U-235, U-238, and Y-90	1
N/A	Southern California Edison Substation	Standing	Am-241, Co-60, Cs-134, Cs-137, H-3, I-129, Pu-239, Pu-240, Pu-241, Pu-242, Sb-125, Sr-90, Th-232, U-234, U-235, and U-238.	2
N/A	Northern Buffer Zone – Northeast Area	No structures	Am-241, Co-60, Cs-134, Cs-137, H-3, I-129, Pu-239, Pu-240, Pu-241, Pu-242, Sb-125, Sr-90, Th-232, U-234, U-235, and U-238.	1

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Table 3.3 (concluded)
Summary of Subarea HSA-7, HSA-3, and NBZ Sites
Potential Radiological Contaminants of Concern

Site No.	Use(s)	Current Status	Potential Radiological Contaminants of Concern	MARSSIM Class
N/A	Northern Buffer Zone – Northwest Area	No structures	Am-241, Co-60, Cs-134, Cs-137, H-3, I-129, Pu-239, Pu-240, Pu-241, Pu-242, Sb-125, Sr-90, Th-232, U-234, U-235, and U-238.	1

4.0 REACTOR/CRITICALITY FACILITIES/SIGNIFICANT SITES WORKS CITED

4.1 BUILDING 4021

Facility Name	Building No.	Period of Operation	Notes
Radioactive Materials Handling Facility (RMHF) Waste Decontamination and Packaging Building	4021	1959 - present	RCRA-permitted facility

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4.2 BUILDING 4022

Facility Name	Building No.	Period of Operation	Notes
Radioactive Materials Handling Facility (RMHF) Radioactive Vault Storage	4022	1959 - present	RCRA-permitted facility

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4.3 BUILDING 4028

Facility Name	Building No.	Period of Operation	Notes
Shield Test Reactor (STR)/Shield Test Irradiation Reactor (STIR)/Liquid Metal Fast Breeder Reactor (LMFBR)	4028	1960 - 1981	

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4.4 BUILDING 4075

Facility Name	Building No.	Period of Operation	Notes
Contaminated Equipment Storage Building	4075	1971-2001	RCRA-permitted facility

Building 4075 Cited Documents

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Facility Name	Building No.	Period of Operation	Notes
Radioactive Accountable Waste Storage Building	4621	Mid-1960s – present	RCRA-permitted facility

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4.6 BUILDING 4654

Facility Name	Building No.	Period of Operation	Notes
Interim Storage Facility	4654	1958 - 1964	

Building 4654 Cited Documents

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Redacted

Legend

- Subarea 7

Centerline Roads

- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings

- Demolished
- Existing
- Parking Lots

Surface Water

- Intermittent Stream
- Stream
- Surface Water
- Lined Channel

Tanks

- Above ground Storage Tank
- Underground Storage Tank
- Unknown Tank Type
- French Drain Holding Tank
- Dry Well
- Tank Footprint
- Well
- French Drain

Utilities

- Gas
- Storm Drain
- Sanitary Sewer
- Sanitary Waste
- Water
- Water (Removed)

Aerial Photograph Data

- Aerial Photograph Features
- Debris Area
- Debris/Disturbed Area
- Disturbed Soil
- Excavation
- Grading
- Spills
- 1981 Rockwell Survey Contaminated Areas

Surface Features

- Tank
- Vault
- Channel
- Drain
- Drainage Divide
- Gutter
- Pipes (Unknown Type)
- Surface Water Flow

Aerial Photograph Descriptors

Type	Description
B	Building
CA	Cleared Area
CONT	Container
CR	Crates
DB	Debris
DG	Disturbed Ground
DTM	Dark Tone Material
EX	Excavation
FA	Fill Area
GR	Graded
GS	Ground Scar
HT	Horizontal Tank
IM	Impoundment
LTMM	Light Toned Mounded Material
MTMM	Medium Toned Mounded Material
OS	Open Storage
PA	Processing Area
PL	Pipeline
POSS	Possible
PROB	Probable
SS	Smoke Stack
ST	Stain
S-T	Storage Tank
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

N

0 50 100 200

Scale In Feet

Historical Site Assessment
Final Technical Memorandum - HSA-7/3/NBZ

Plate 1
Subarea HSA-7
Santa Susana Field Laboratory

U.S. EPA Region 9

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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Legend

HSA Sub-Area 3 Boundary

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream

Aerial Photography Data
- Aerial Photography Features
- Debris Area

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Sanitary Waste
- Water

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Aerial Photograph Descriptors

Type	Description
CA	Cleared Area
ST	Stain

N

0 20 40 80

Scale In Feet

Historical Site Assessment
Final Technical Memorandum - HSA-7/3/NBZ

Plate 1
Subarea HSA-3
Santa Susana Field Laboratory

U.S. EPA Region 9

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Source:Boeing Company, 2008
CIRGIS, 2007

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Legend

HSA Sub-Area NBZ Boundary

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Tanks
- Above ground Storage Tank
- Underground Storage Tank
- Unknown Tank Type
- French Drain Holding Tank
- Sump
- Dry Well
- Tank Footprint
- Drain
- Well
- French Drain
- Drainage
- Leach Field
- Septic System

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Sanitary Waste
- Water
- Water (Removed)

N

0 145 290 580
Scale In Feet

Historical Site Assessment
Final Technical Memorandum - HSA-7/3/NBZ

Plate 1
Subarea NBZ-NE
Santa Susana Field Laboratory

U.S. EPA Region 9

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Source: Boeing Company, 2008
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Legend

HSA Sub-Area NBZ Boundary

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Tanks
- Above ground Storage Tank
- Underground Storage Tank
- Unknown Tank Type
- French Drain Holding Tank
- Sump
- Dry Well
- Tank Footprint
- Drain
- Well
- French Drain
- Drainage
- Leach Field
- Septic System

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Sanitary Waste
- Water
- Water (Removed)

N

0 125 250 500
Scale In Feet

Historical Site Assessment
Final Technical Memorandum - HSA-7/3/NBZ

Plate 1
Subarea NBZ-NW
Santa Susana Field Laboratory

U.S. EPA Region 9

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Source:Boeing Company, 2008
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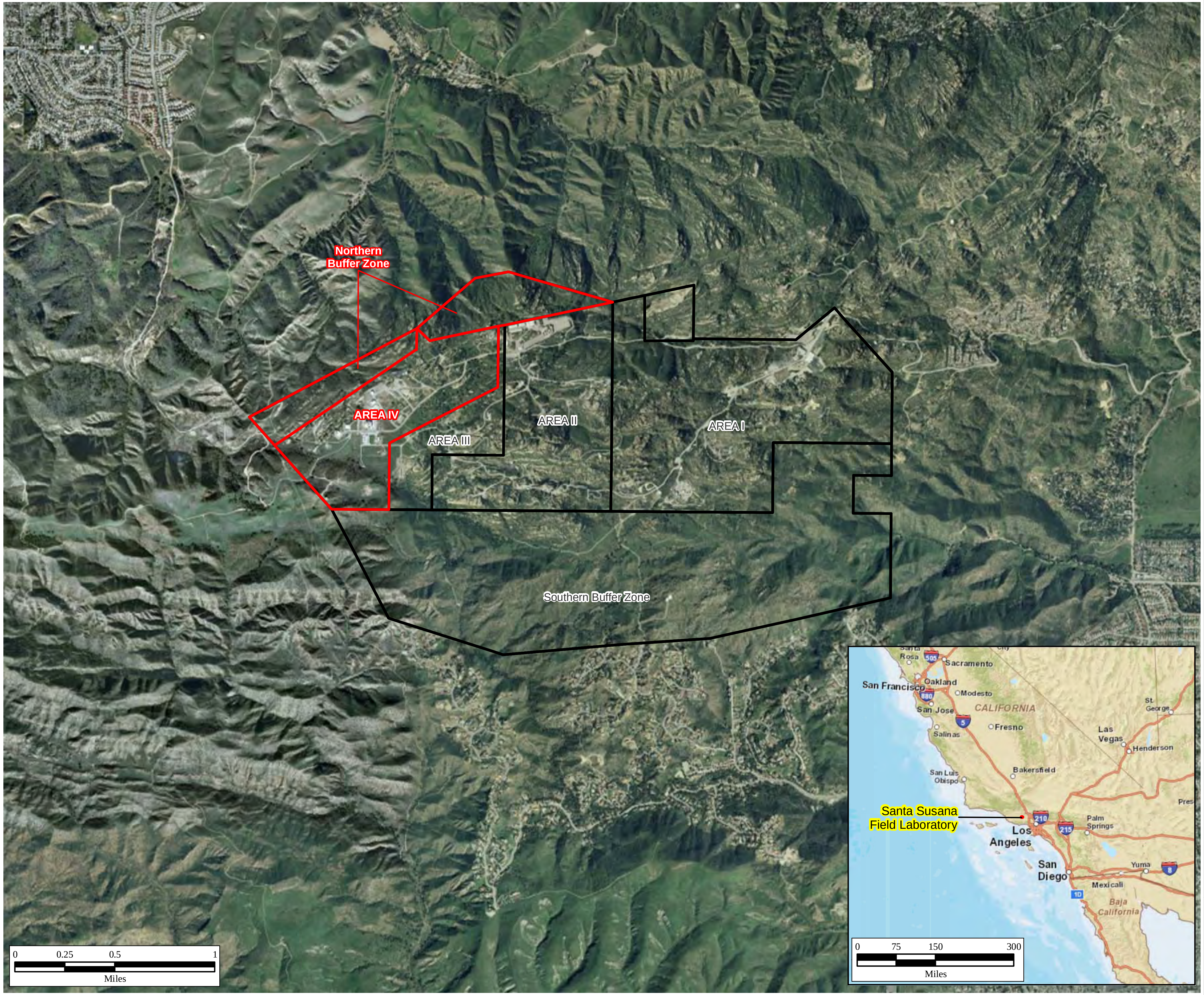
Historical Site Assessment
Final Technical Memorandum - HSA-7/3/NBZ

Figure 1.1
Site Location
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

EPA Study Area Boundary;
Area IV and Northern Buffer Zone

Santa Susana Field Laboratory
Property Boundary

N

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Sorce: Boeing Company, 2008
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HGL HydroGeoLogic, Inc

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Historical Site Assessment
Final Technical Memorandum - HSA-7/3/NBZ

Figure 1.2
General Site Layout for
Area IV/HSA Subareas
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

HSA Subarea

Buildings

Existing
Removed

0 250 500 1000
Scale In Feet

N

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Sorce: Boeing Company, 2008
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Figure 1.3a
Subarea HSA-7
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

- Subarea 7
- Demolished Building
- Existing Building

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Sorce: Boeing Company, 2008
CIRGIS, 2007

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Historical Site Assessment
Final Technical Memorandum - HSA-7/3/NBZ

Figure 1.3b
Subarea HSA-3
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

- Subarea 3
- Demolished Building
- Existing Building

N

0 50 100 200
Scale In Feet

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Sorce: Boeing Company, 2008
CIRGIS, 2007

HGL HydroGeoLogic, Inc

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Historical Site Assessment
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Figure 1.3c
Subarea HSA-NBZ-NE
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Subarea NBZ-NE

Demolished Building

Existing Building

N

0 200 400 800
Scale In Feet

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Sorce: Boeing Company, 2008
CIRGIS, 2007

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Historical Site Assessment
Final Technical Memorandum - HSA-7/3/NBZ

Figure 1.3d
Subarea HSA-NBZ-NW
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Subarea NBZ-NW

Demolished Building

Existing Building

N

0 200 400 800

Scale In Feet

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Sorce: Boeing Company, 2008
CIRGIS, 2007

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1a
Building 4021
Site Photographs

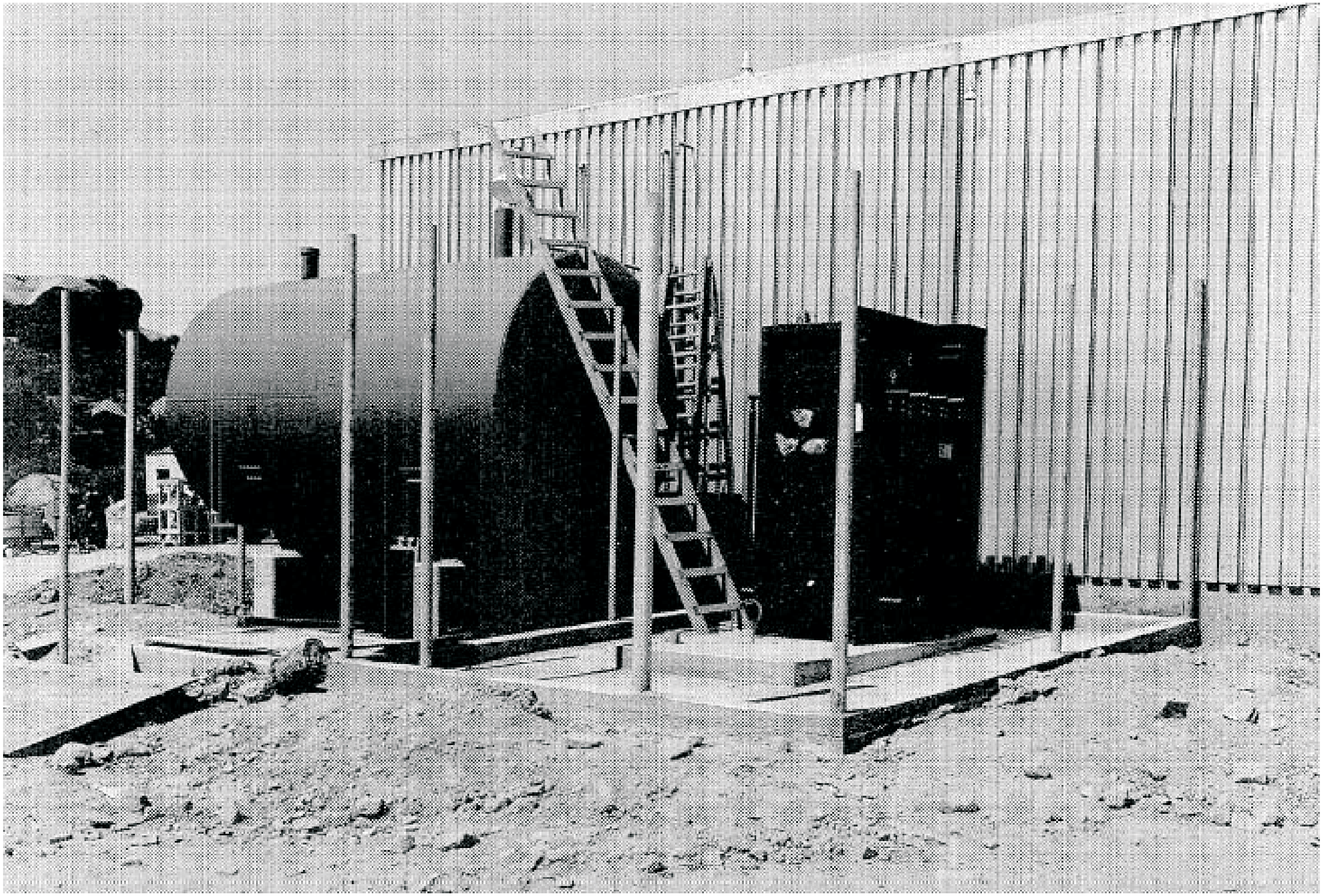
Redacted

\\az-srv-02\SharedGraphics\Phoenix\Graphics\SantaSusana\HSA-7\Figures\(2-1b)Bldg4021CP.cdr
Project:EP9038
Revised: 06/29/11 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1b
Building 4021
Construction
Photograph
1959

Redacted



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Revised: 06/29/11 TJ
Source: Boeing Company, 2008

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Figure 2.1c
Building 4021
Radioactive Waste
Holdup Tank
Photograph

\\az-srv-02\SharedGraphics\Phoenix\Graphics\SantaSusana\HSA-7\Figures\(2-1d)Bldg4021ST.cdr
Project:EP9038
Revised: 07/14/11 TB
Source: Boeing Company, 2008

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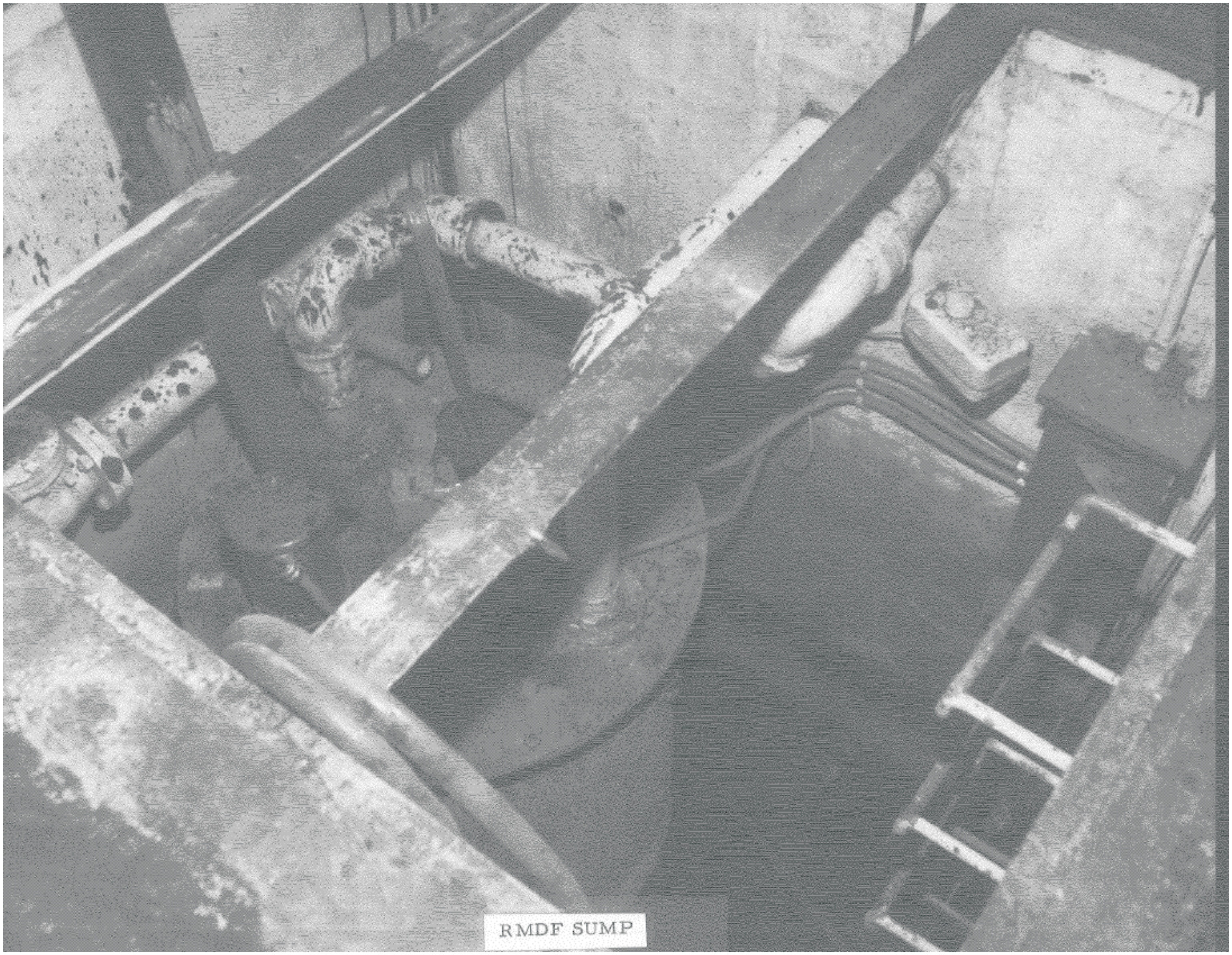
Figure 2.1d
Building 4021
Septic Tank
Installation
1959



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Revised: 06/29/11 TJ
Source: Boeing Company, 2008

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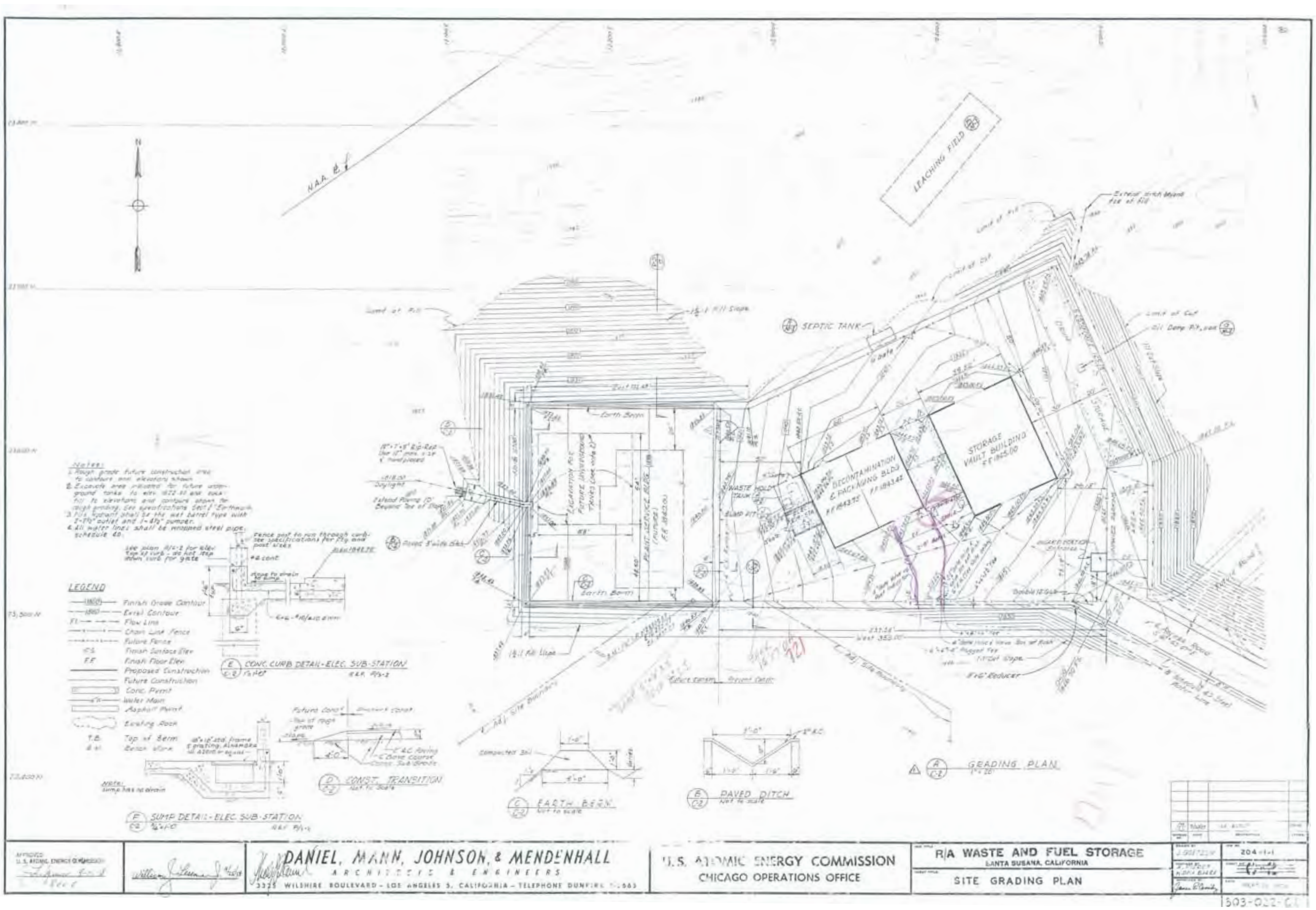
Figure 2.1e
Building 4021
Sump Tank
Photograph

Redacted



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Source: Boeing Company, 2008

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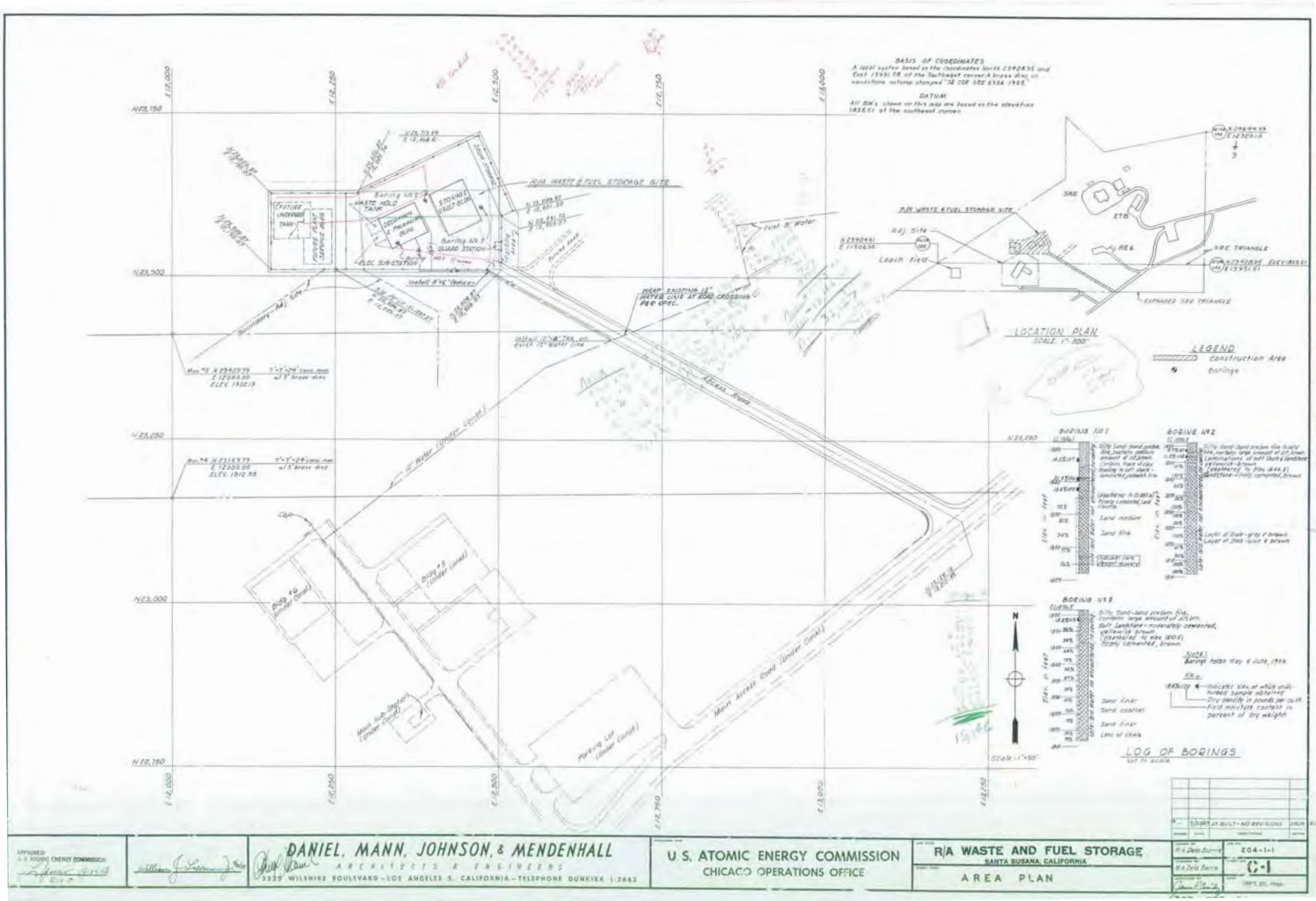
Figure 2.1f
Building 4021
Site Grading Plan



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Revised: 06/29/11 TJ
Source: Boeing Company, 2008

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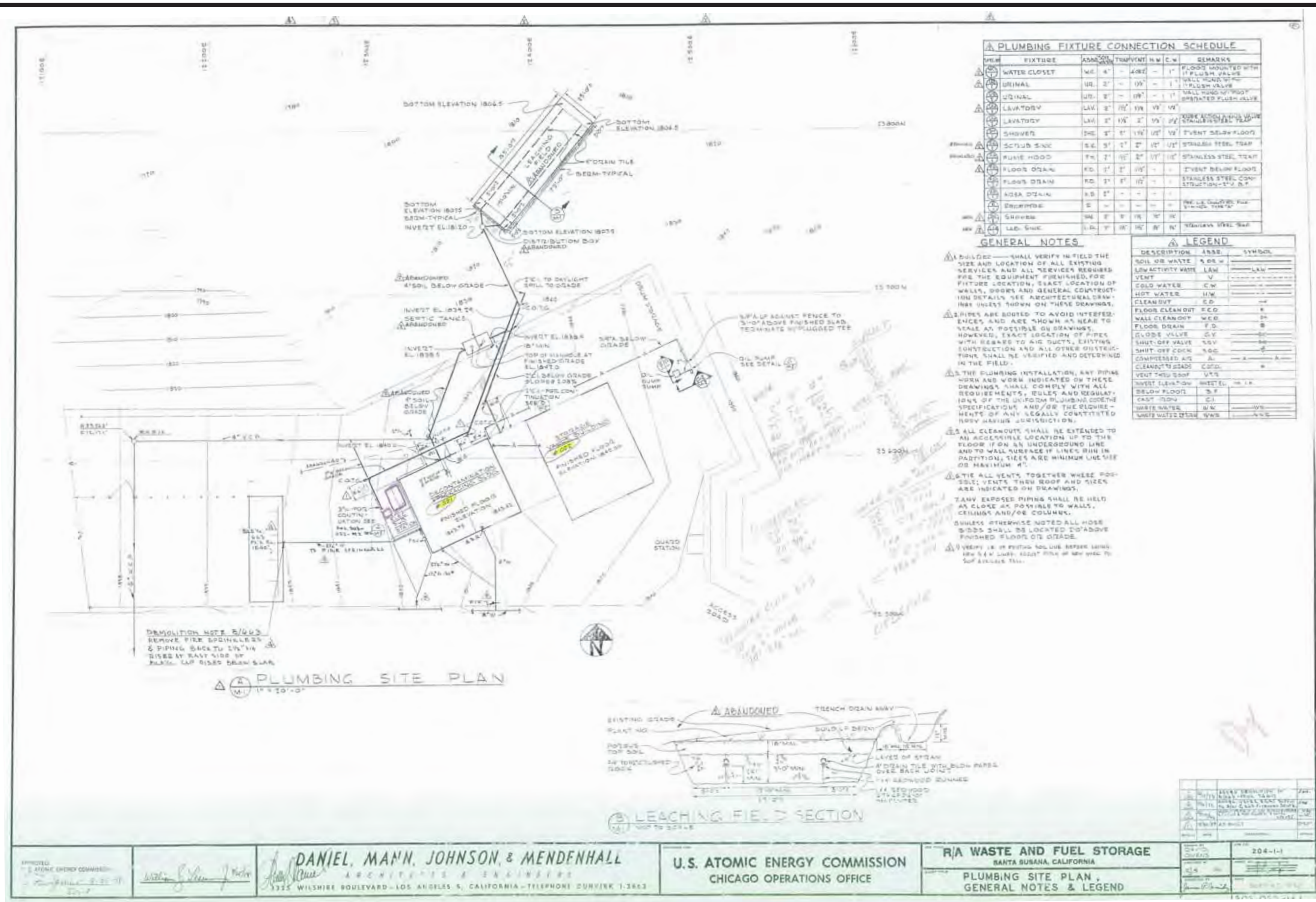
Figure 2.1g
Building 4021
Area Plan



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Source: Boeing Company, 2008

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Figure 2.1h
Building 4021
Site Plumbing
Plan

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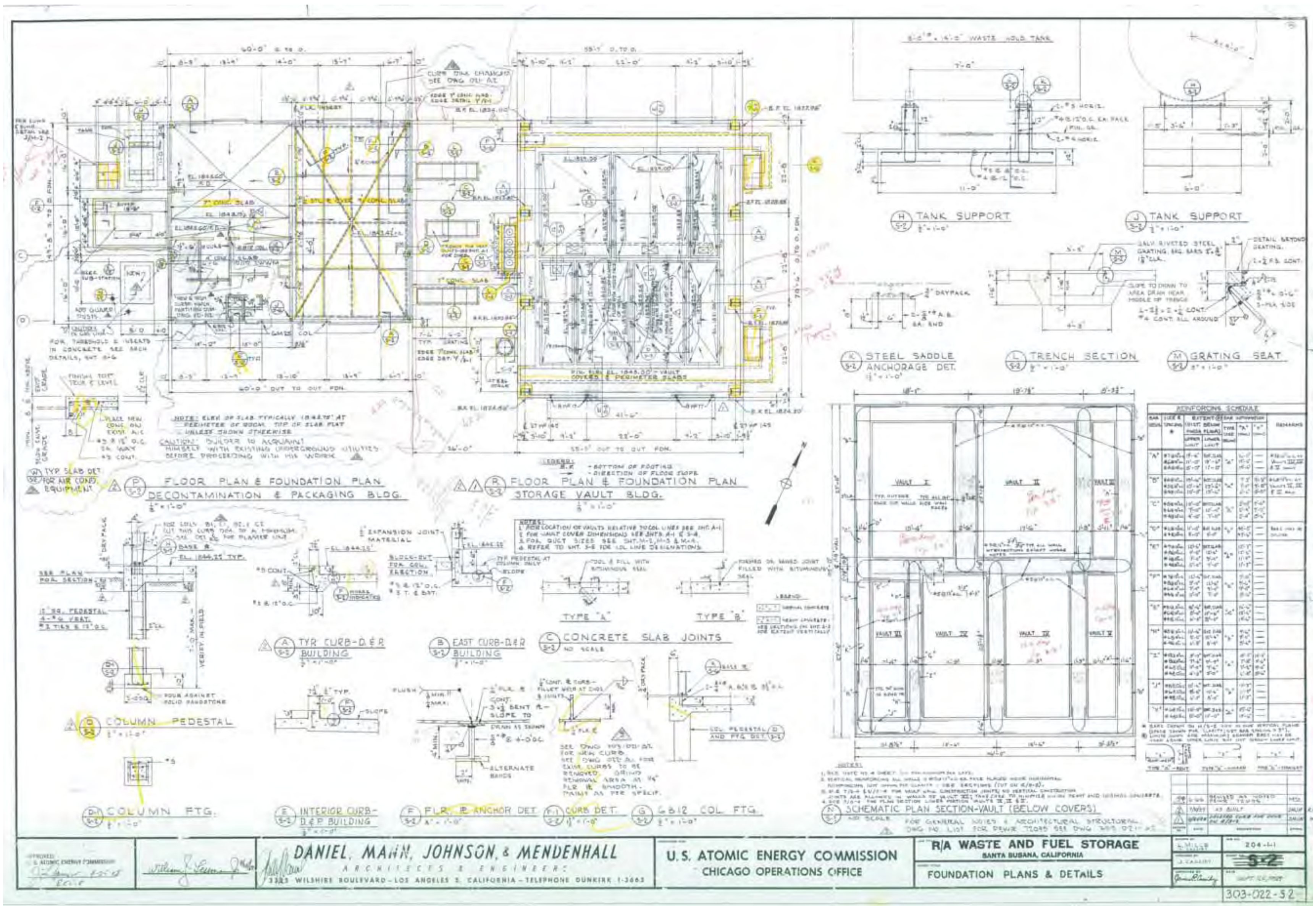

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Source: Boeing Company, 2008

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Figure 2.1i
Building 4021
Foundation Plan

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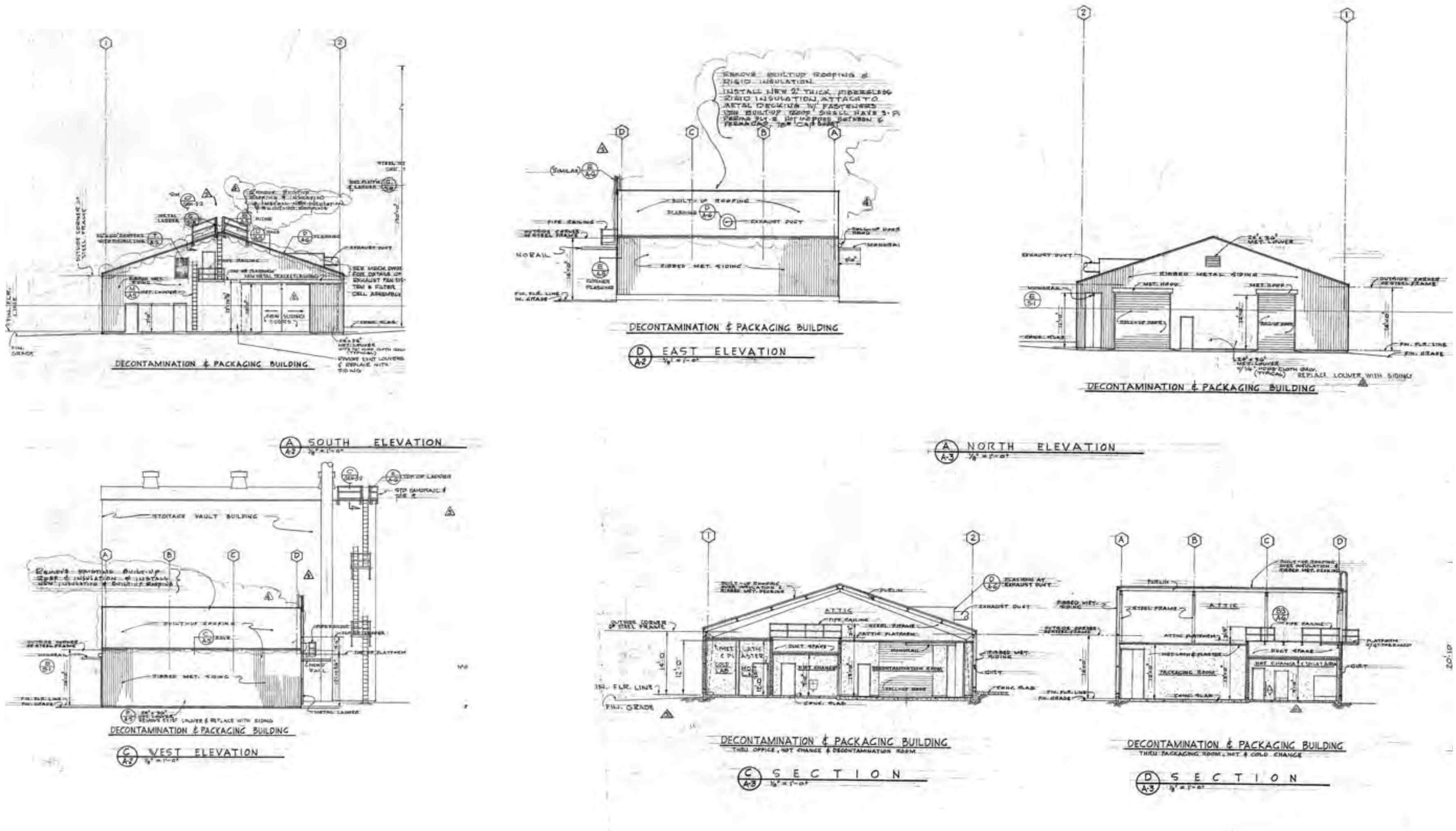

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Source: Boeing Company, 2008

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Figure 2.1j
Building 4021
Elevations

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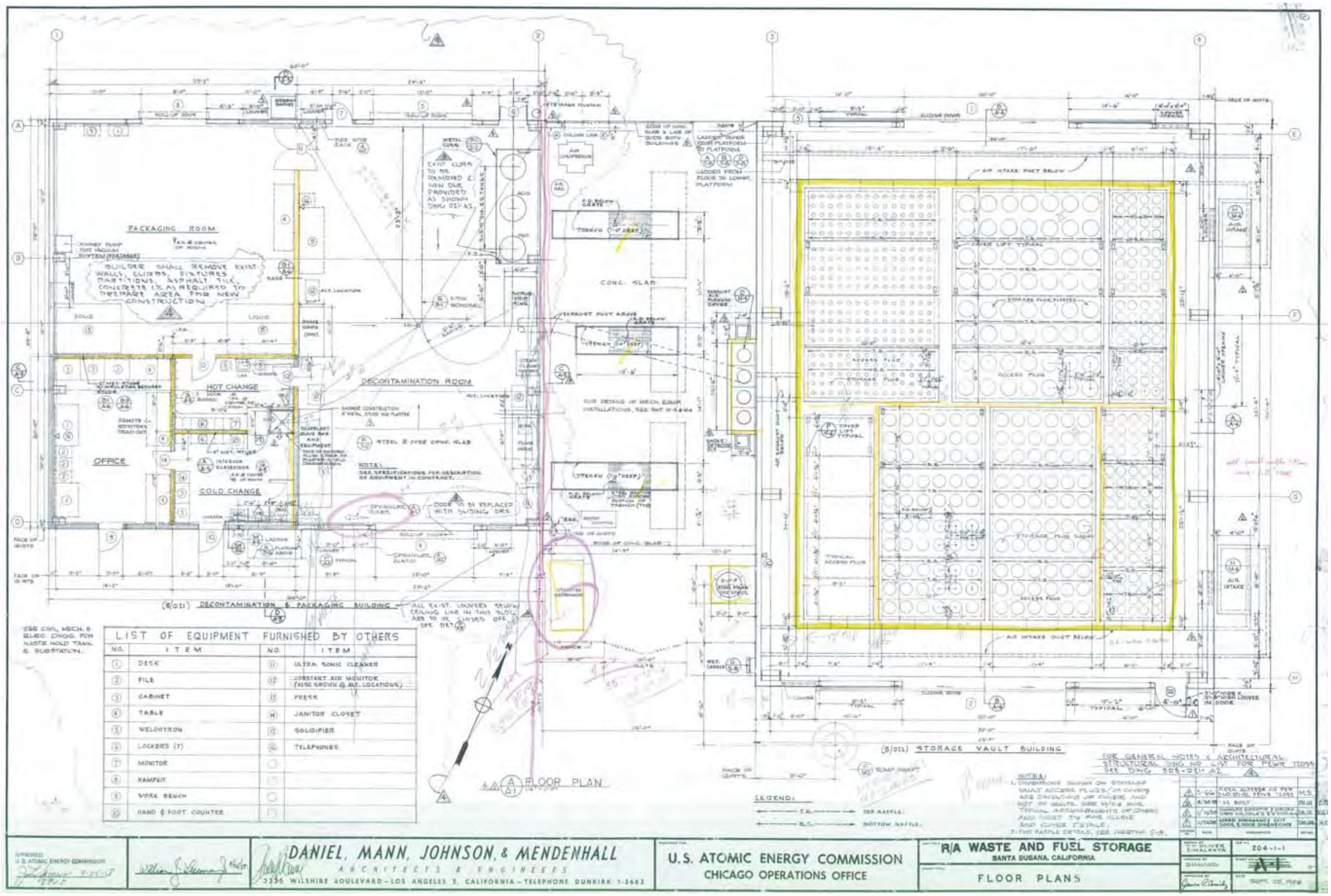

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Revised: 06/29/11 TJ
Source: Boeing Company, 2008

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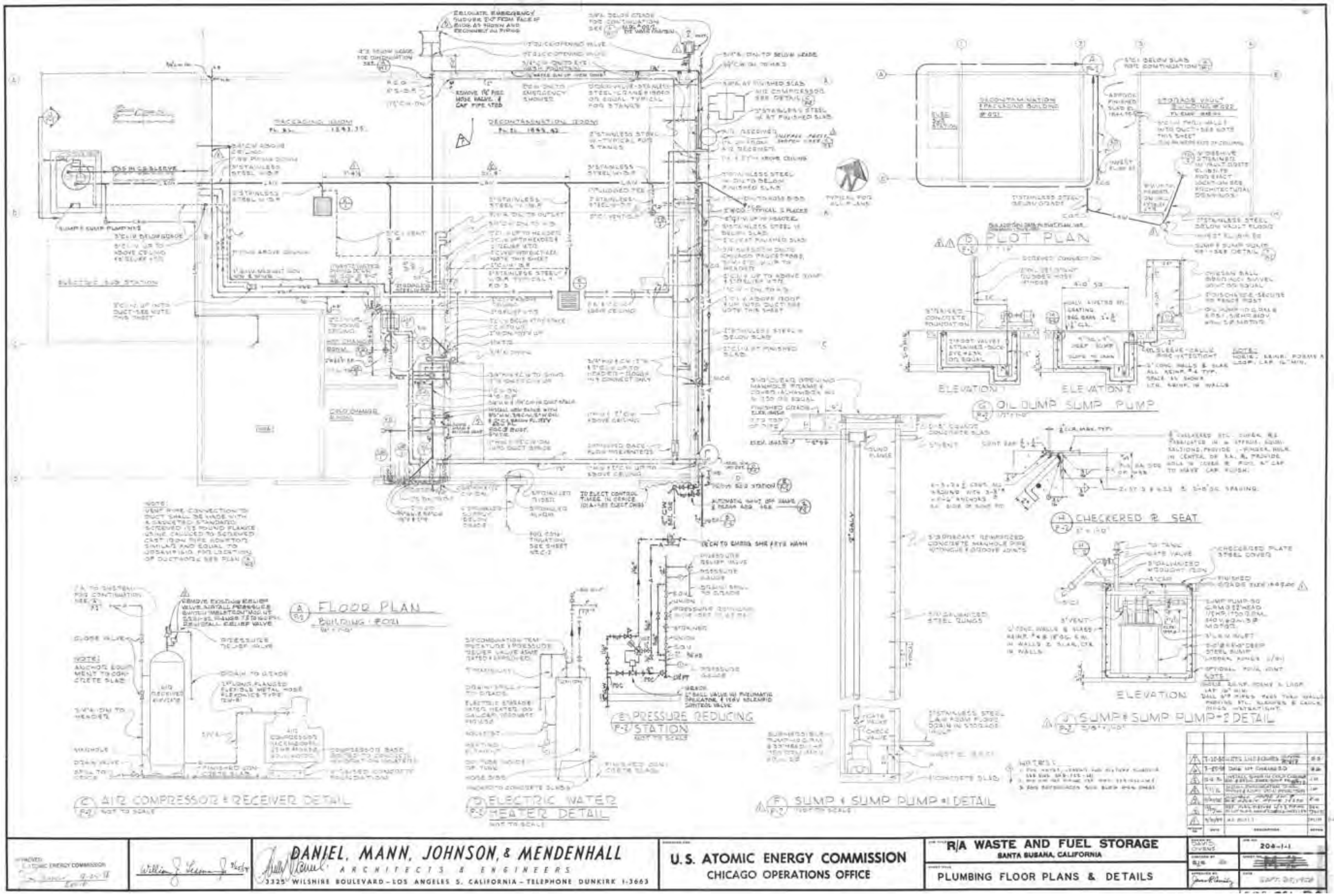
Figure 2.1k
Building 4021
Floor Plan

Redacted



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Source: Boeing Company, 2008

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Figure 2.11
Building 4021
Plumbing Floor Plan

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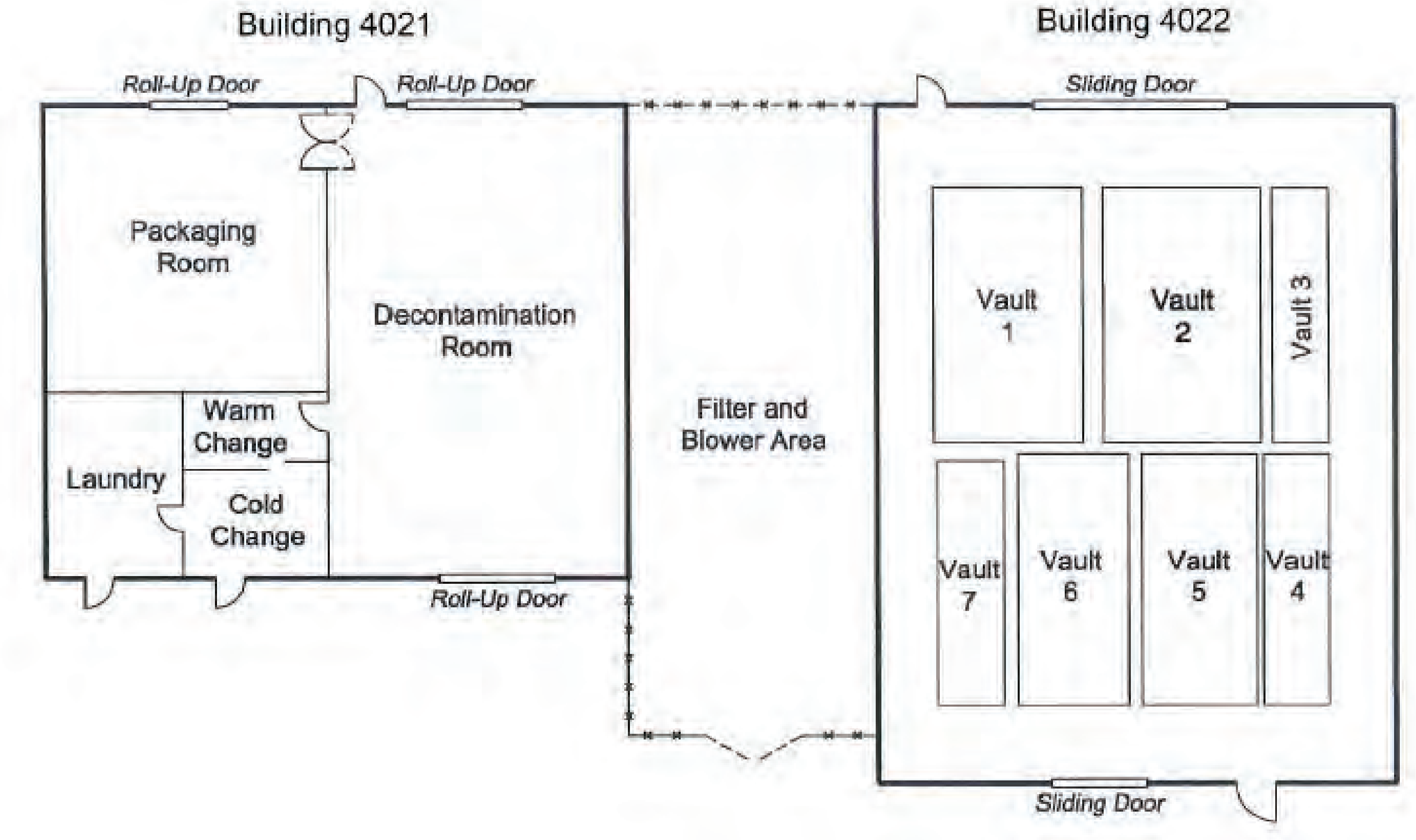

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Source: Boeing Company, 2008

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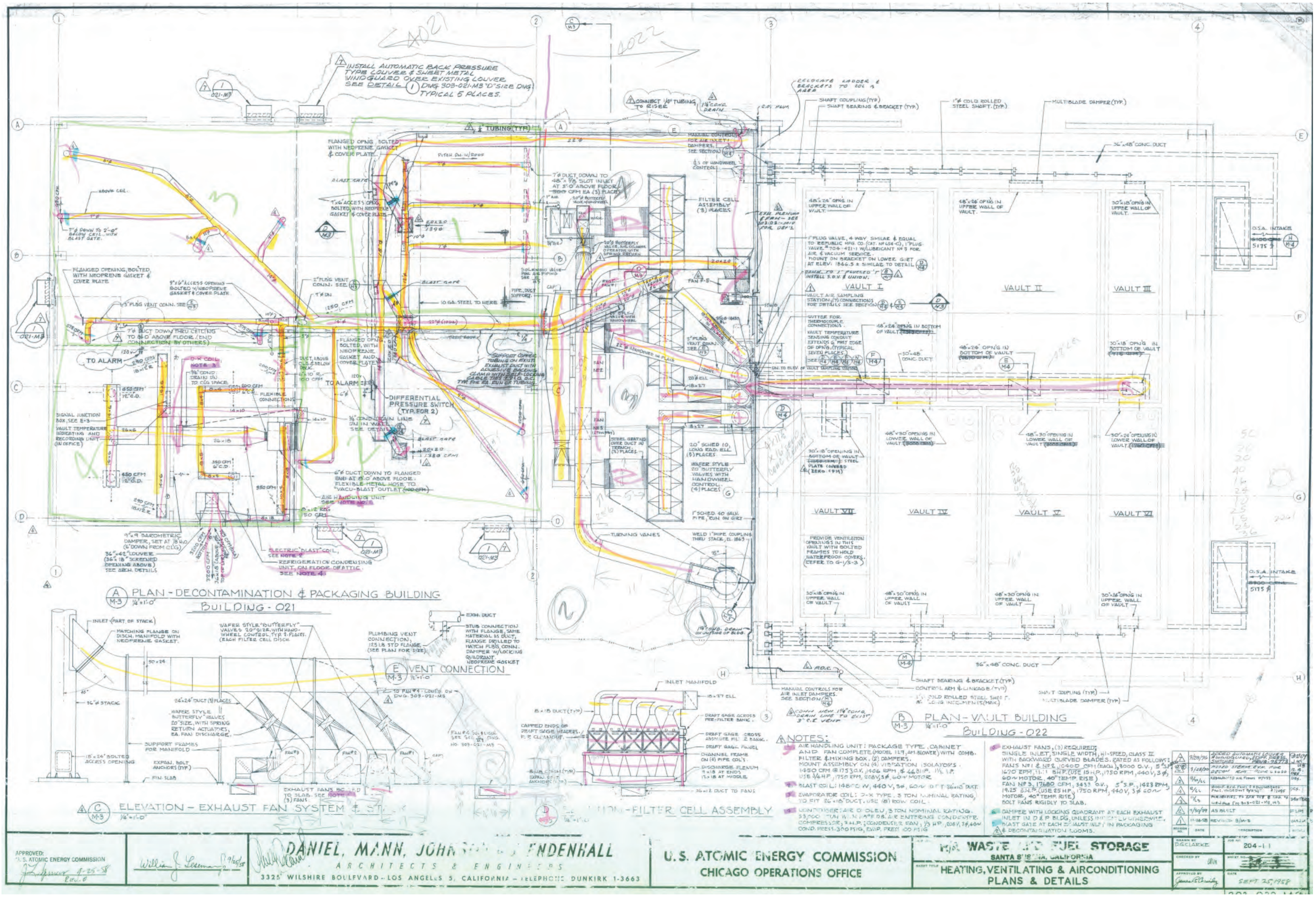
Figure 2.1m
Building 4021
Floor Plan
Schematic Layout

Redacted



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Revised: 07/15/11 TB
Source: Boeing Company, 2008

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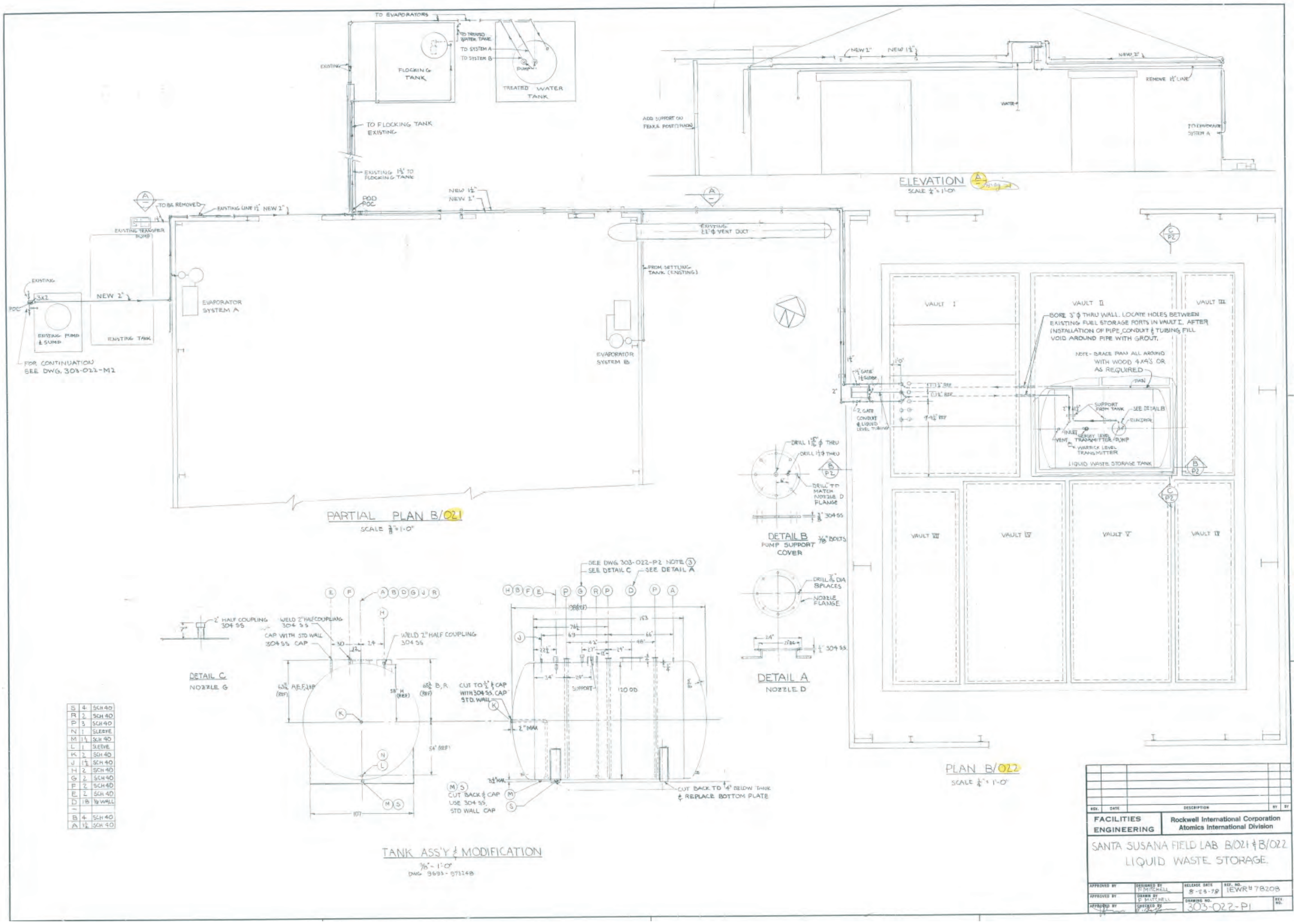
Figure 2.1n
Building 4021
Heating, Ventilation and Air Conditioning Plan

Redacted



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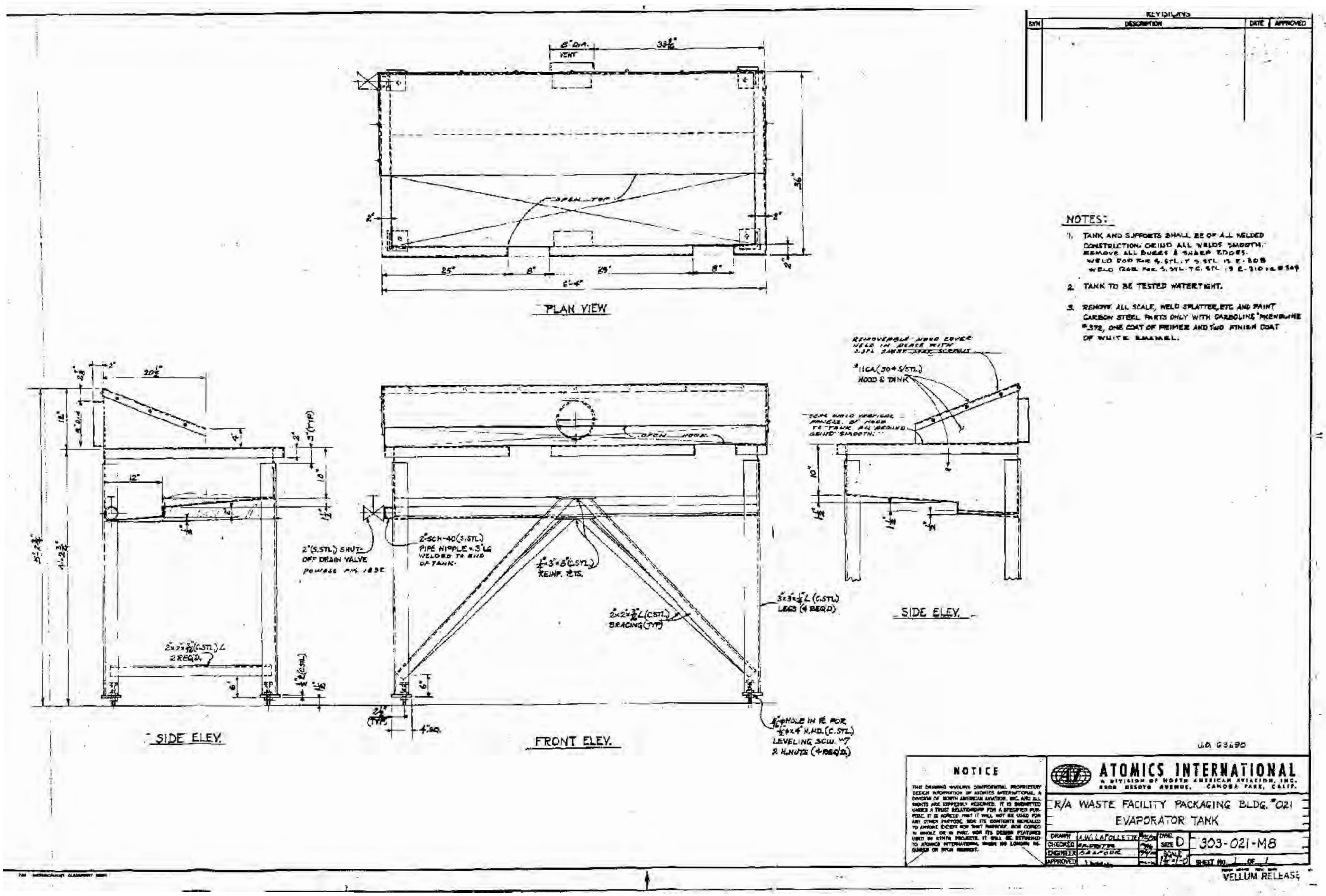
Redacted



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Revised: 07/25/11 TJ
Source: Boeing Company, 2008

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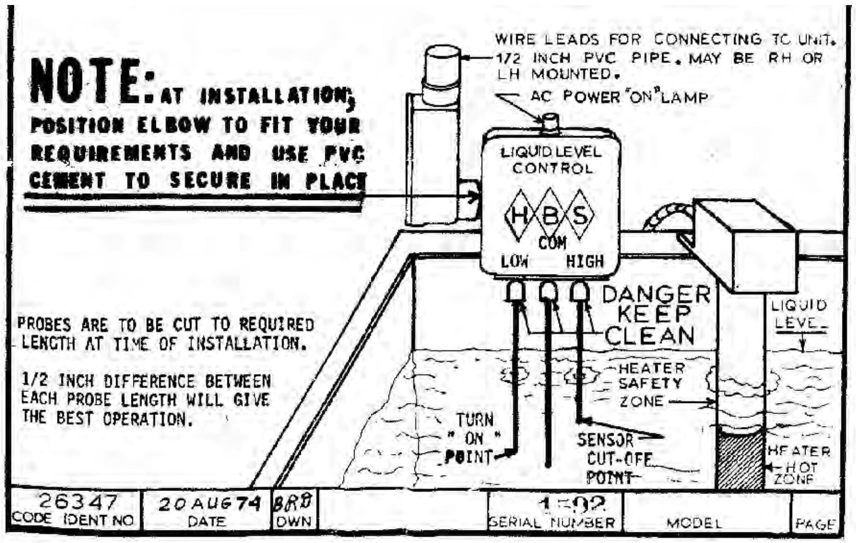
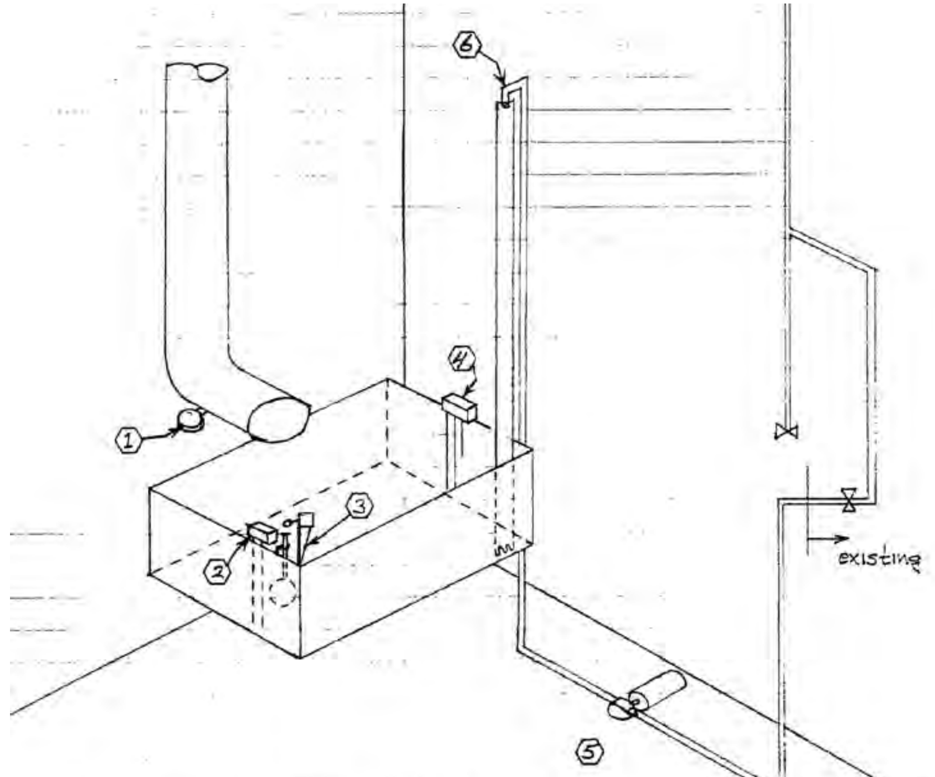
Figure 2.1p
Building 4021
Evaporator Tank





① flammable gas detector head - requires penetration thru vent and leads to and from control circuitry in office, as fire safety to heaters

② existing conductivity probe - as low level heater shutoff

③ float and micro switch - as overflow safety switch to pump, float minimum size 3" dia.

④ high-low conductivity probe - as level controller on pump. will require relay to actuate pump

⑤ 1 hp, 115V, 13.2 Amp pump - orient as shown so impeller can be easily changed

⑥ suction breaker - at least 10 ft. above floor

\\az-srv-02\SharedGraphics\Phoenix\Graphics\SantaSusana\HSA-7\Figures\(2-1q)Bldg4021ETS.cdr
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Revised: 07/25/11 TJ
Source: Boeing Company, 2008

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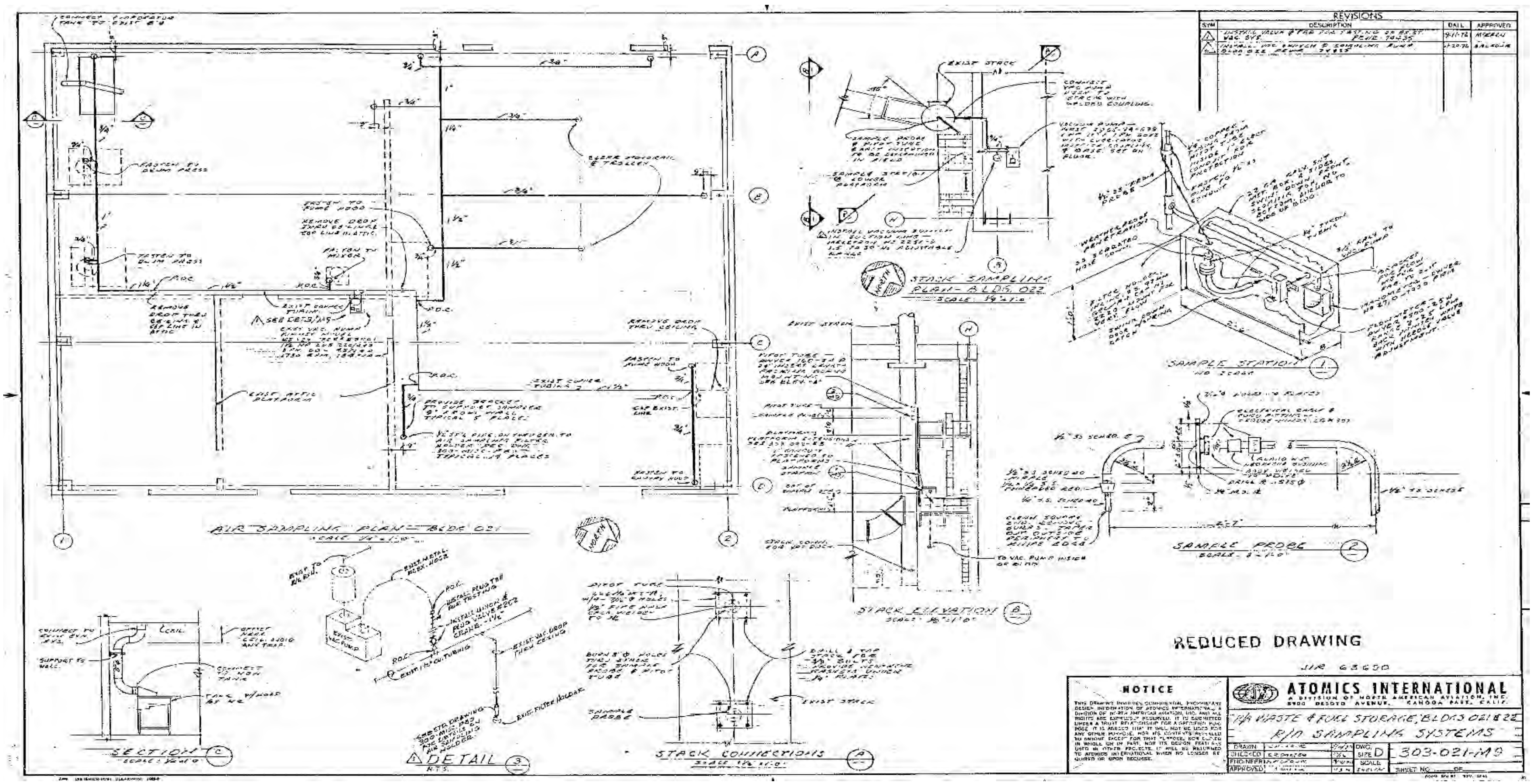
Figure 2.1q
Building 4021
Evaporator Tank
Sketches



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Revised: 07/14/11 TB
Source: Boeing Company, 2008

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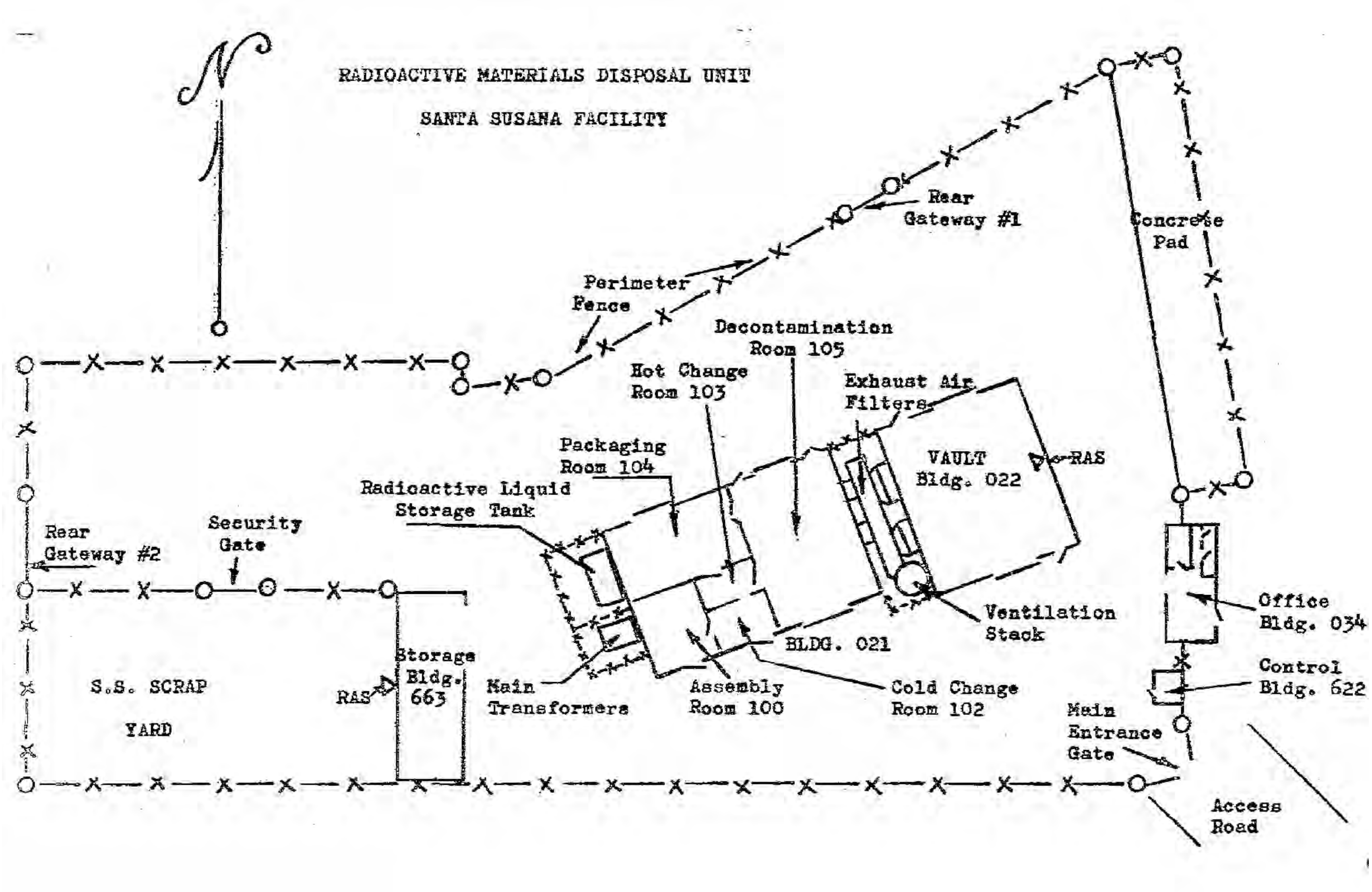
Figure 2.1r
Building 4021
Radioactive Air
Sampling System

Redacted



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Source: Boeing Company, 2008

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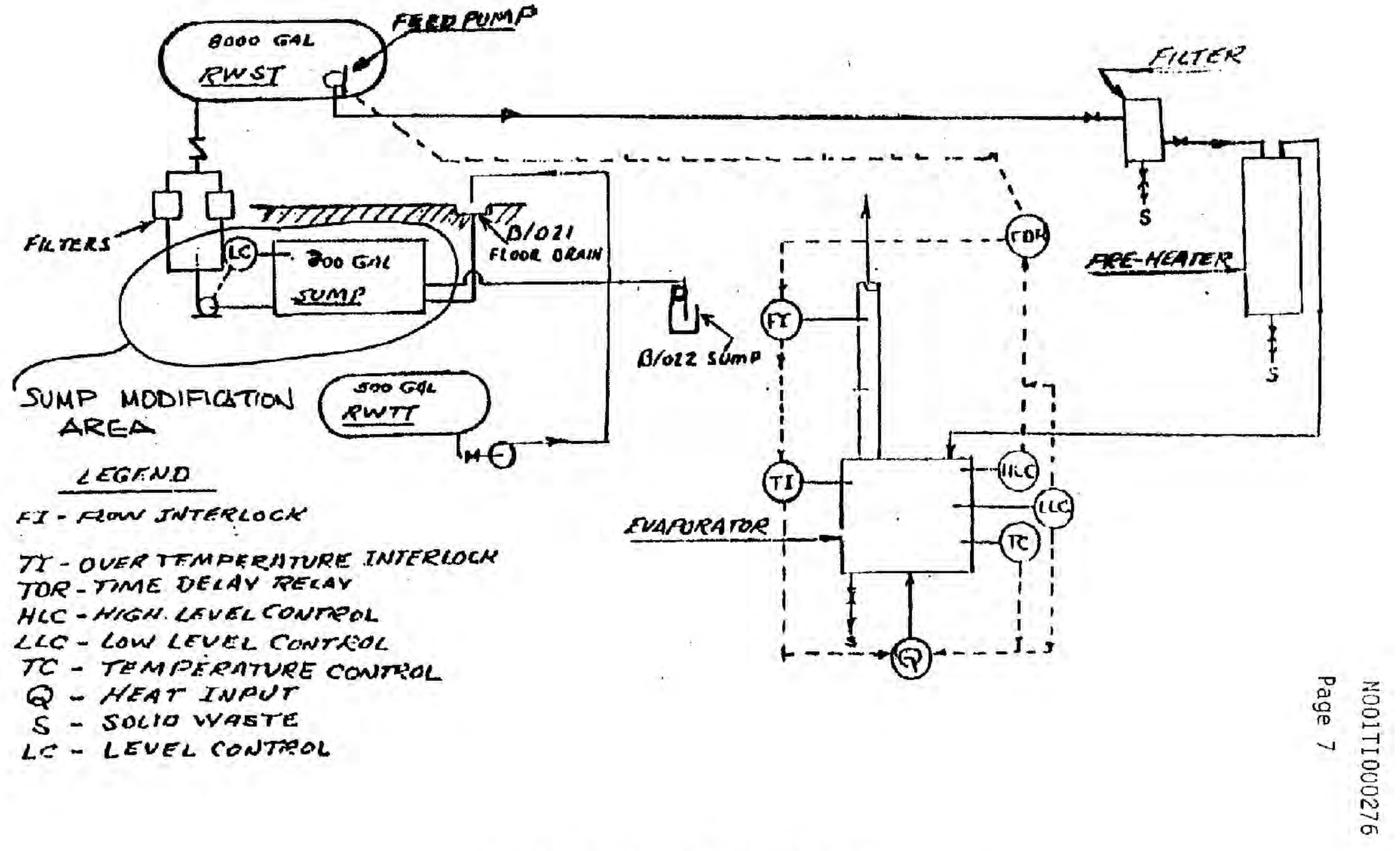
Figure 2.1s
RMFH
Site Map

Redacted



RMDF Radioactive Water System

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Revised: 07/14/11 TB
Source: Boeing Company, 2008

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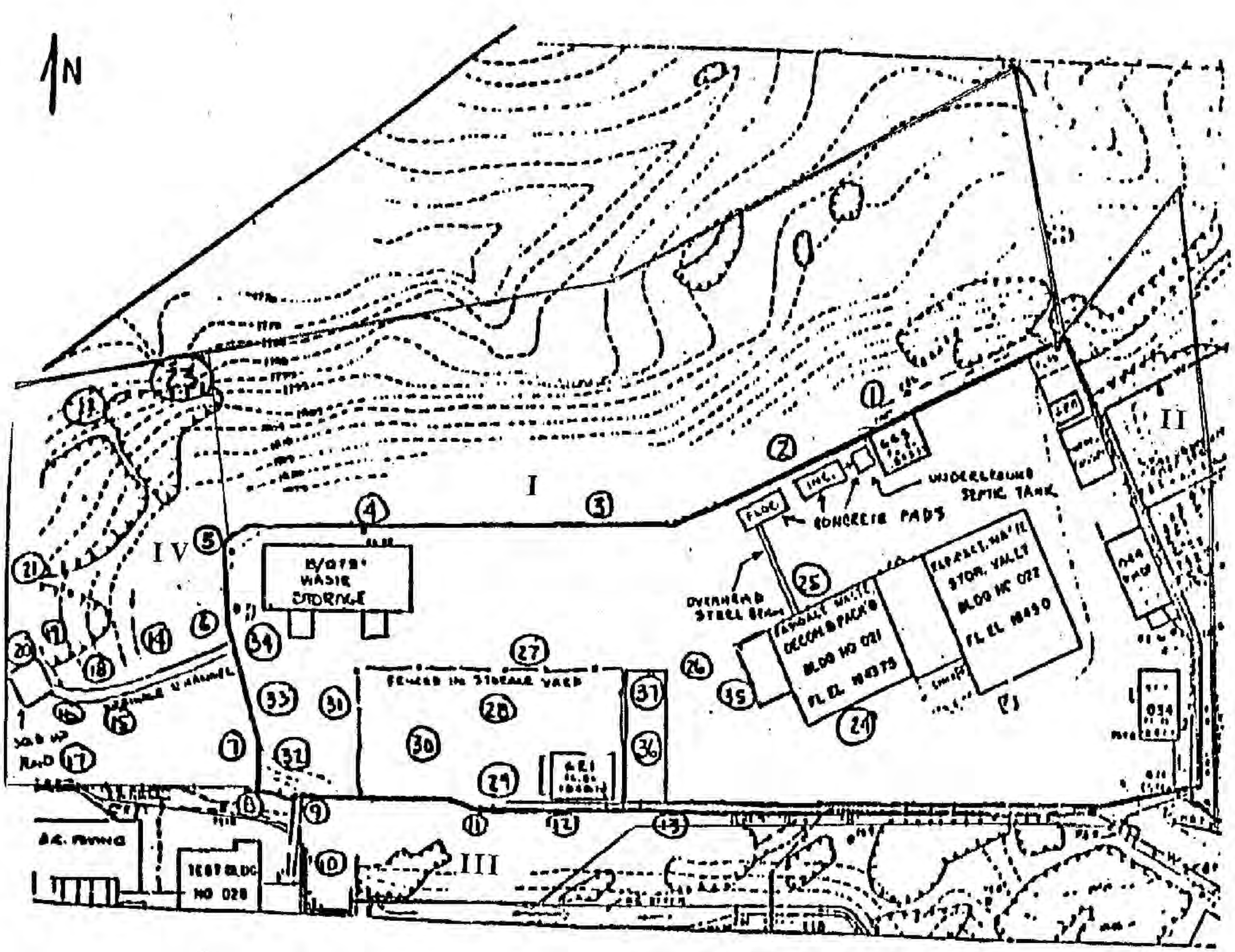
Figure 2.1t
RMHF
Radioactive
Water System



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Source: Boeing Company, 2008

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Figure 2.1u
Rockwell Environmental Survey Map 1981

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Project:EP9038
Revised: 07/08/11 TJ
Source: Boeing Company, 2008

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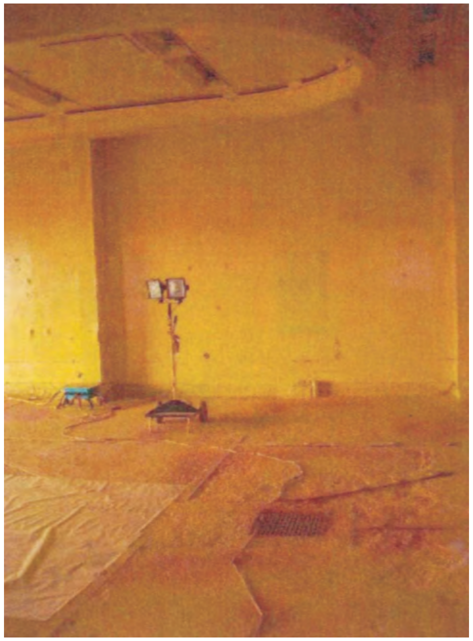
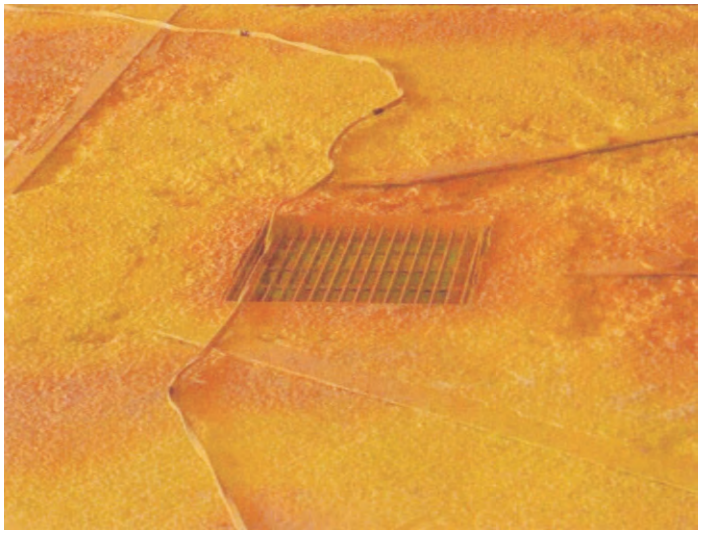
Figure 2.1v
Building 4021
Western Exterior,
Former T-1 Location,
Current Sump and
Substation Location





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Revised: 07/08/11 TJ
Source: Boeing Company, 2008

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Figure 2.1w
Building 4021
Decontamination
Room Sump
Photograph 2009

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Project:EP9038
Revised: 07/08/11 TJ
Source: Boeing Company, 2008

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Figure 2.1x
Building 4021
Packaging Room
Sump Photograph
2009

Redacted

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Project:EP9038
Revised: 07/08/11 TJ
Source: Boeing Company, 2008

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Figure 2.1y
Filter/Blower Area With Trenches and North Slope Drainage Photograph 2009

Redacted

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Project:EP9038
Revised: 07/08/11 TJ
Source: Boeing Company, 2008

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**Figure 2.1z
RMHF Northern Drainage Swale Photographs 2009**

*\\az-srv-02\SharedGraphics\Phoenix\Graphics\
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Revised: 06/29/11 TJ
Source: Boeing Company, 2008*

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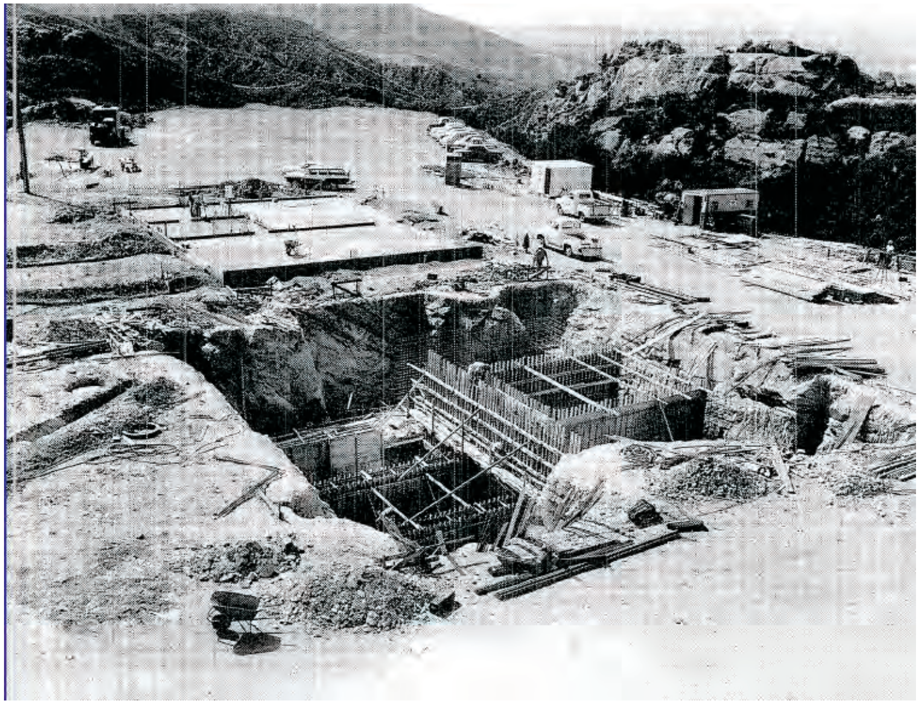
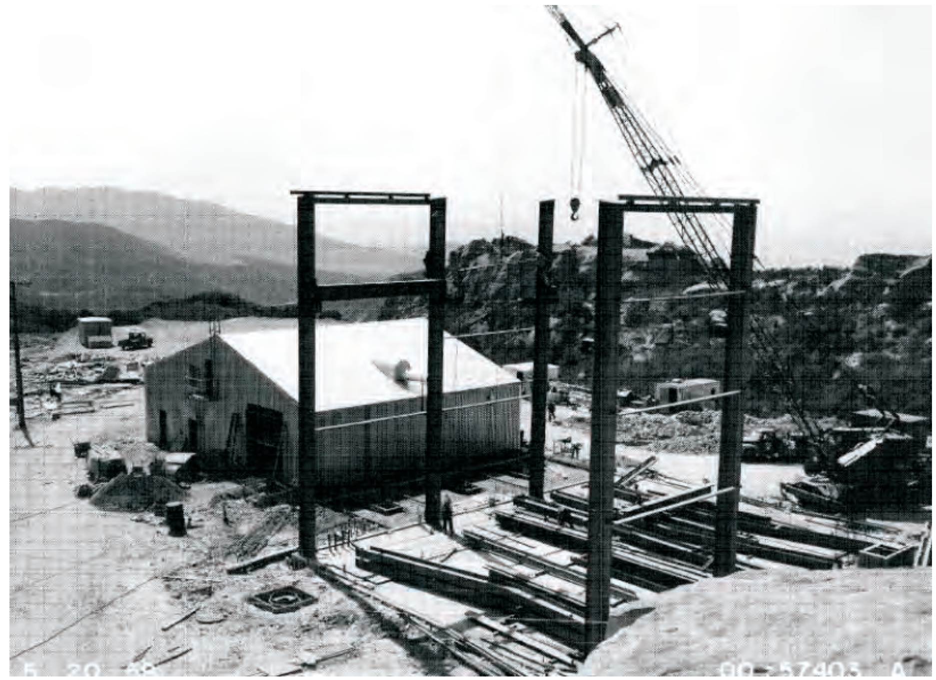
**Figure 2.2a
Building 4022
Site Photograph**

Redacted





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Source: Boeing Company, 2008

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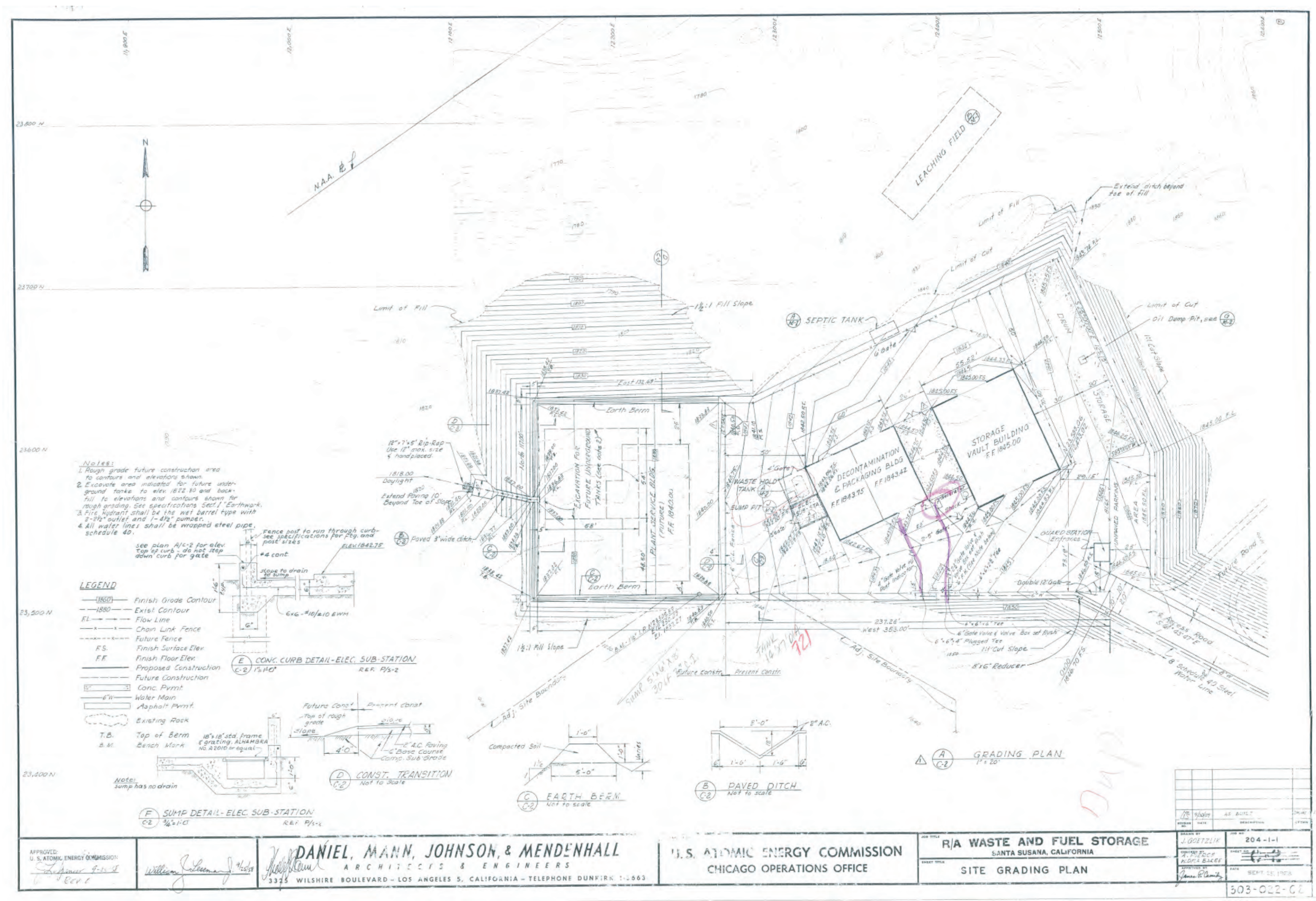
Figure 2.2b
Building 4022
Construction
Photographs
1959

Redacted



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Source: Boeing Company, 2008

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Figure 2.2c
Building 4022
Site Grading
Plan

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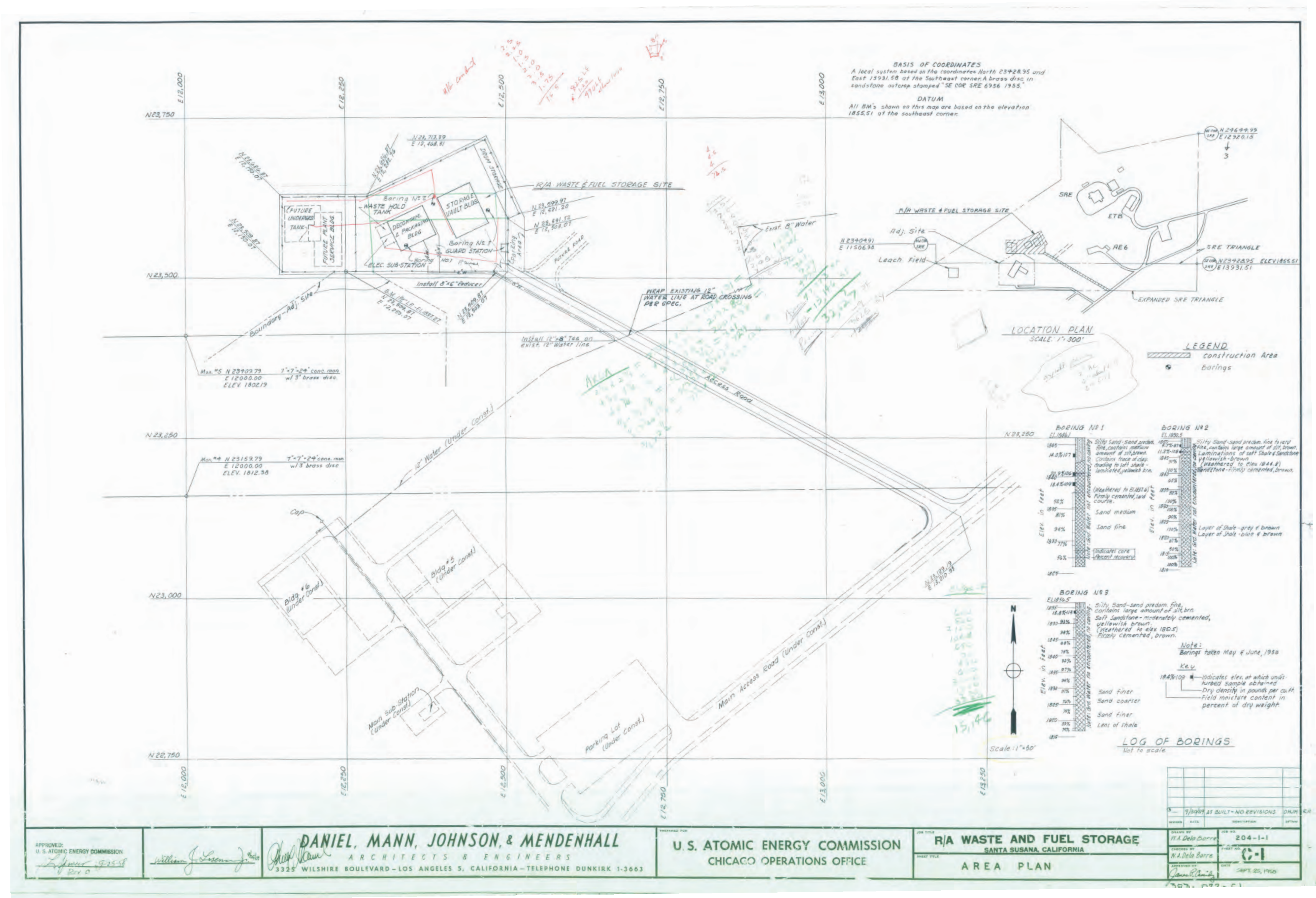

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Source: Boeing Company, 2008

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**Figure 2.2d
Building 4022
Area Plan**

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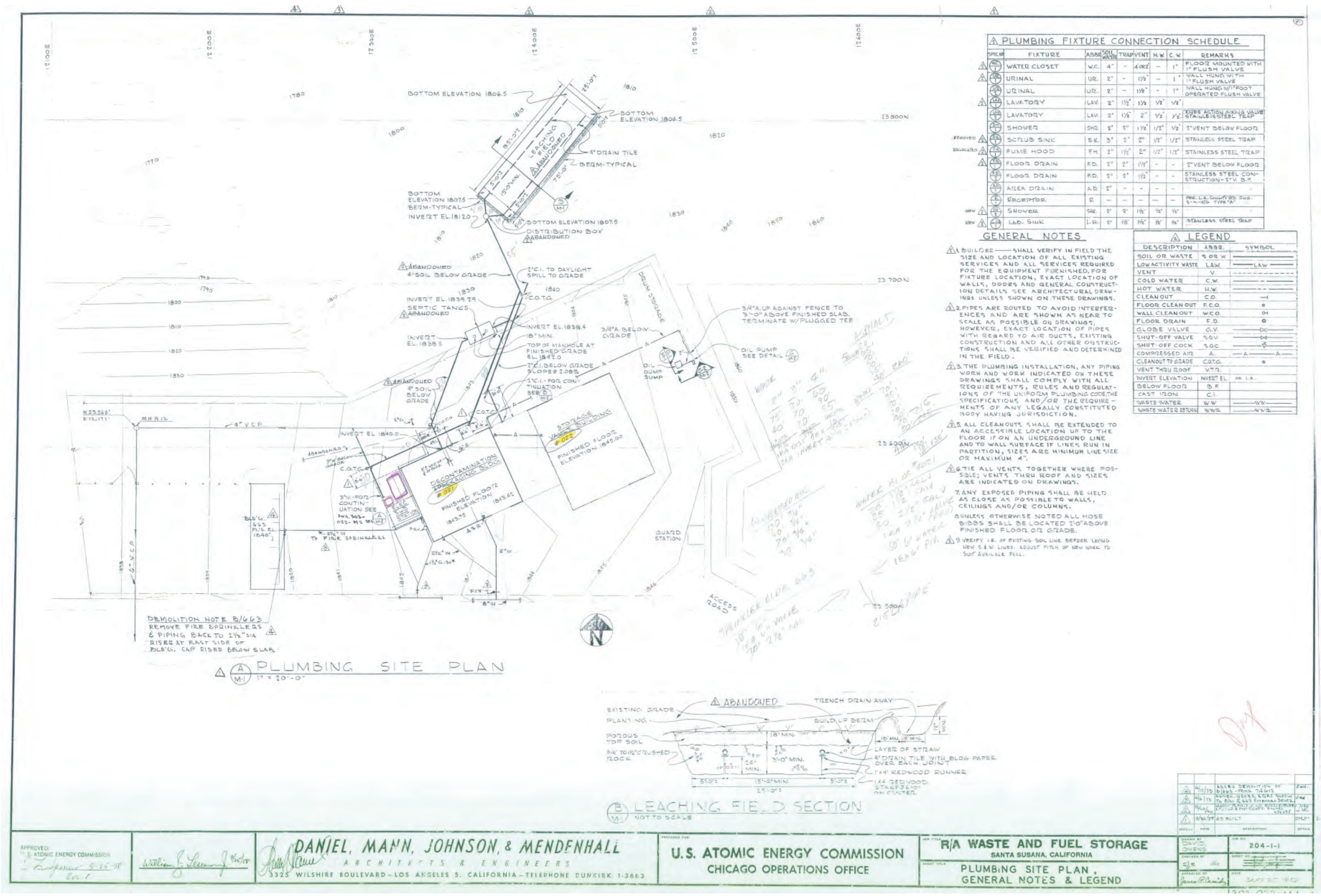

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Revised: 06/29/11 TJ
Source: Boeing Company, 2008

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Figure 2.2e
Building 4022
Site Plumbing
Plan

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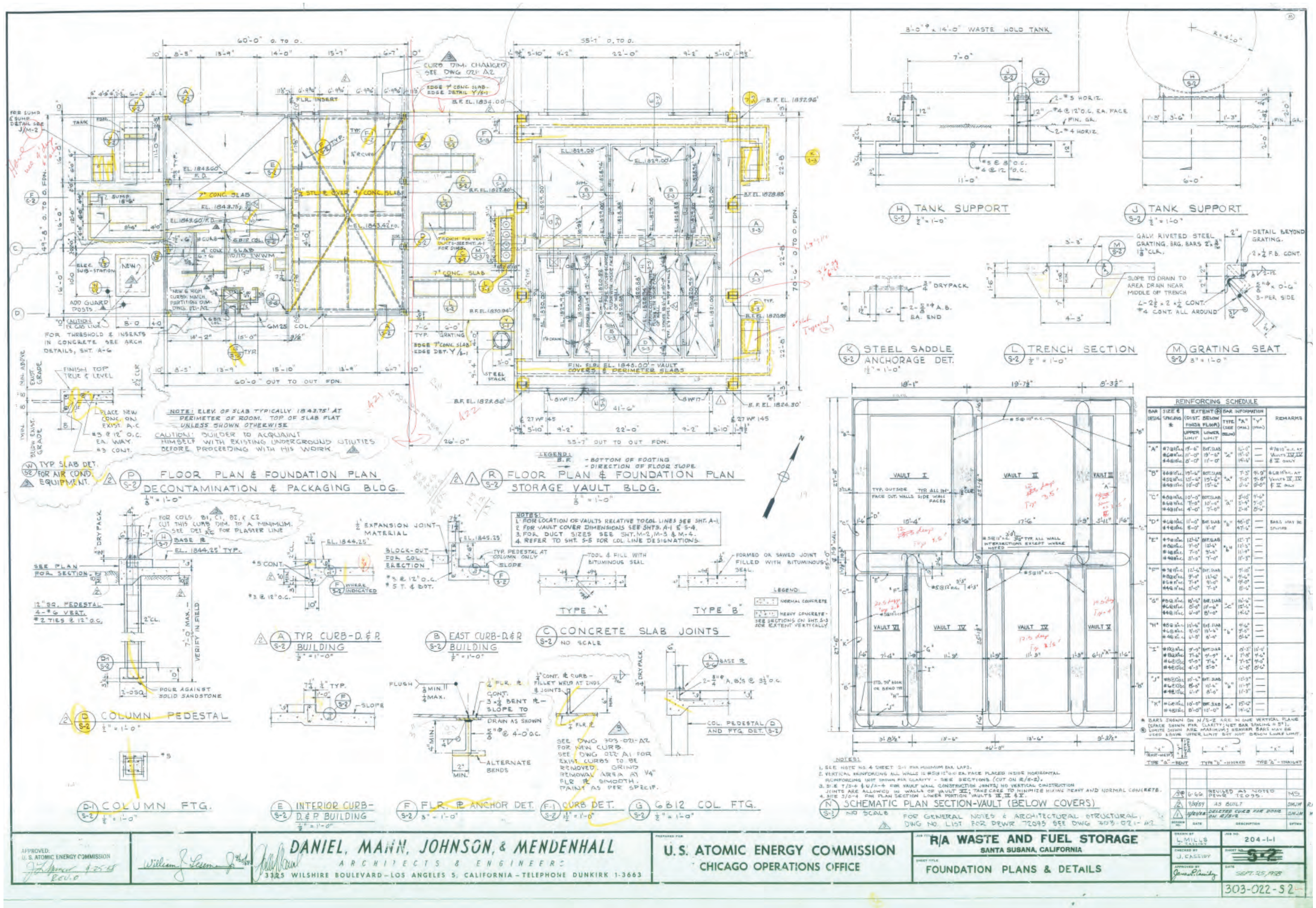

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Source: Boeing Company, 2008

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Figure 2.2f
Building 4022
Foundation Plan

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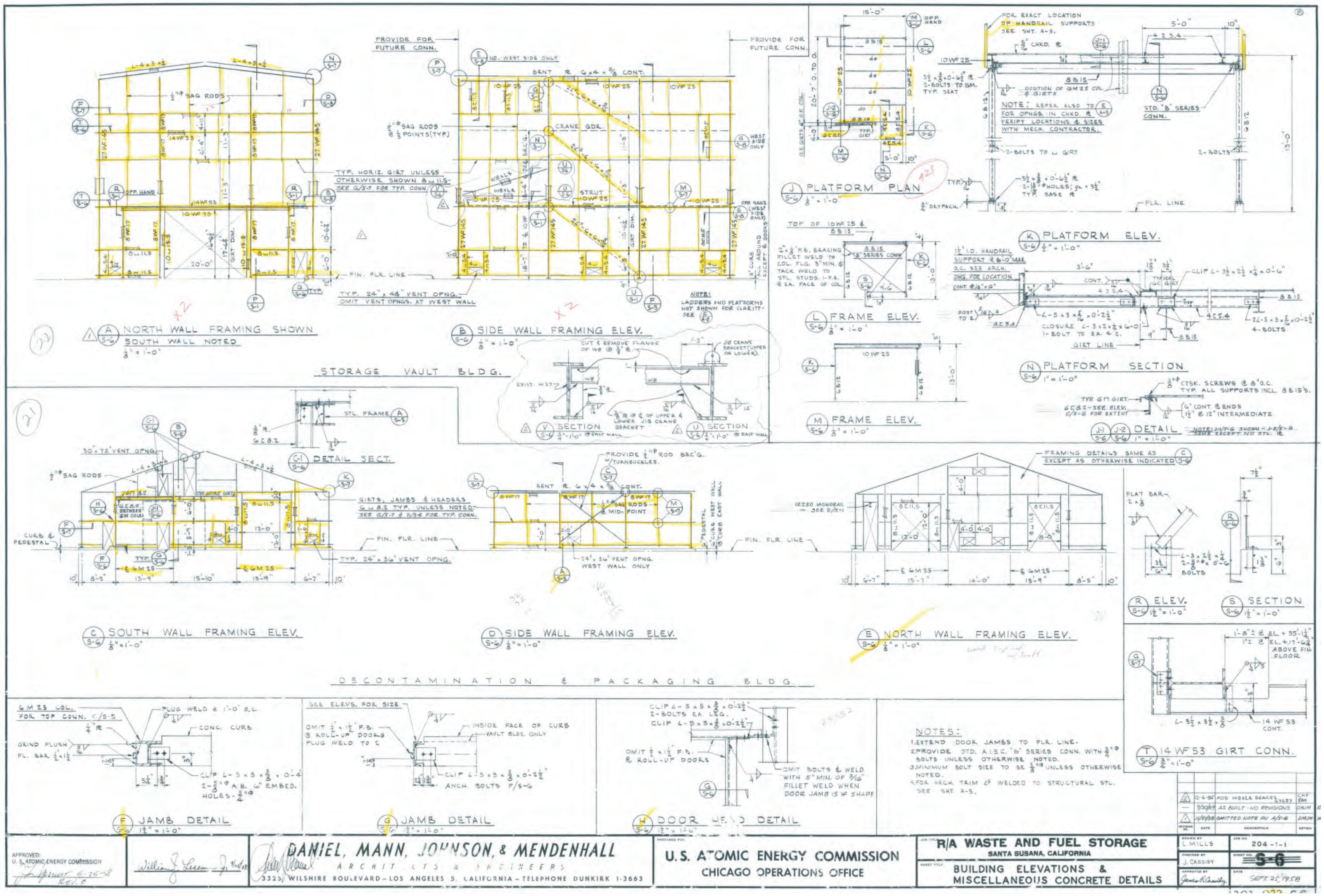

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Figure 2.2g
Building 4022
Framing Plan

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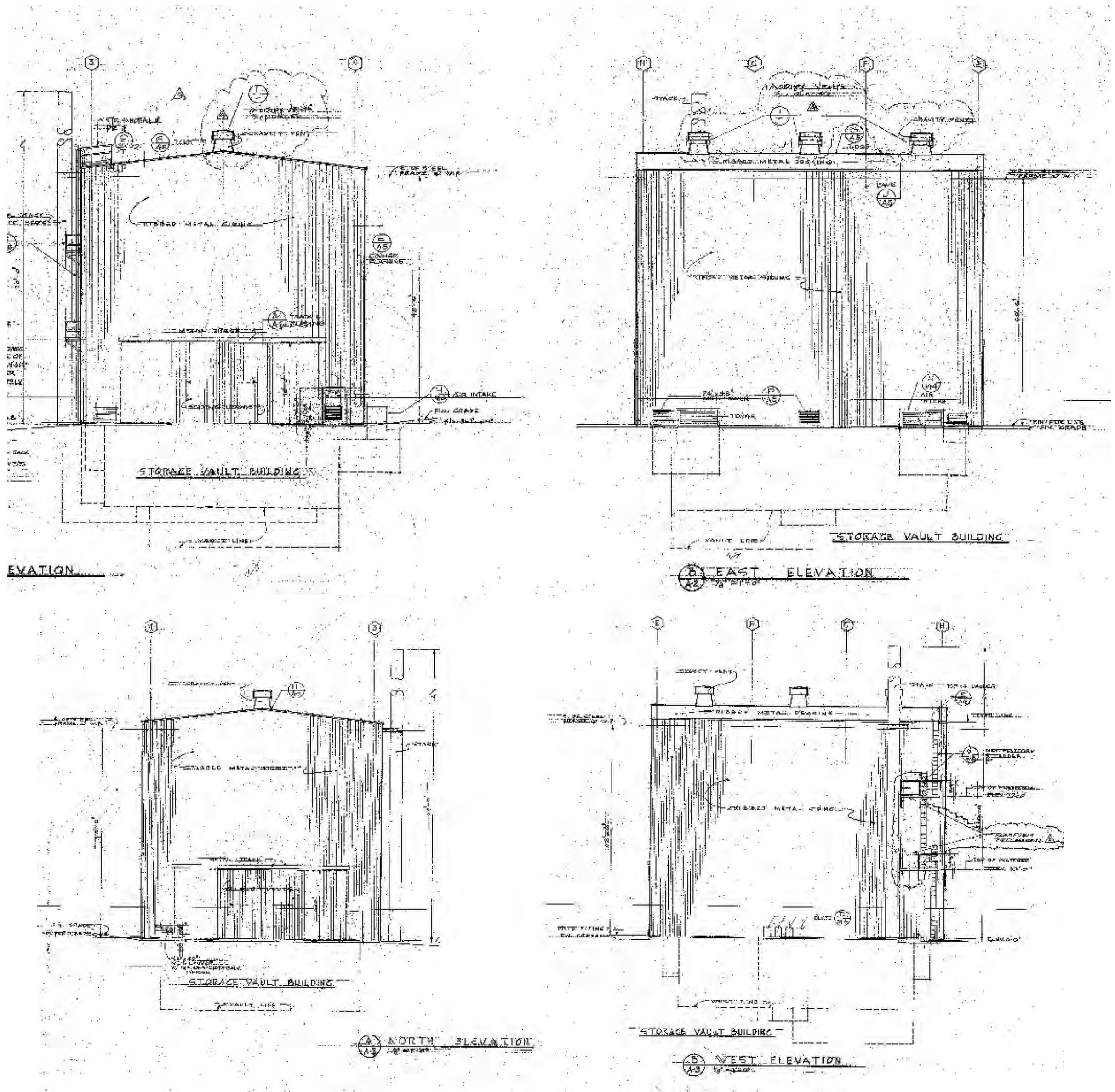

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Figure 2.2h
Building 4022
Elevations

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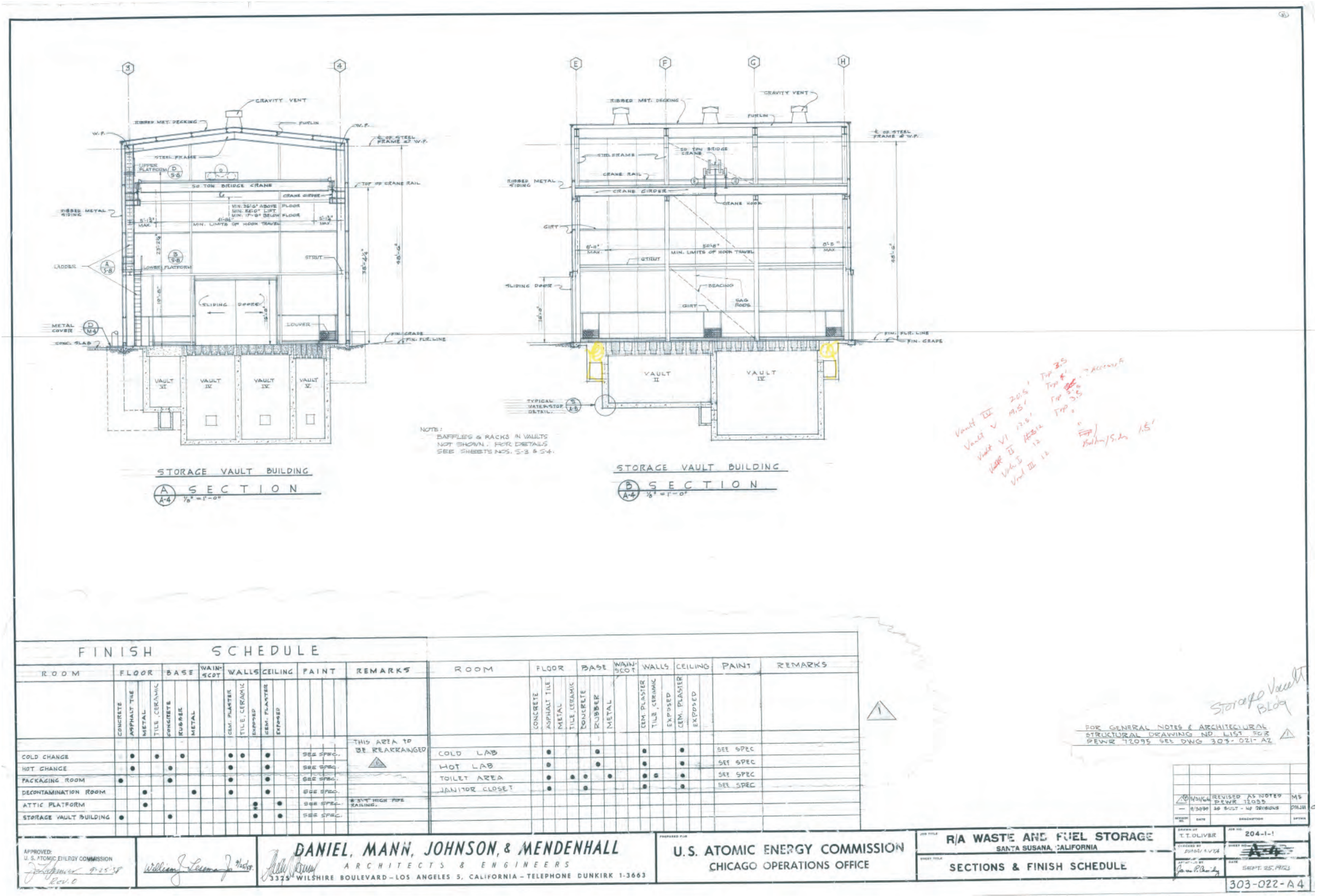

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Source: Boeing Company, 2008

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Figure 2.2i
Building 4022
Section View

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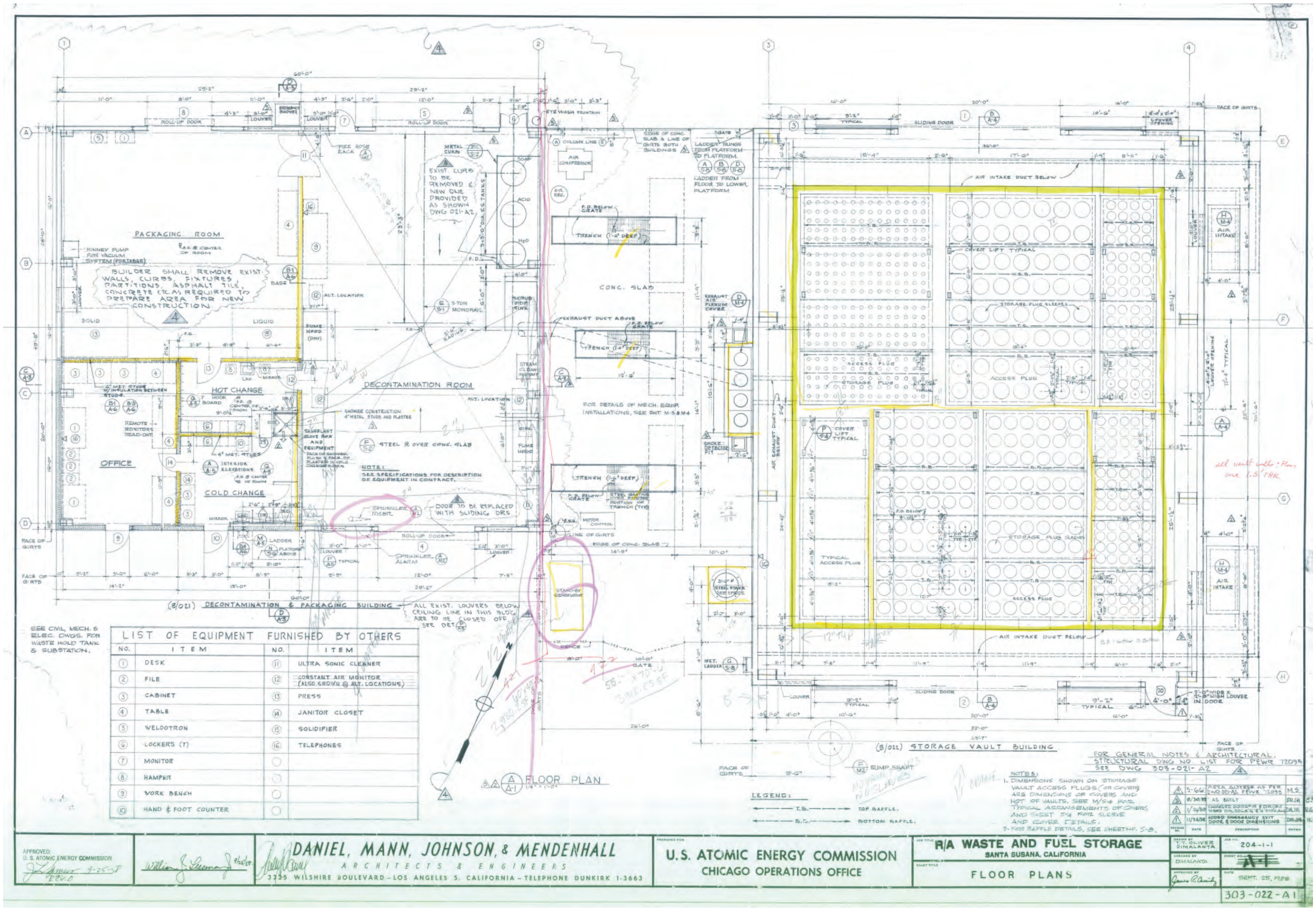

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Revised: 06/29/11 TJ
Source: Boeing Company, 2008

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Figure 2.2j
Building 4022
Floor Plan

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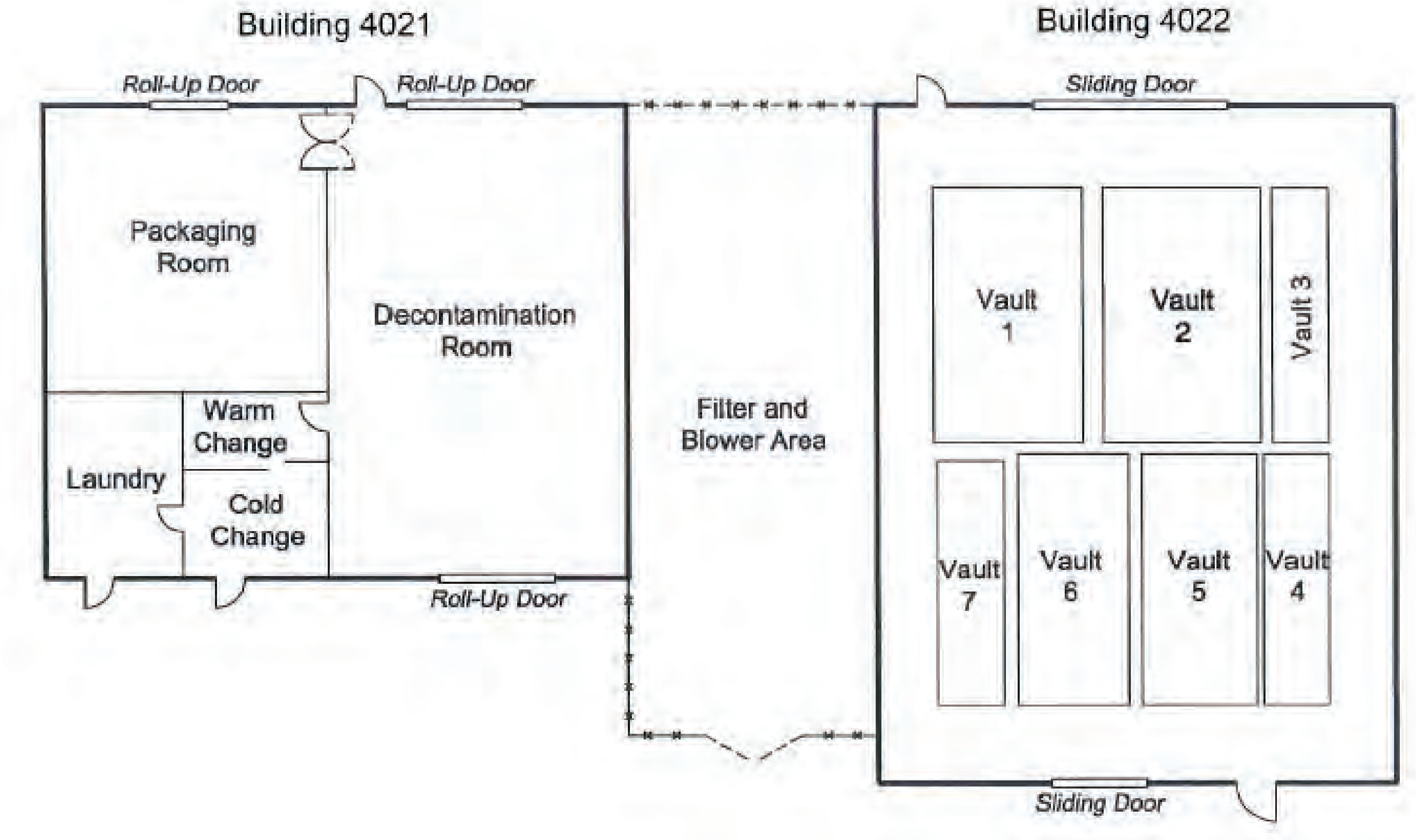

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Source: Boeing Company, 2008

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**Figure 2.2k
Building 4022
Floor Plan
Schematic Layout**

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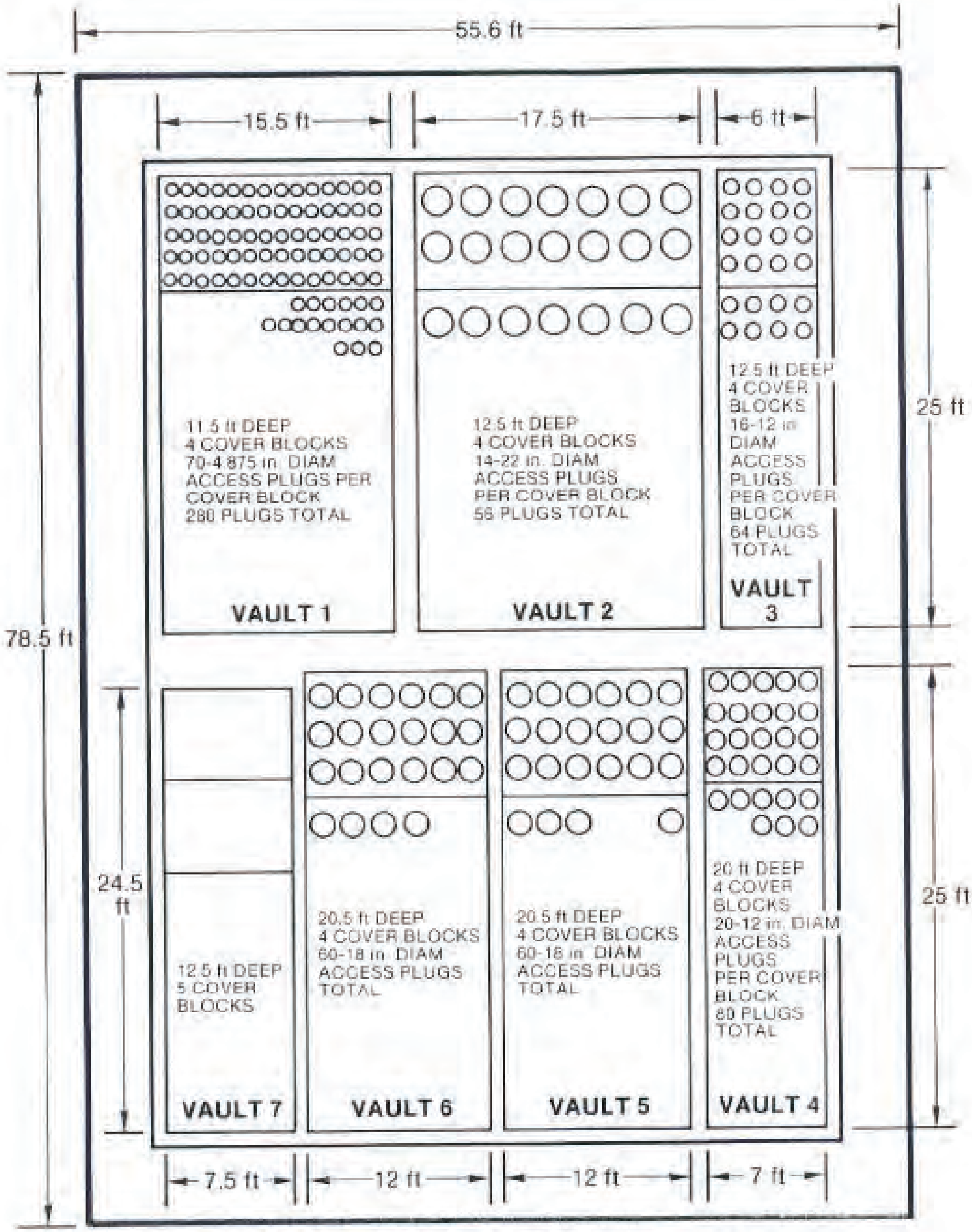

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Revised: 07/14/11 TB
Source: Boeing Company, 2008

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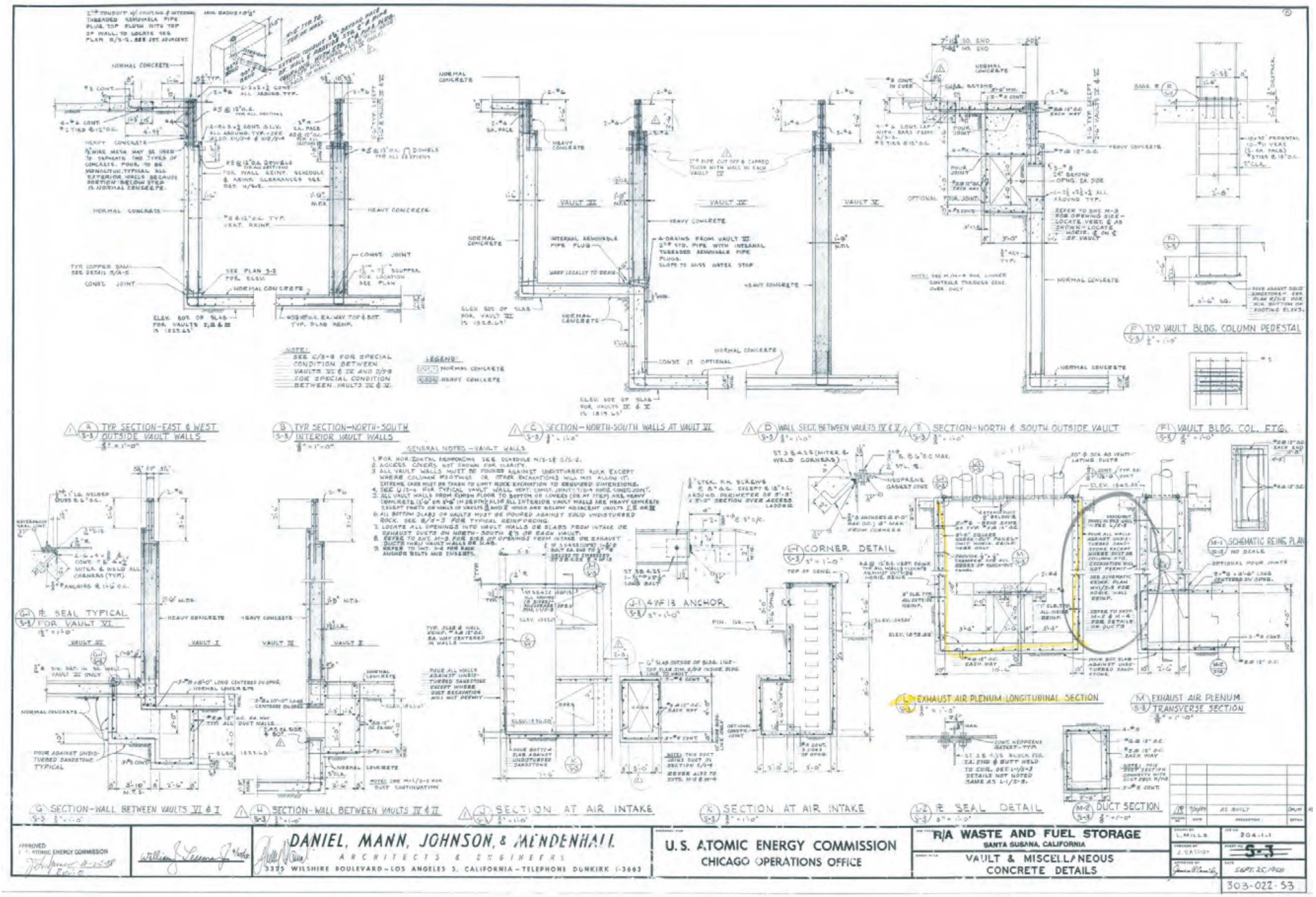
Figure 2.2l
Building 4022
Floor Plan
Vault Details



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Revised: 06/29/11 TJ
Source: Boeing Company, 2008

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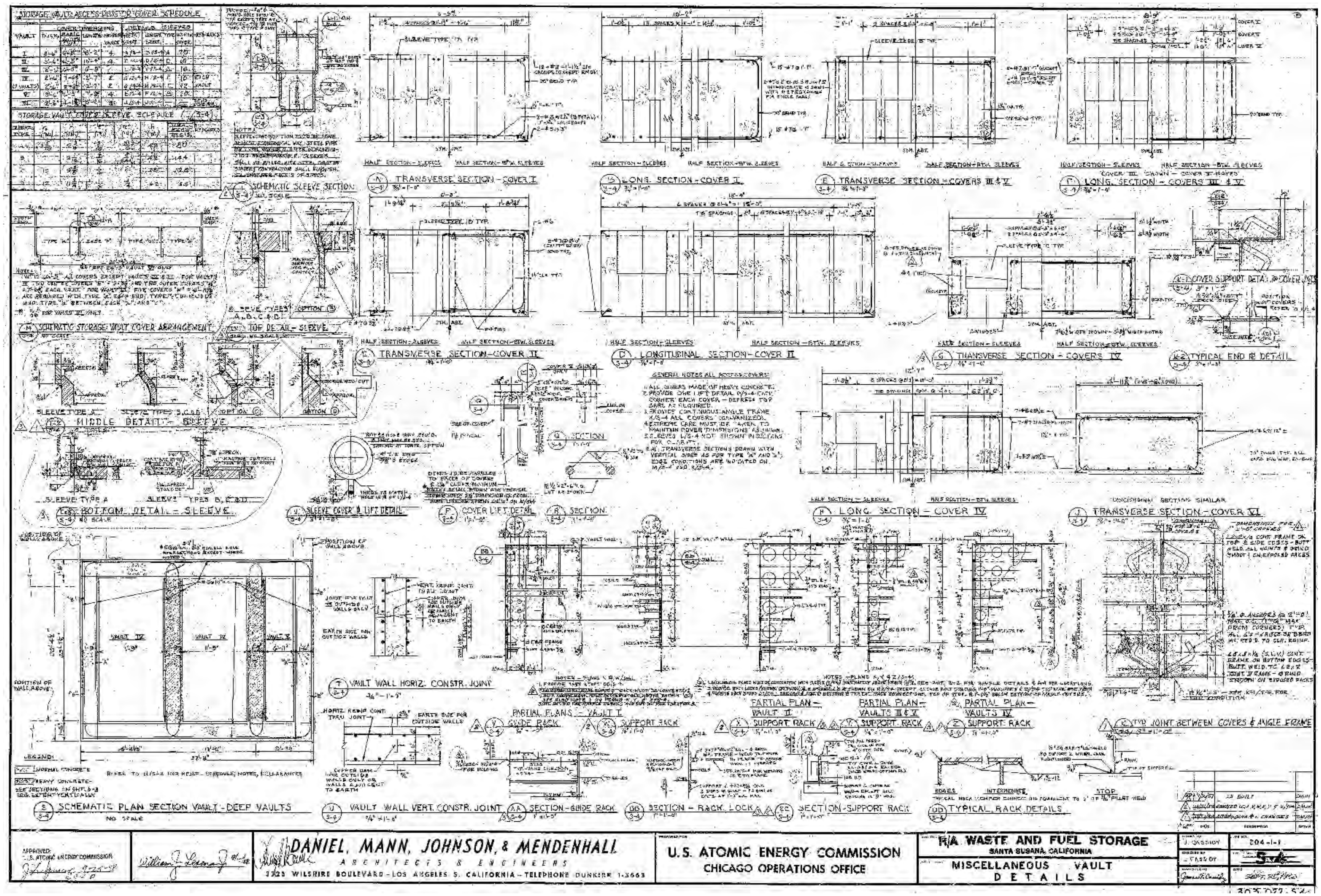
Figure 2.2m
Building 4022
Vault Sections

Redacted



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Source: Boeing Company, 2008

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Figure 2.2n
Building 4022
Miscellaneous
Vault Details

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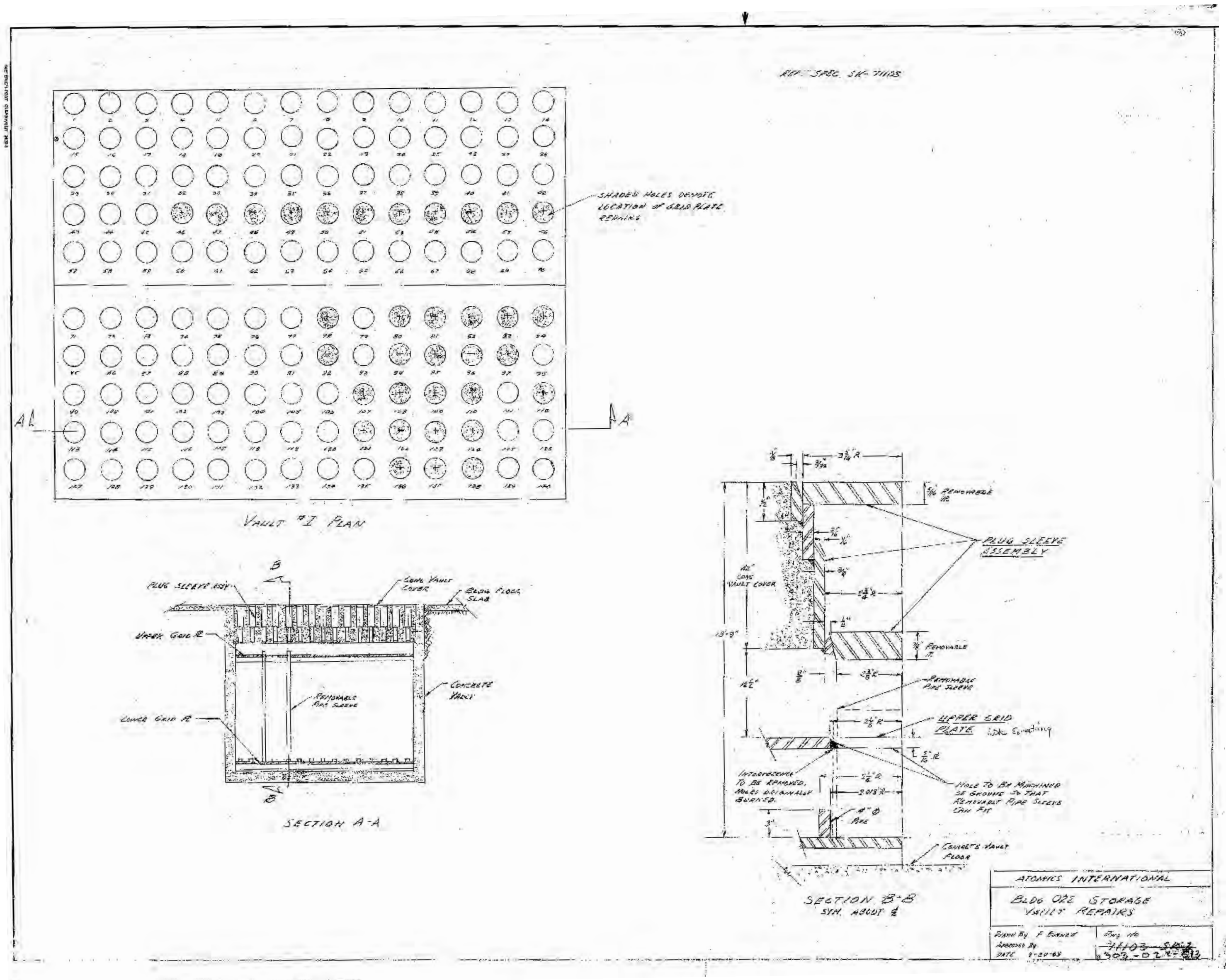

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Revised: 06/29/11 TJ
Source: Boeing Company, 2008

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Figure 2.2o
Building 4022
Vault 1 Plan

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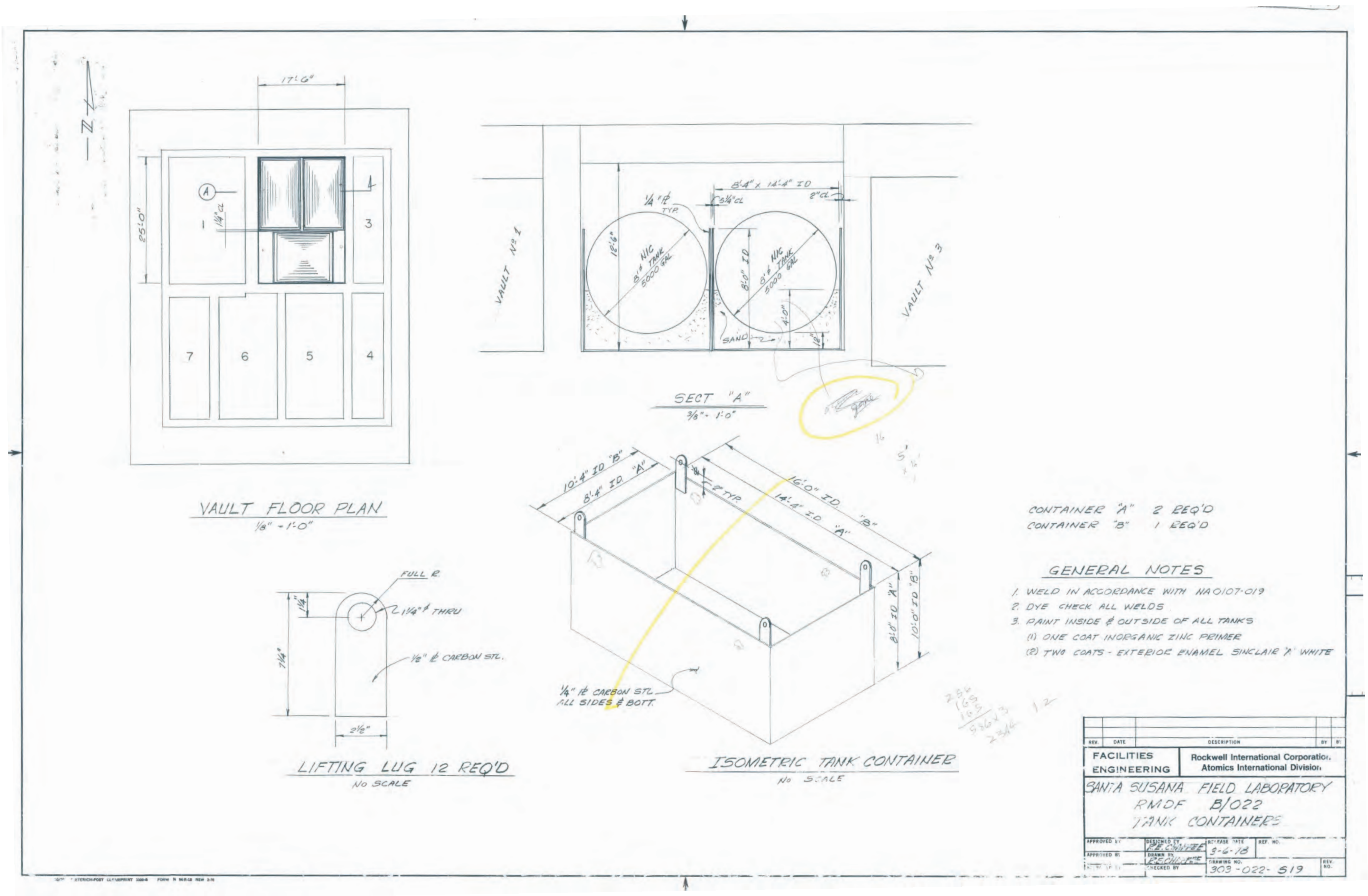

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Project:EP9038
Revised: 06/29/11 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2p
Building 4022
Vault 2 Tanks

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2q
Building 4022
Vault 5
North View

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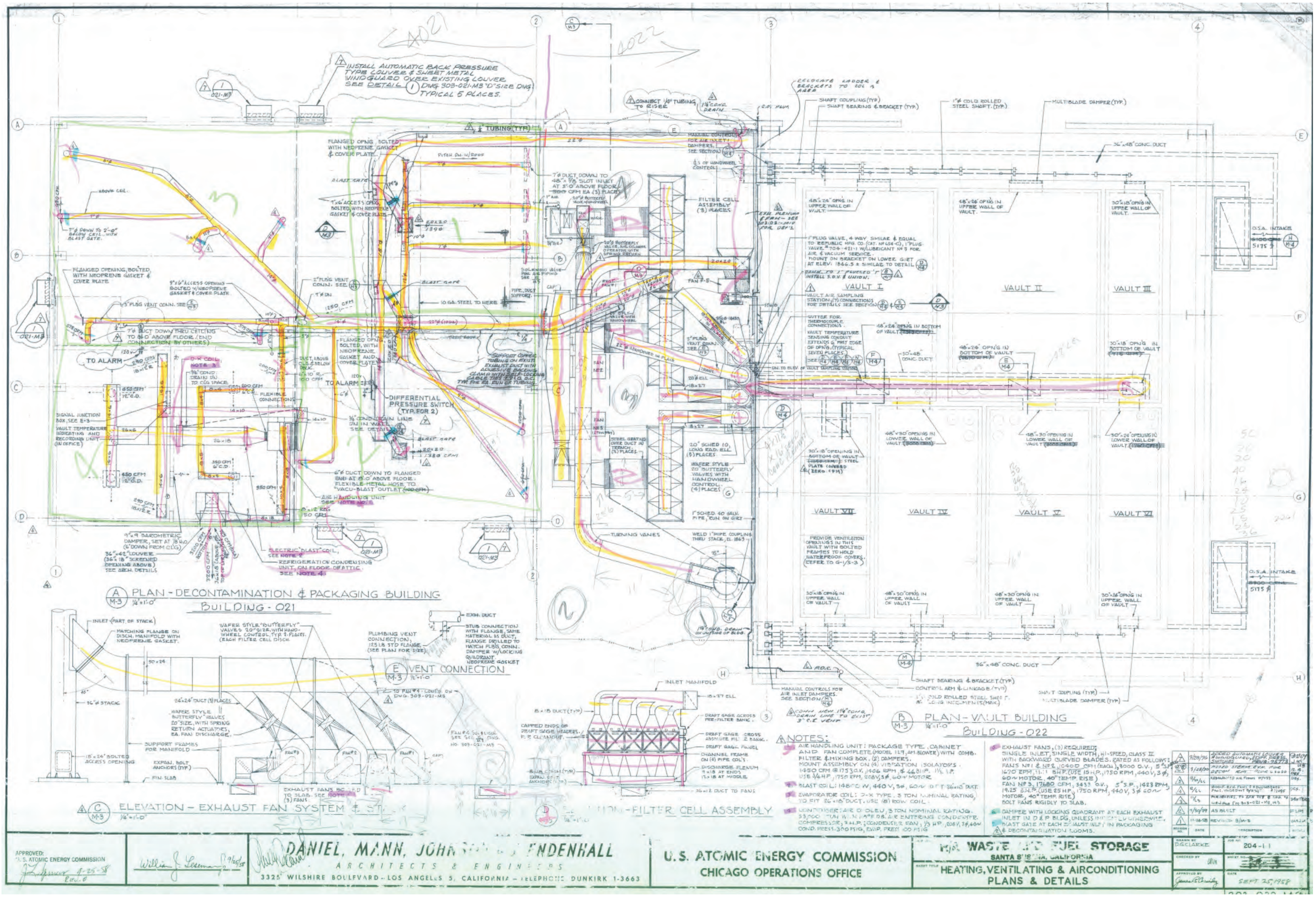

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2r
Building 4022
Heating, Ventilation and Air Conditioning Plan

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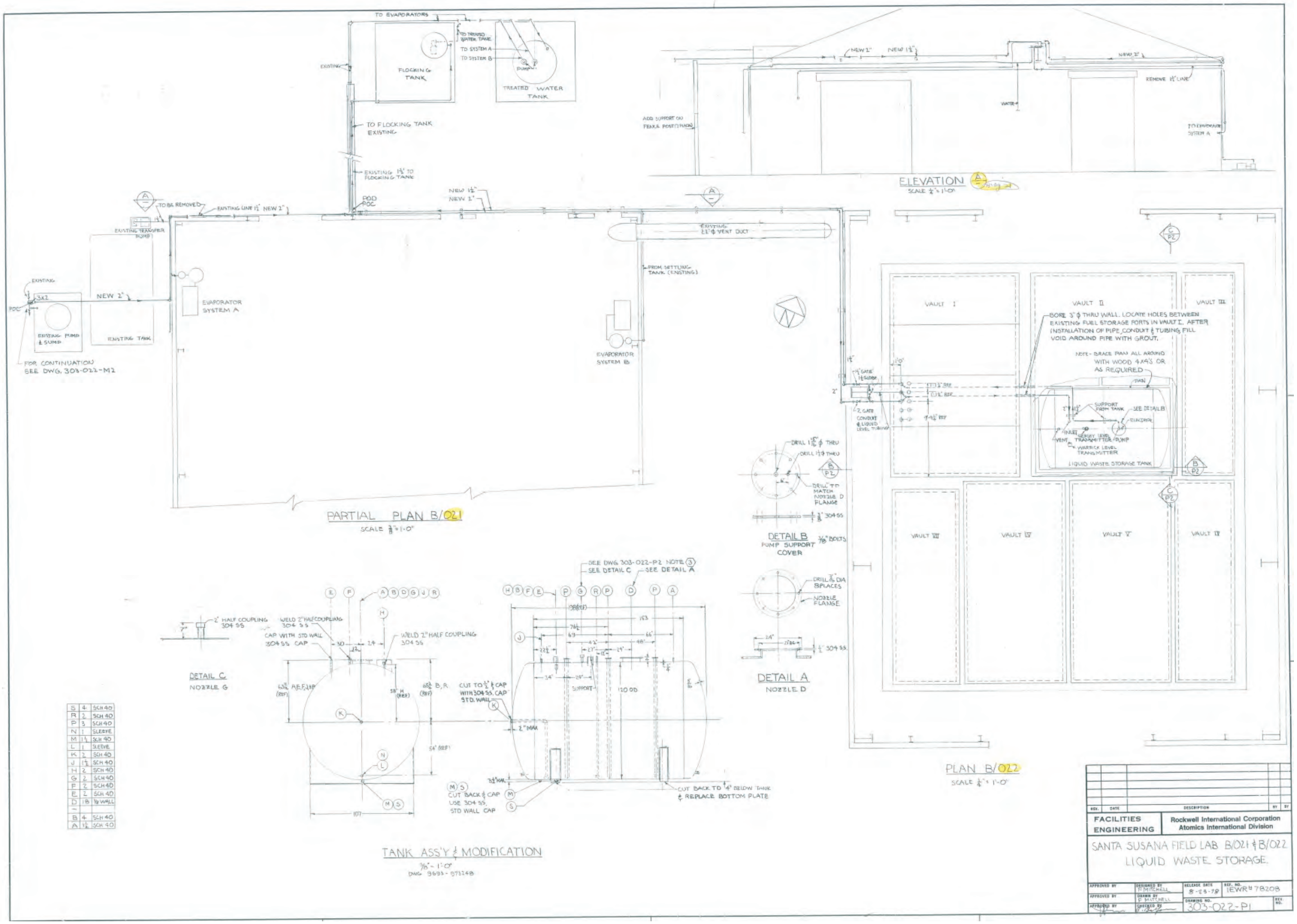

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U.S. EPA Region 9

Figure 2.2s
Building 4022
Liquid Waste
Storage Plan

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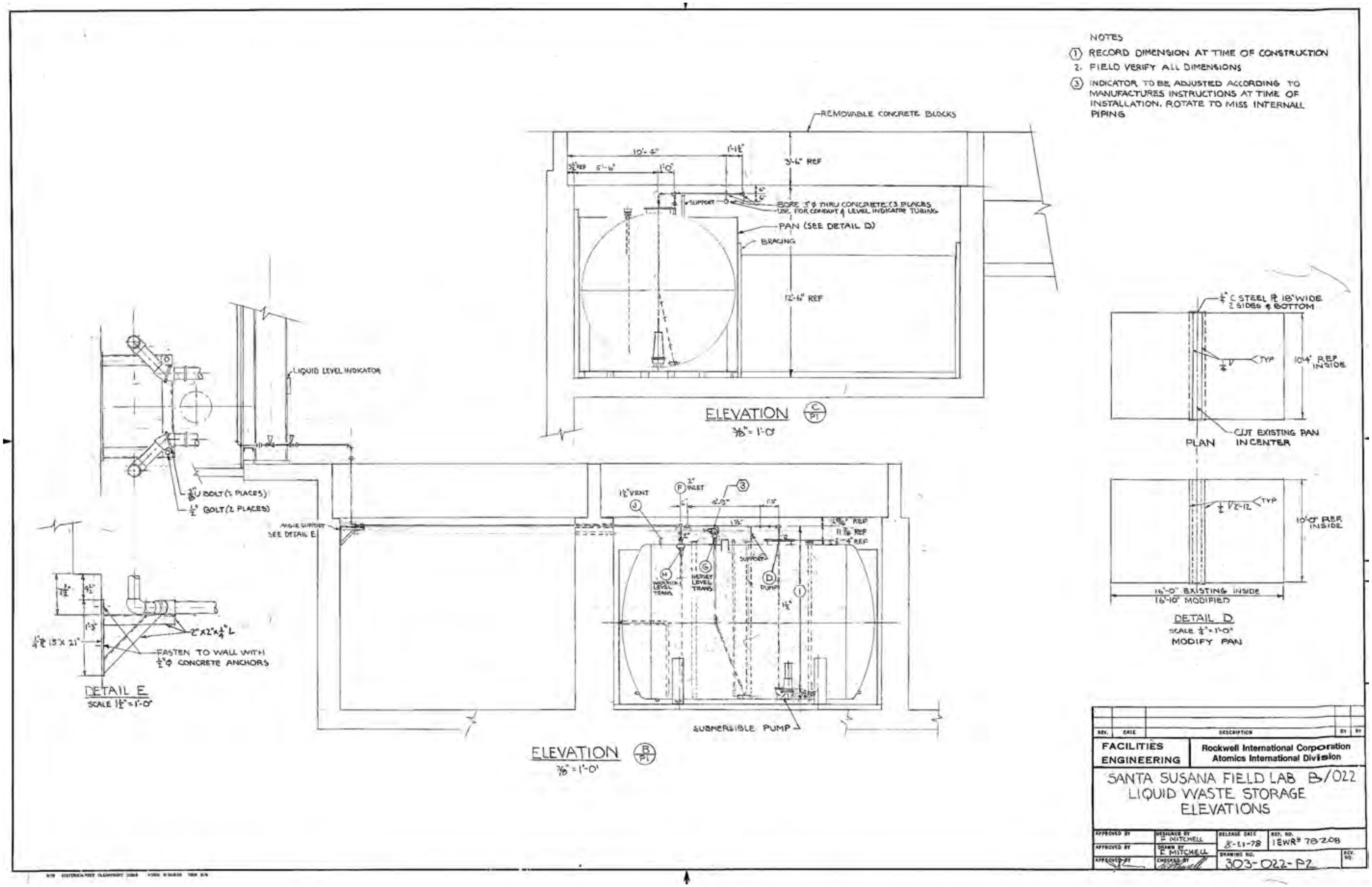

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2t
Building 4022
Liquid Waste Storage
Elevation Plan

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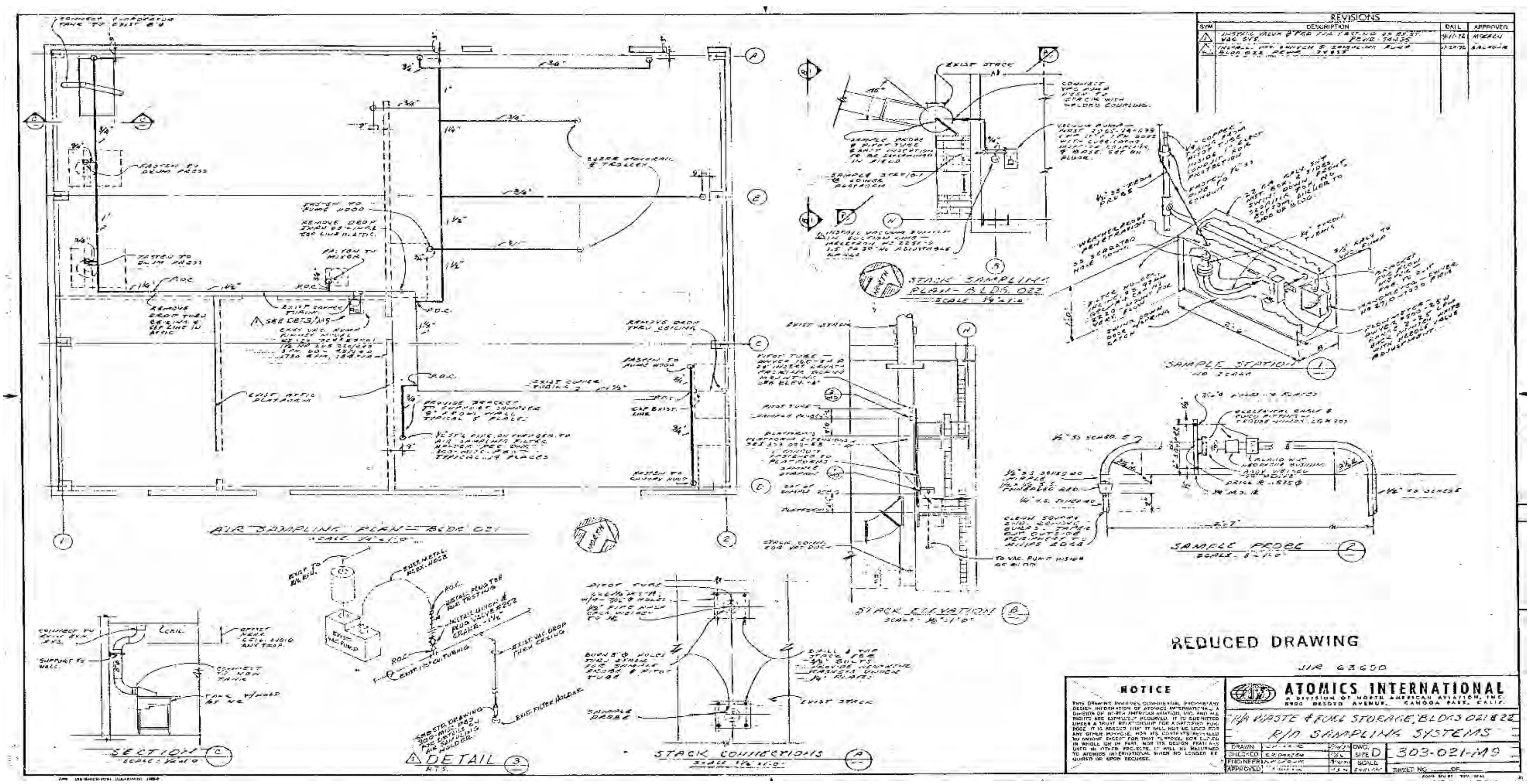

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U.S. EPA Region 9

Figure 2.2u
Building 4022
Radioactive Air Sampling System

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2v
Building 4022
Interior Photograph
2009

Redacted

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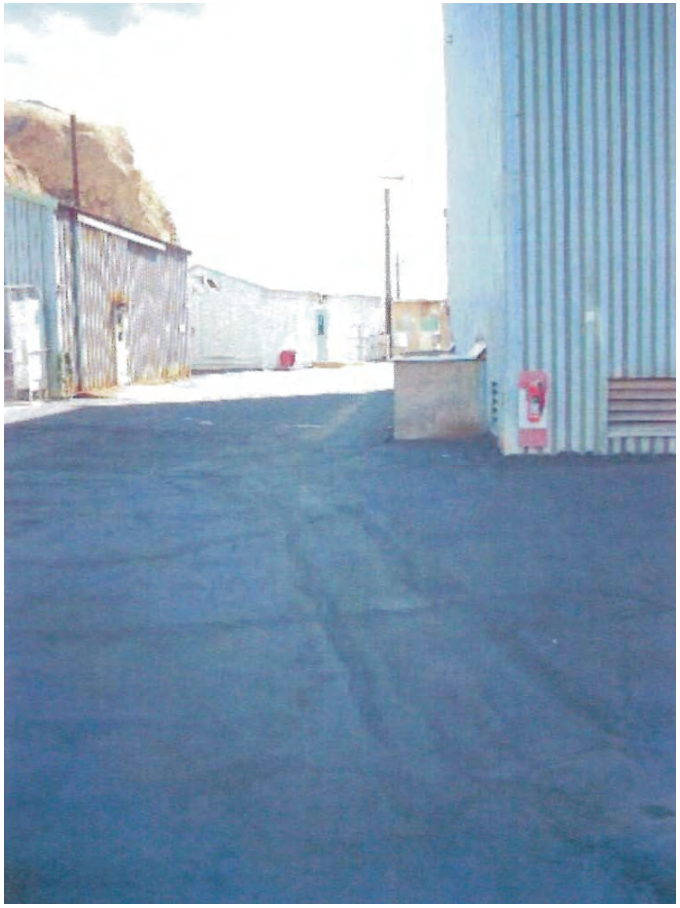
Revised: 07/08/11 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2w
Building 4022
Southwest Exterior
with Sump Location
Photograph 2009



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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2x
Building 4022
Surface Drainage
Photographs 2009

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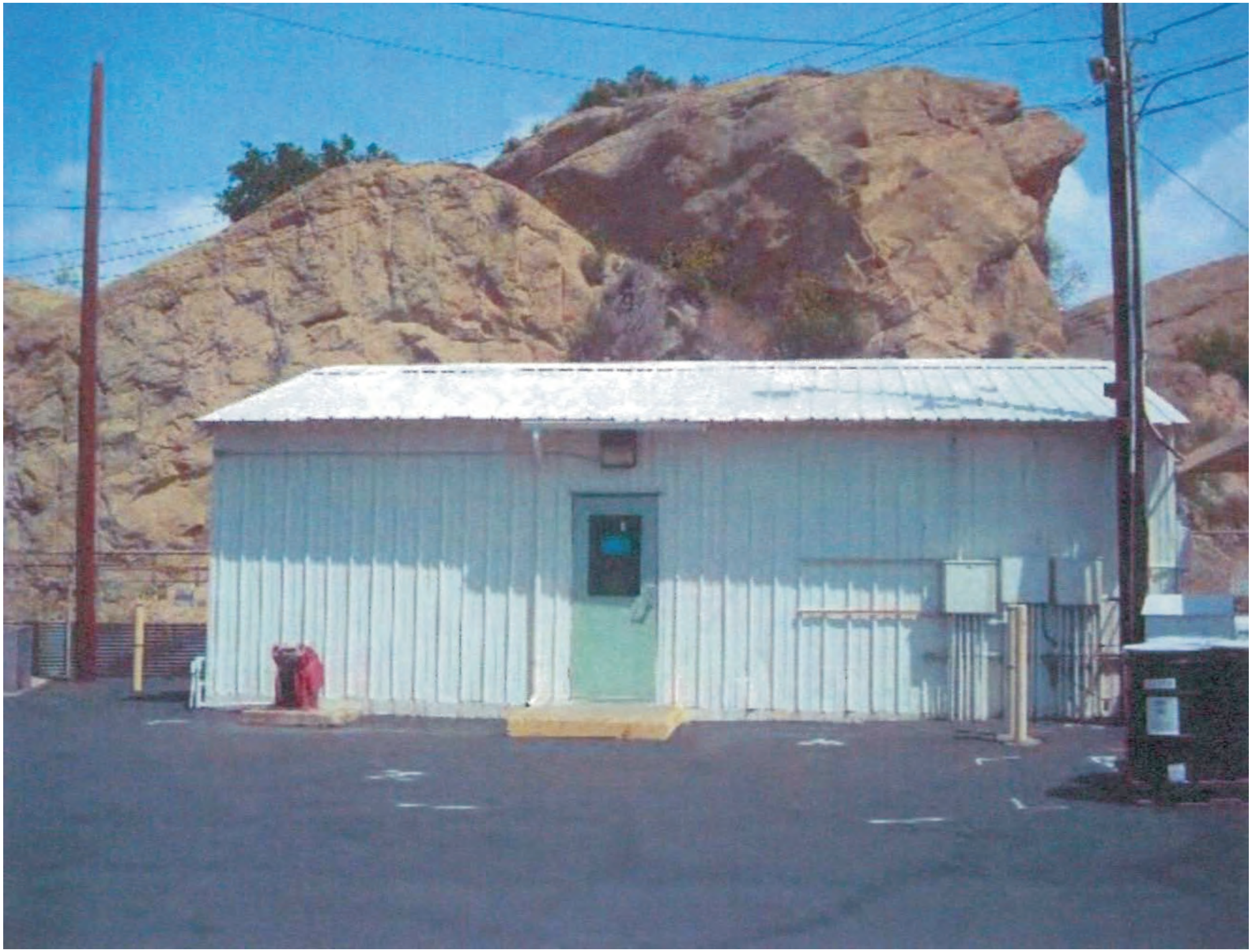

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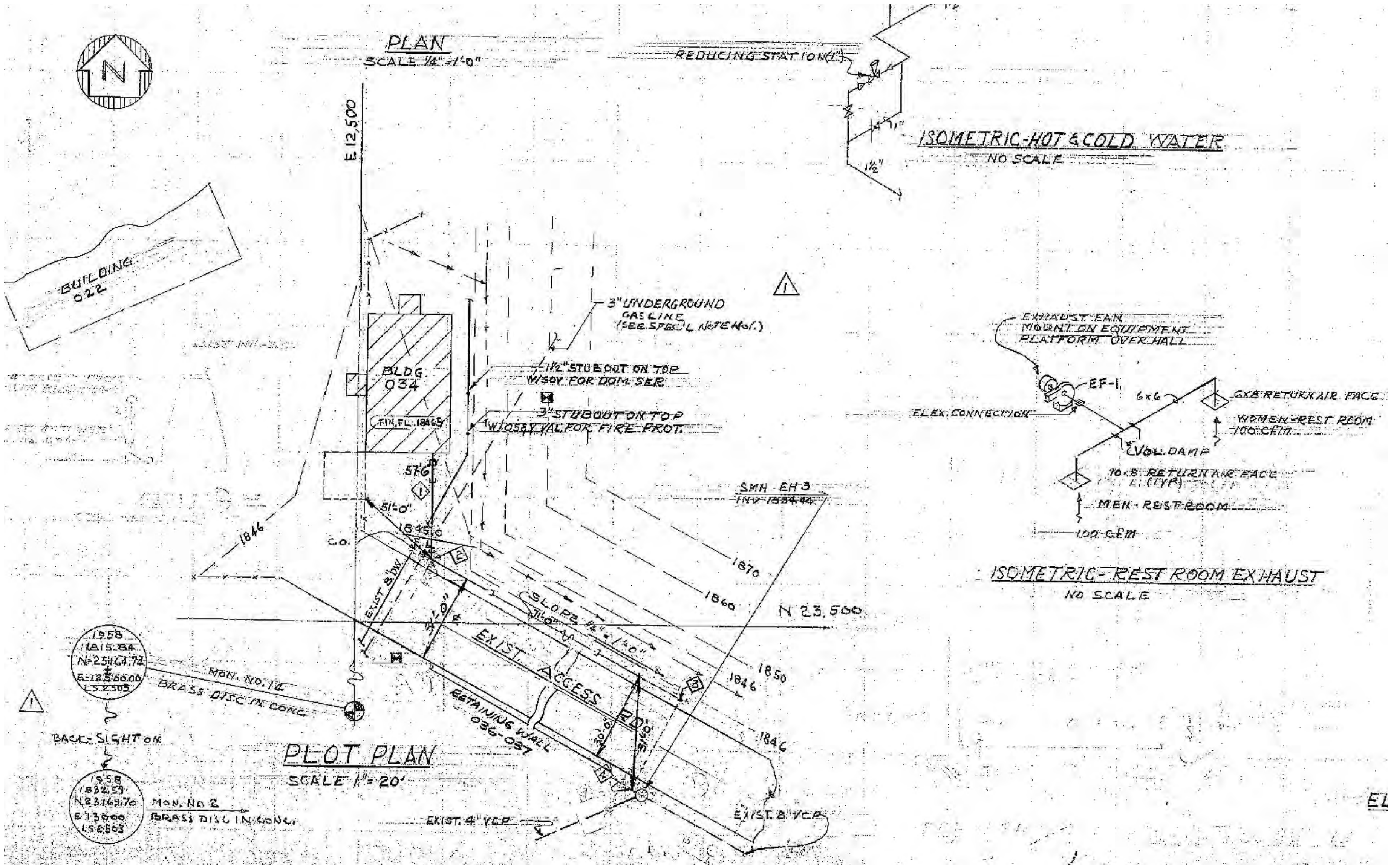
U.S. EPA Region 9

Figure 2.3a
Building 4034
Site Photograph



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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.3b
Building 4034
Plot Plan

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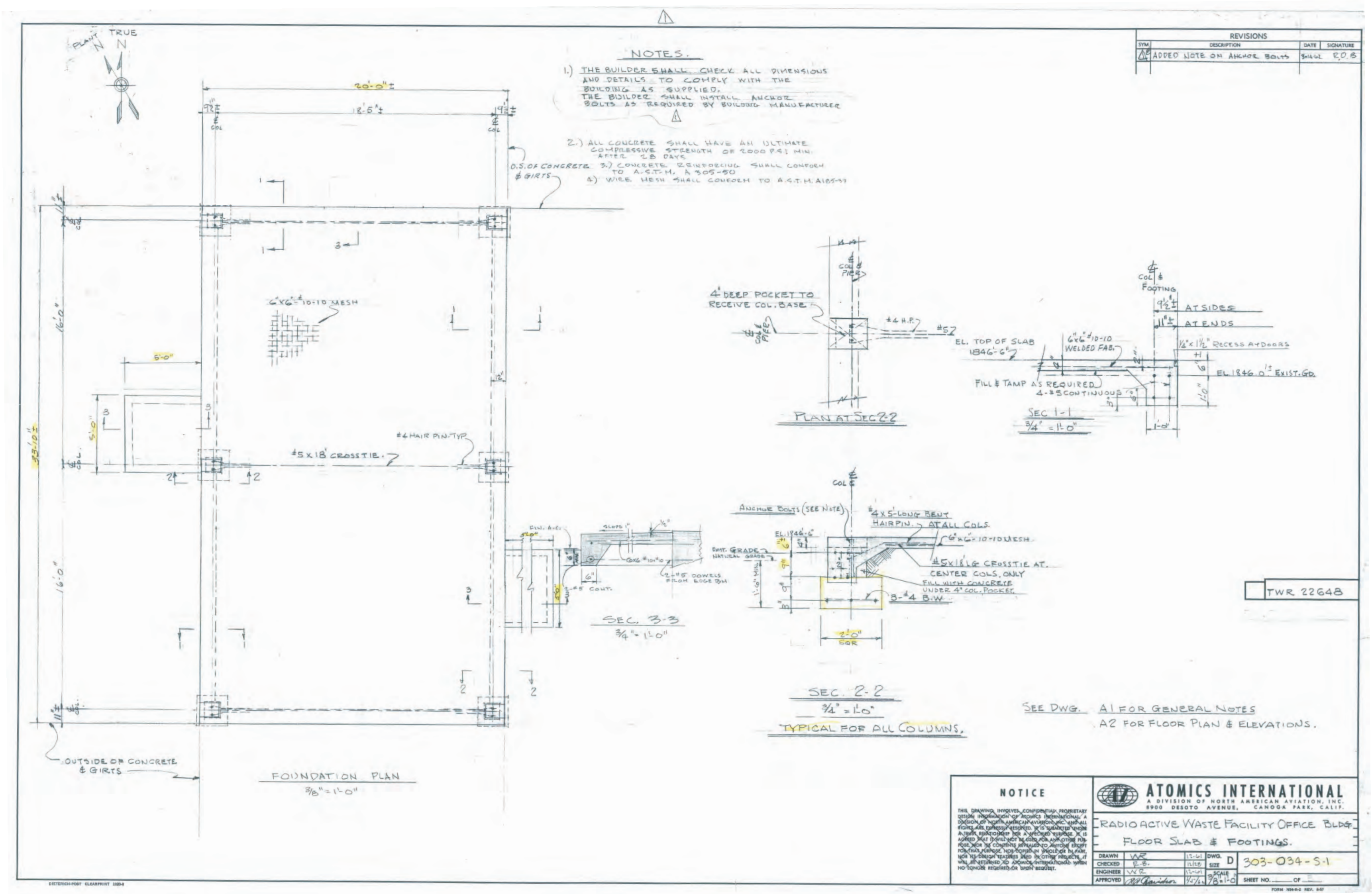

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.3c
Building 4034
Foundation Plan

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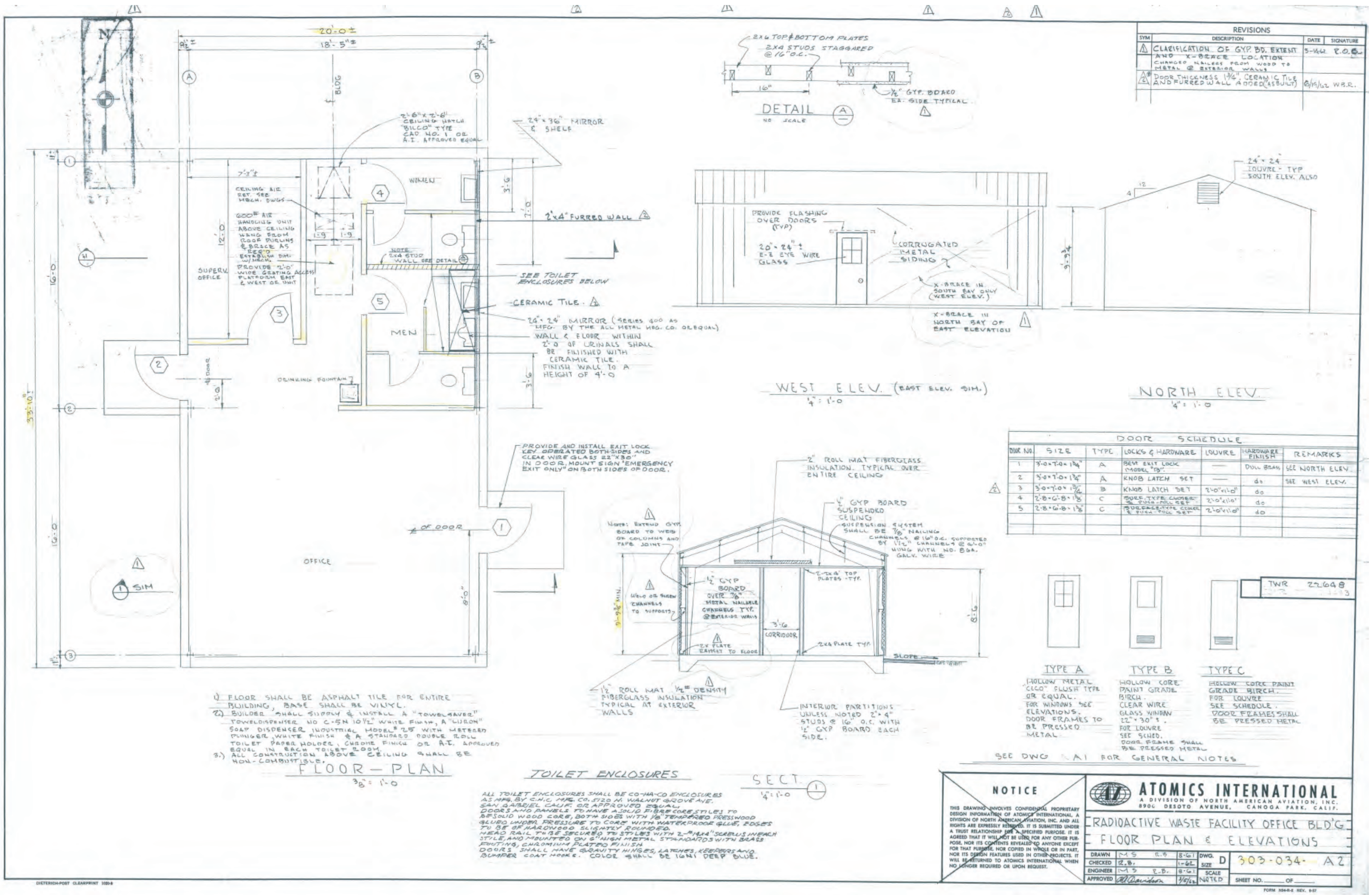

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U.S. EPA Region 9

Figure 2.3d
Building 4034
Floor and Elevation Plans

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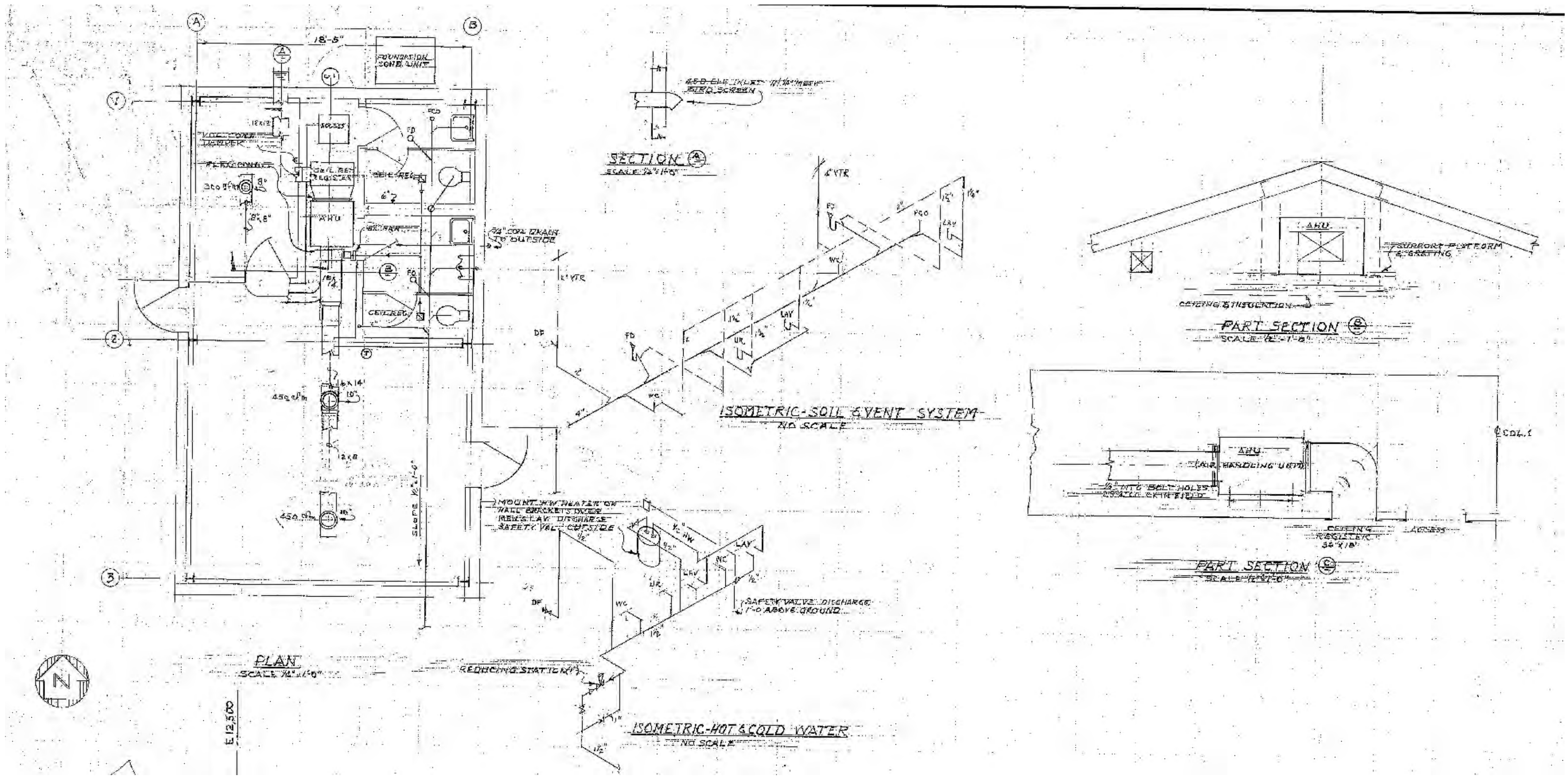

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.3e
Building 4034
Plumbing Plan

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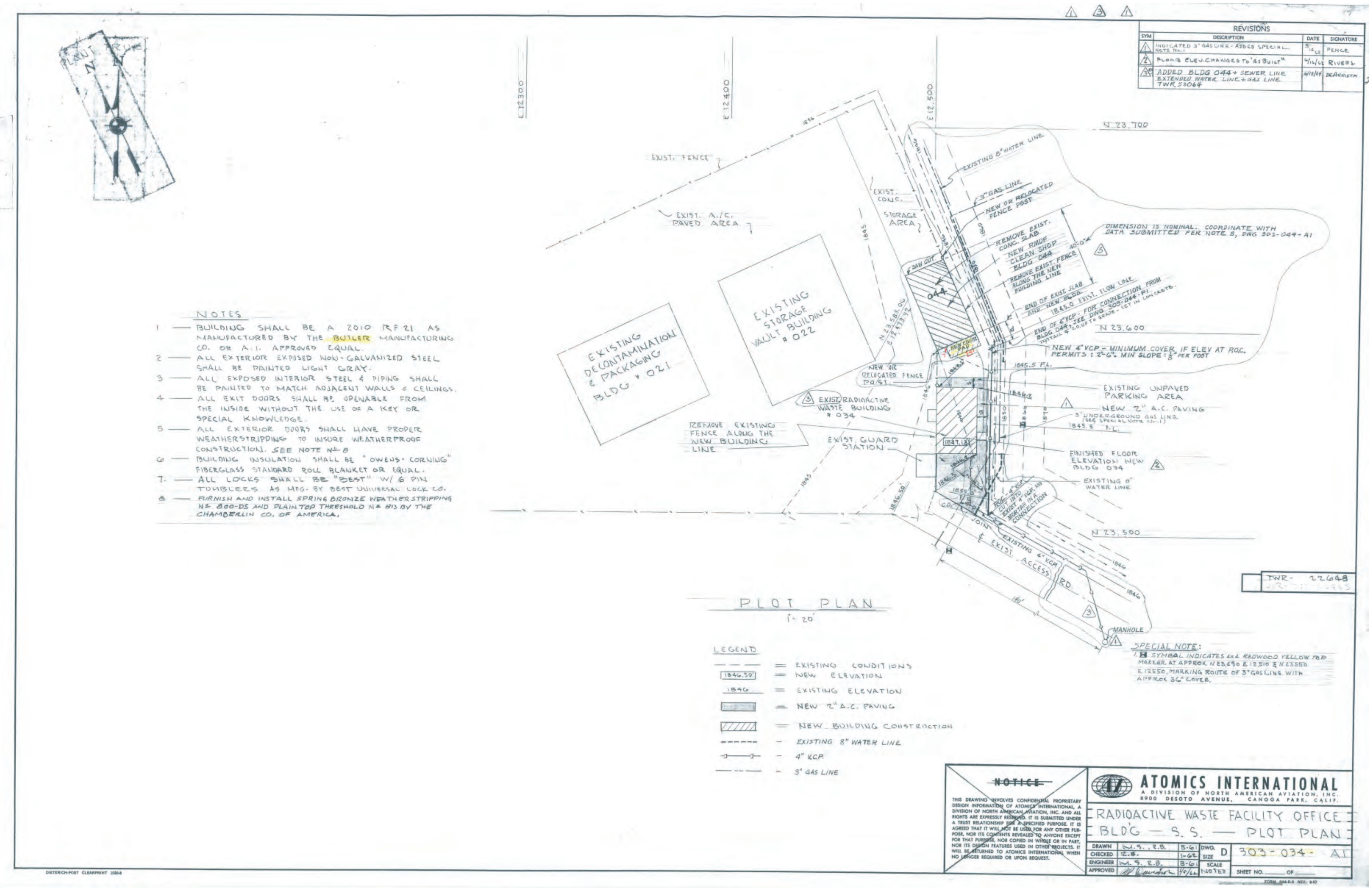
Revised: 06/29/11 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

**Figure 2.4a
Building 4044
Site Photograph**

Redacted



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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4b
Building 4044
Plot Plan

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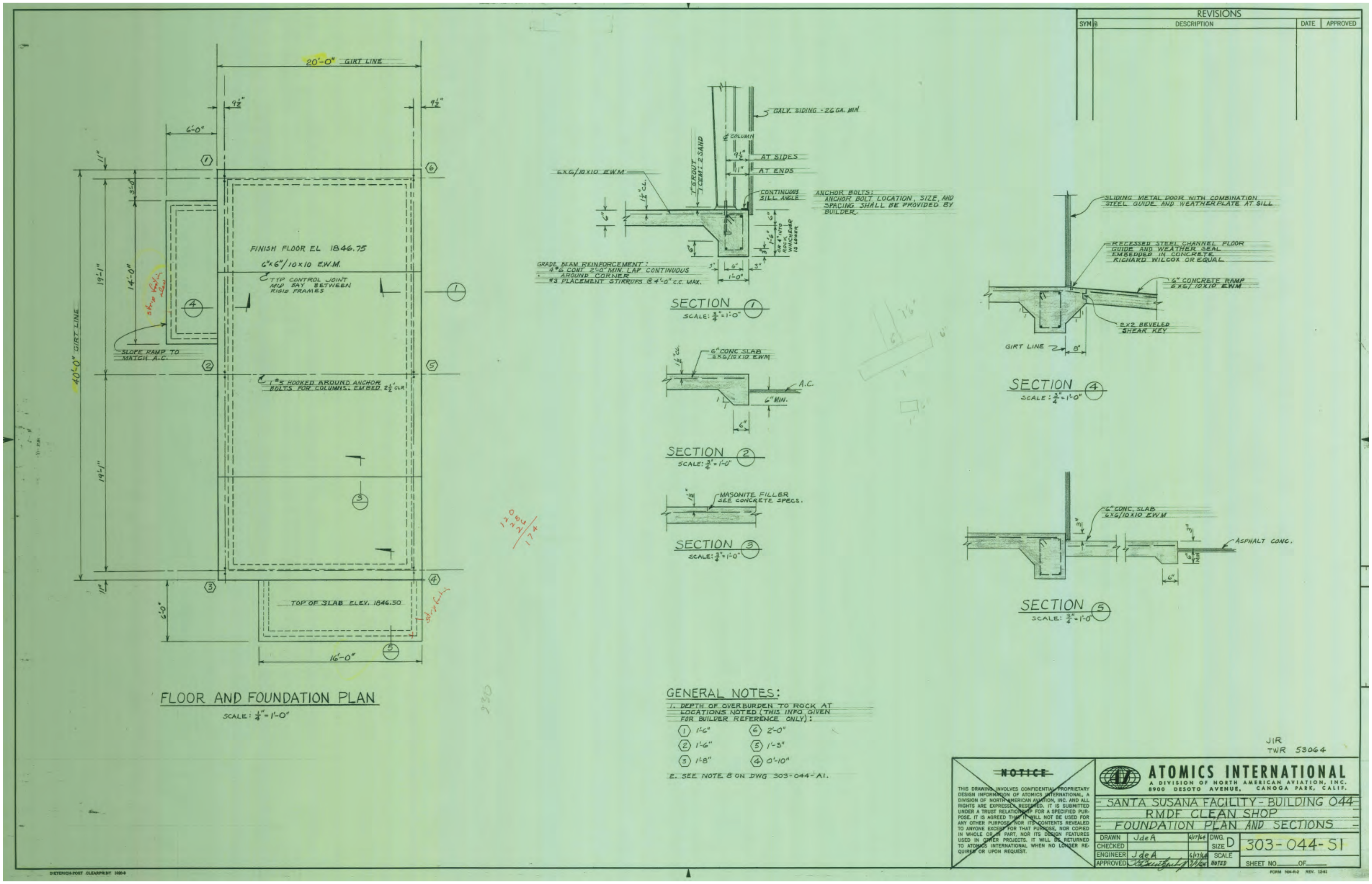

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4c
Building 4044
Foundation Plan

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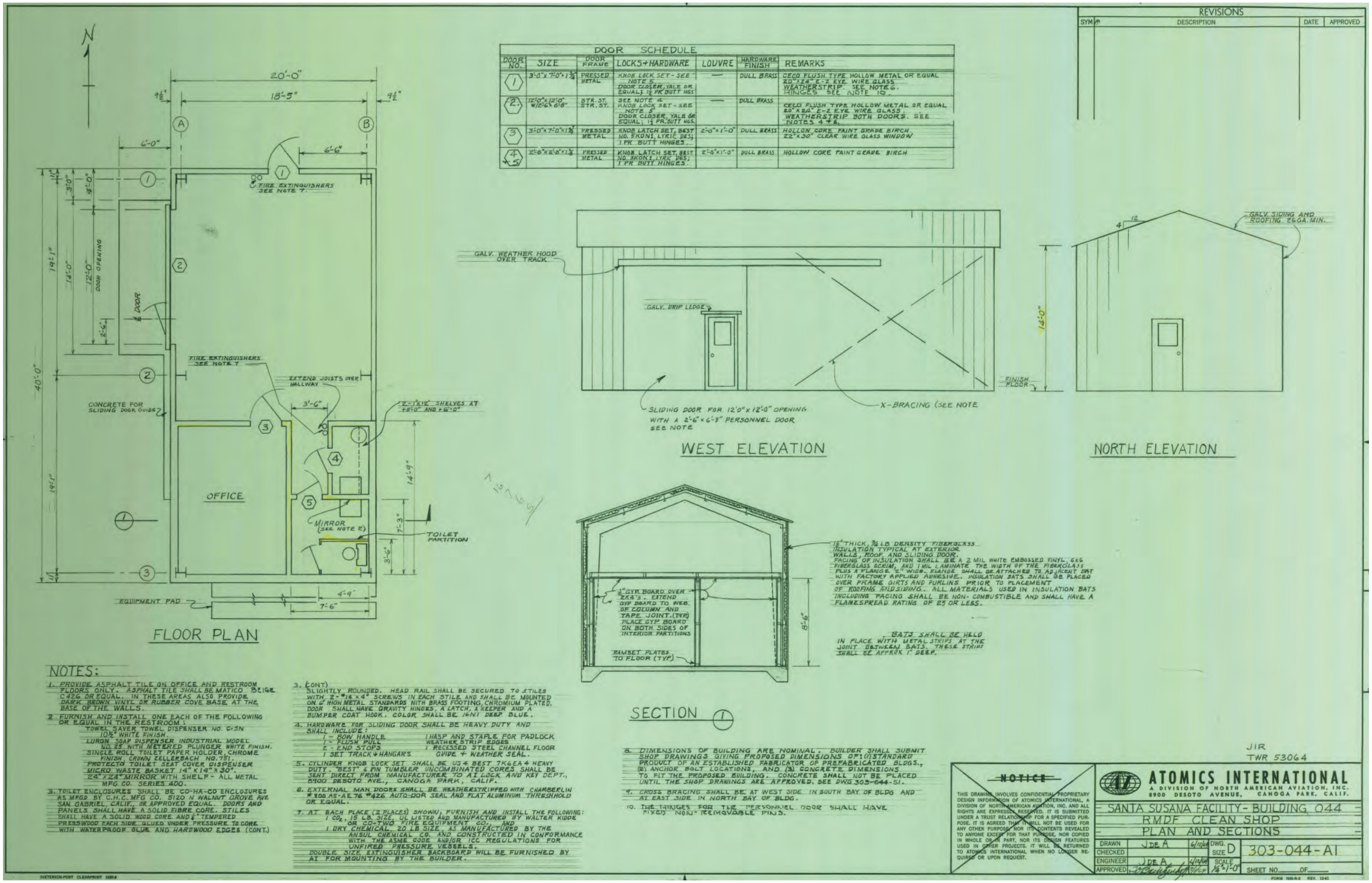

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Figure 2.4d
Building 4044
Floor and Section Plans

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U.S. EPA Region 9

Figure 2.4e
Building 4044
Radioactive
Waste Photograph

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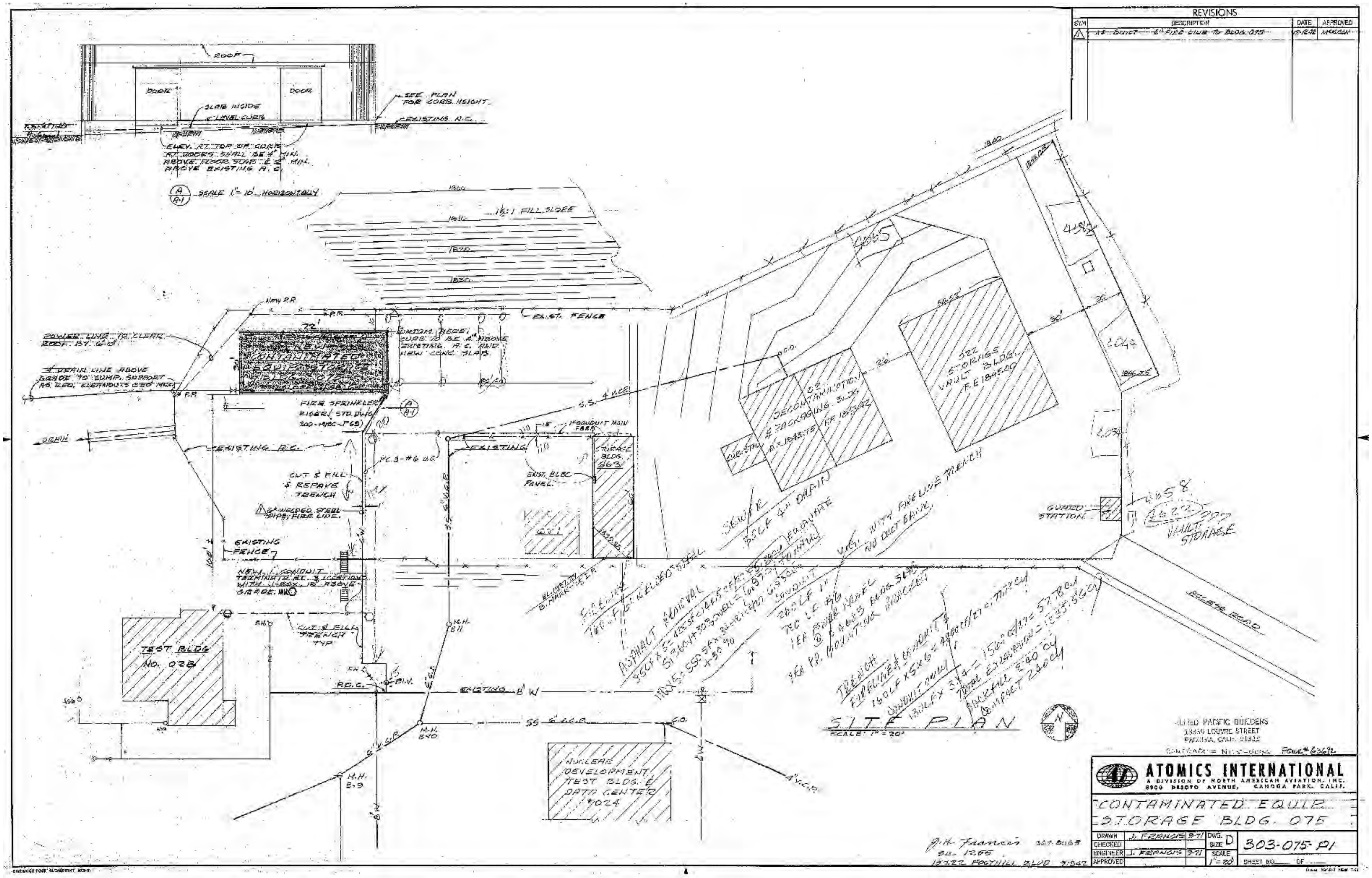
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.5a
Building 4075
Site Photograph



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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.5b
Building 4075
Plot Plan

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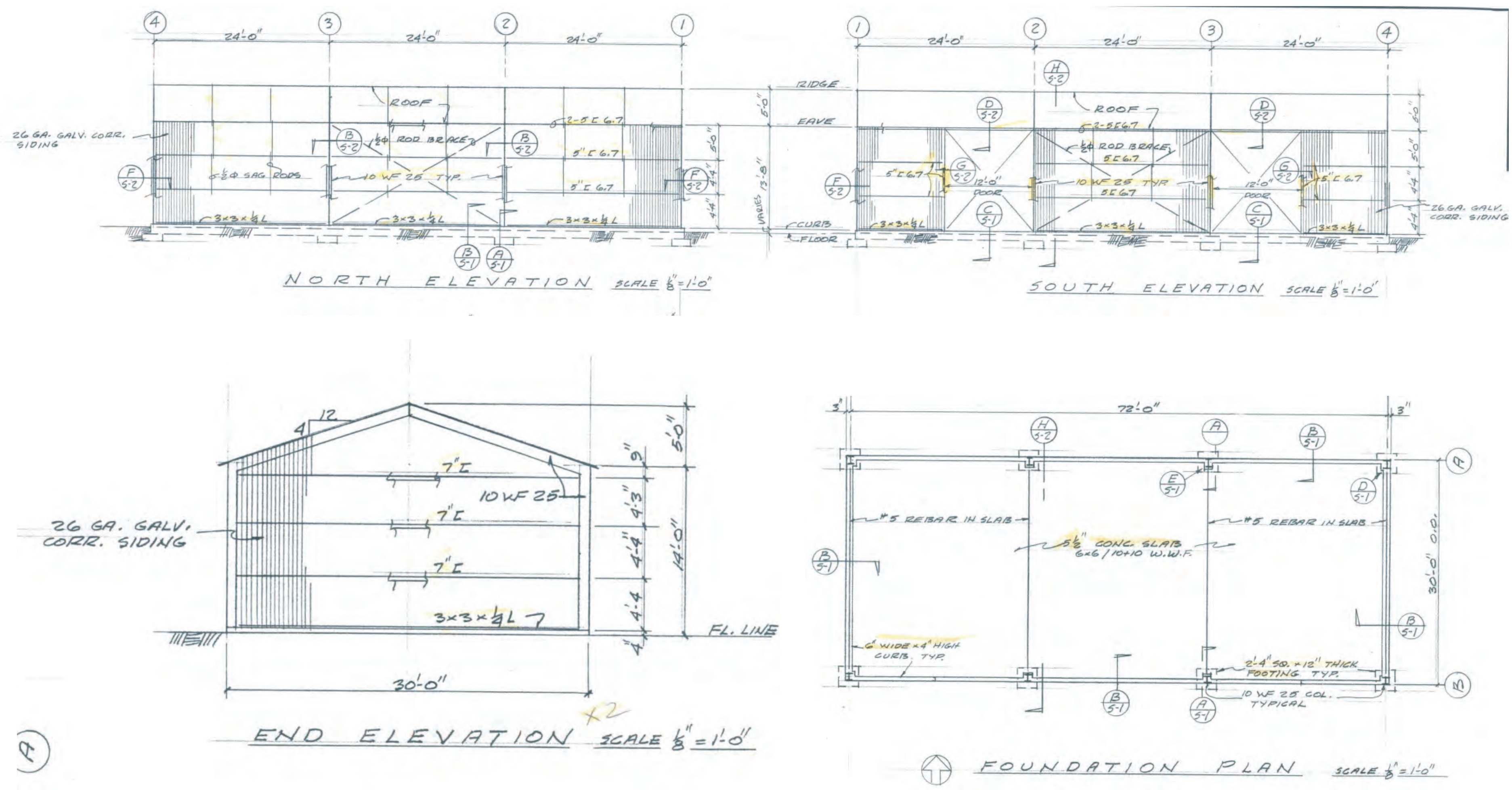

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.5c
Building 4075
Foundation and
Elevation Plans

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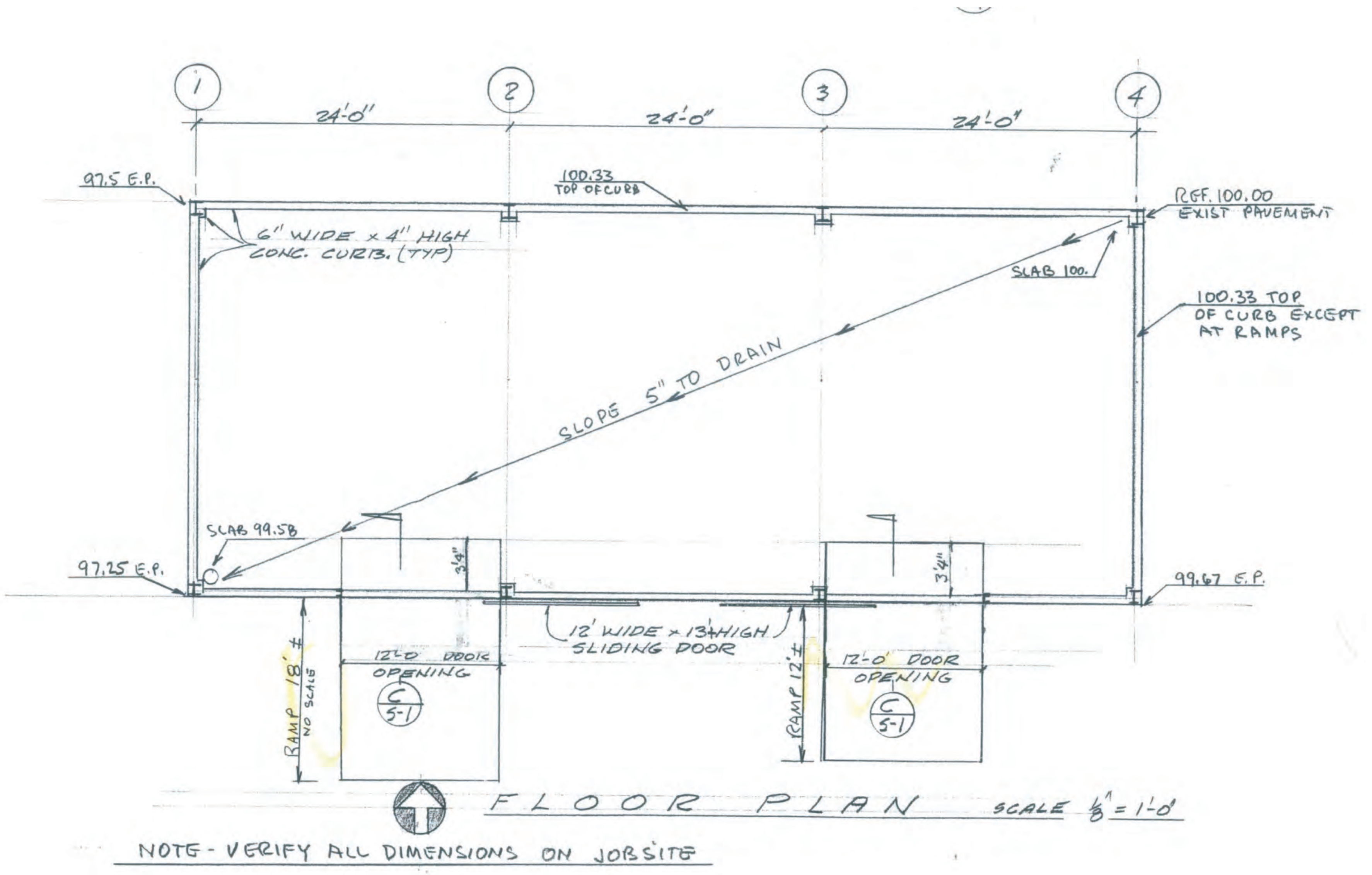

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.5d
Building 4075
Floor Plan

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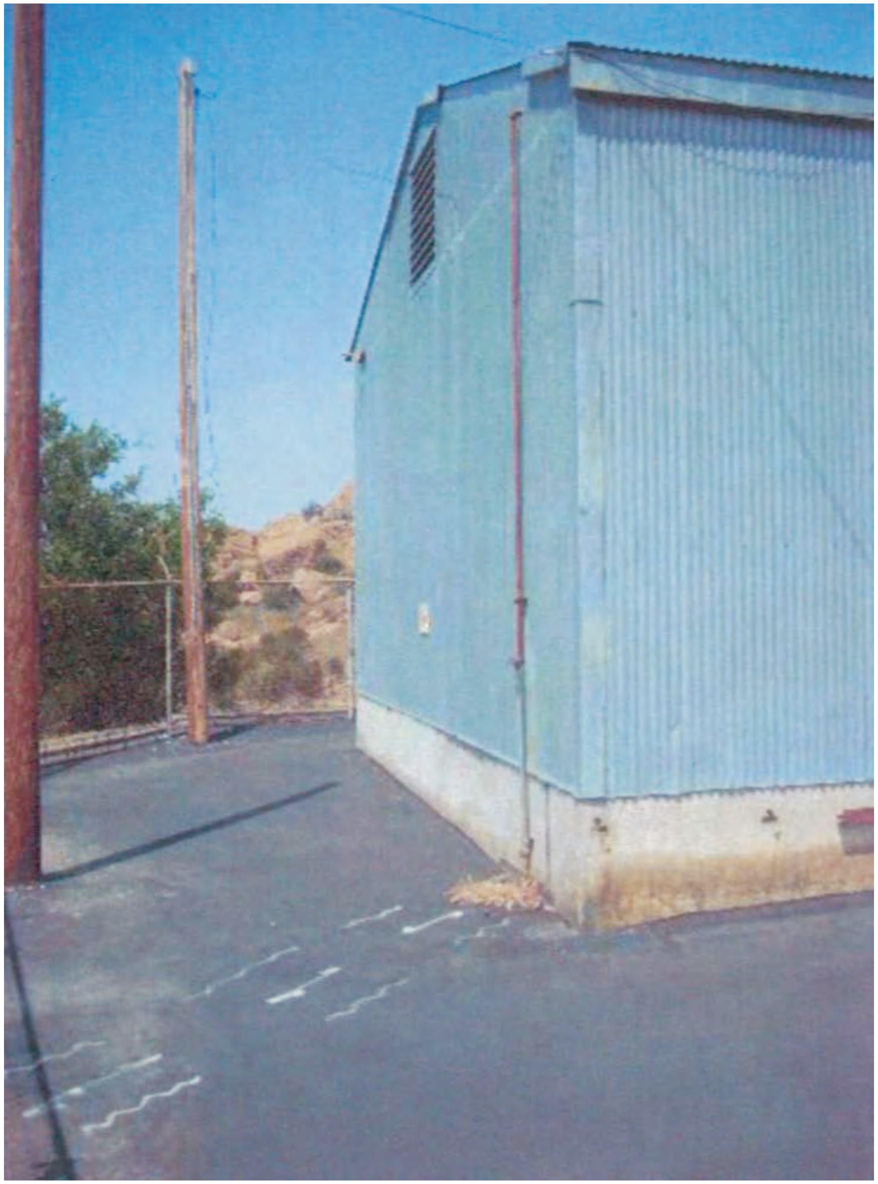
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.5e
Building 4075
Disturbed Soil
Area



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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.5f
Building 4075
Subsurface Drainage to Stormwater Culvert
Photograph 2009

Redacted

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.6a
Building 4563
Site Photograph

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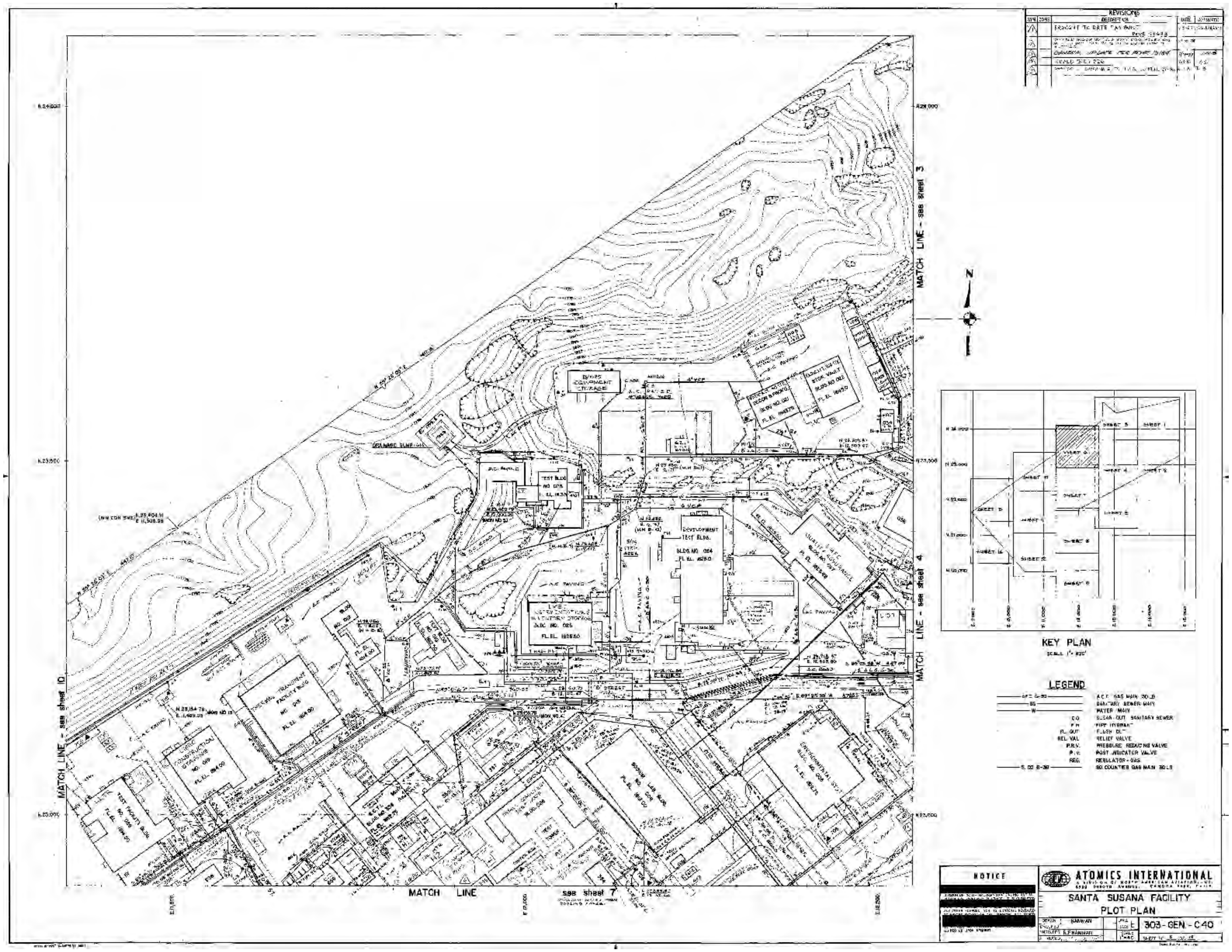

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.6b
Building 4563
Plot Plan

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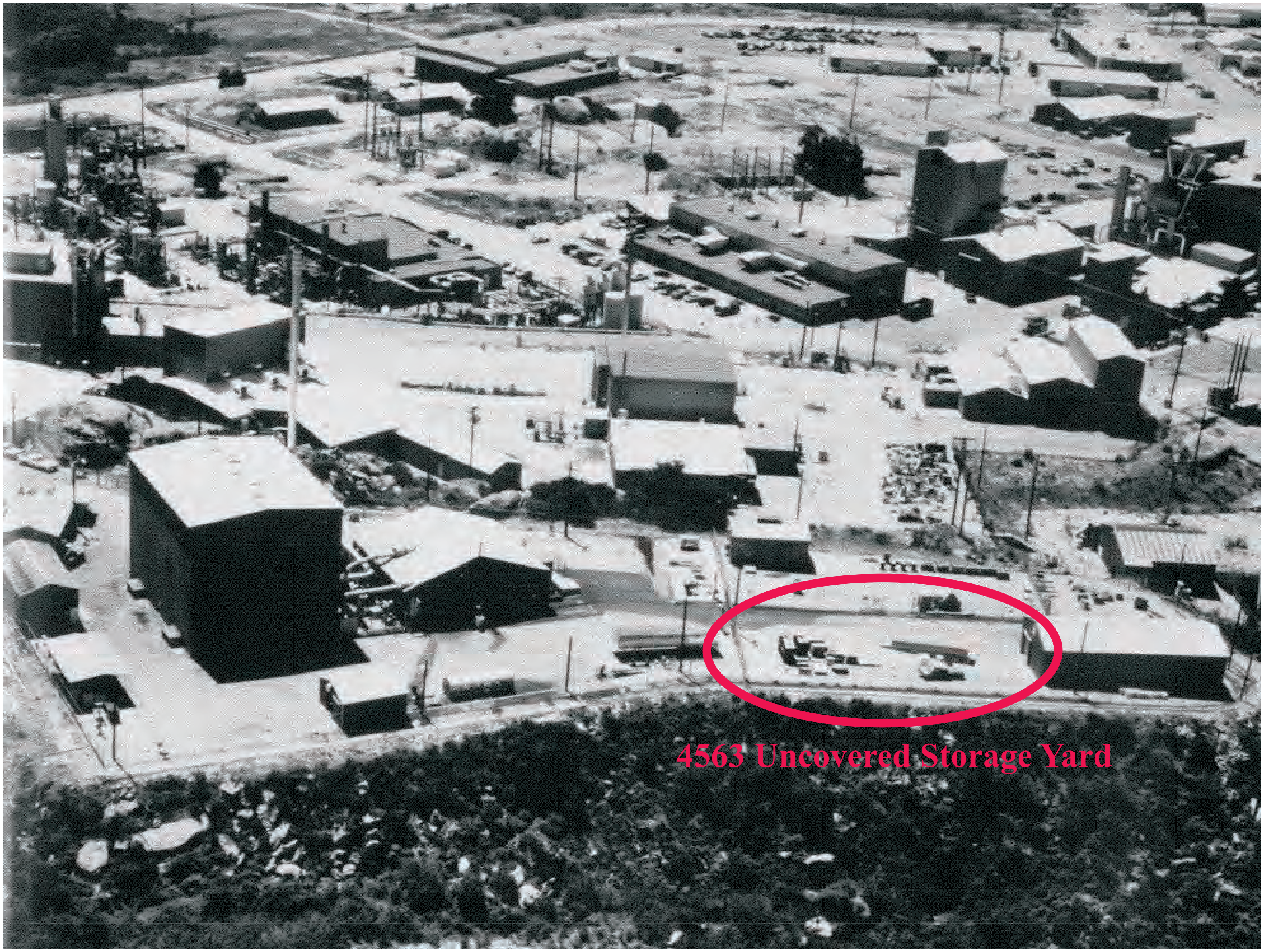

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U.S. EPA Region 9

Figure 2.6c
Building 4563 Uncovered Storage Yard Photograph

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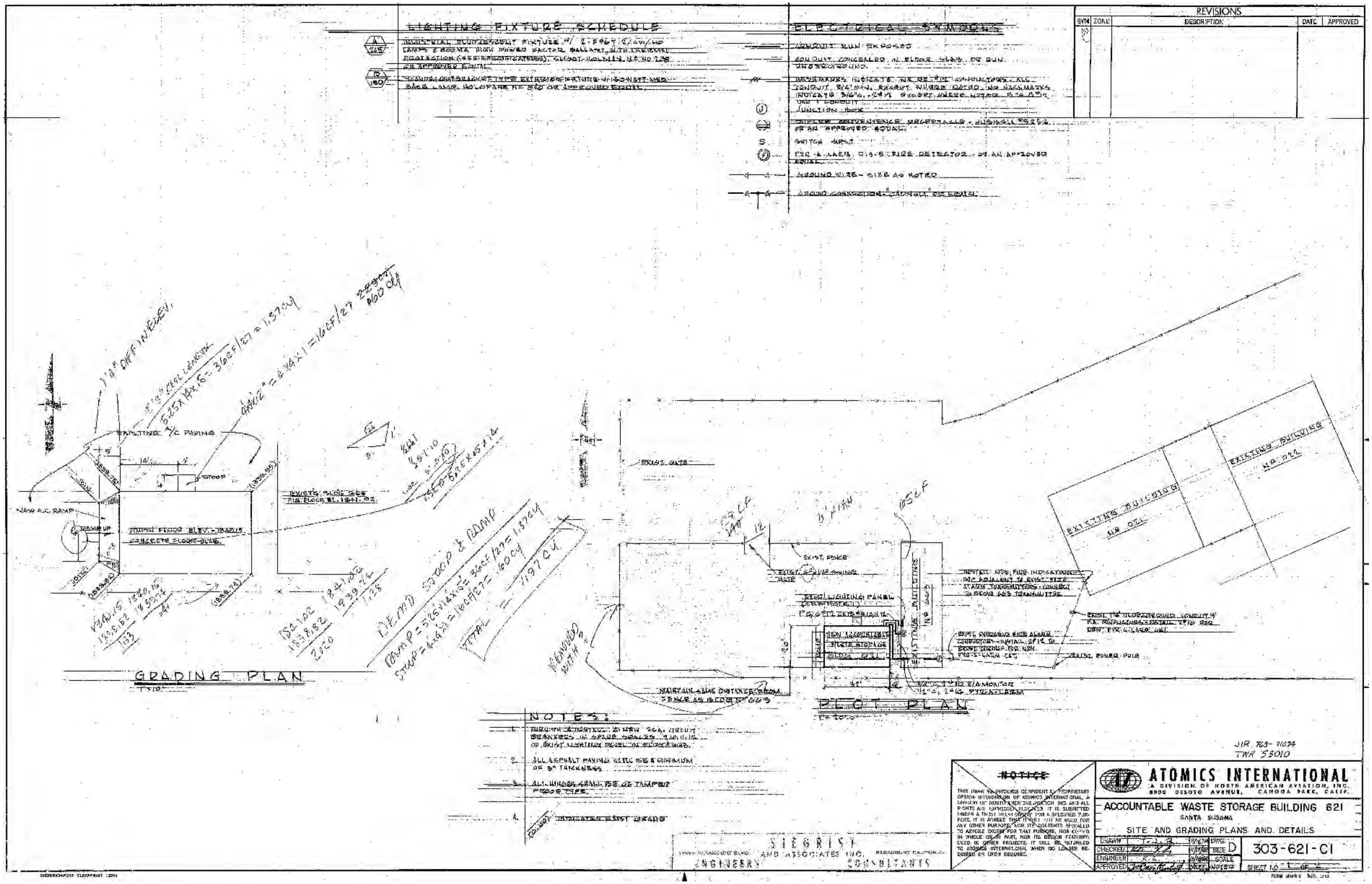
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.7a
Building 4621
Site Photograph



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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.7b
Building 4621
Grading and
Plot Plans

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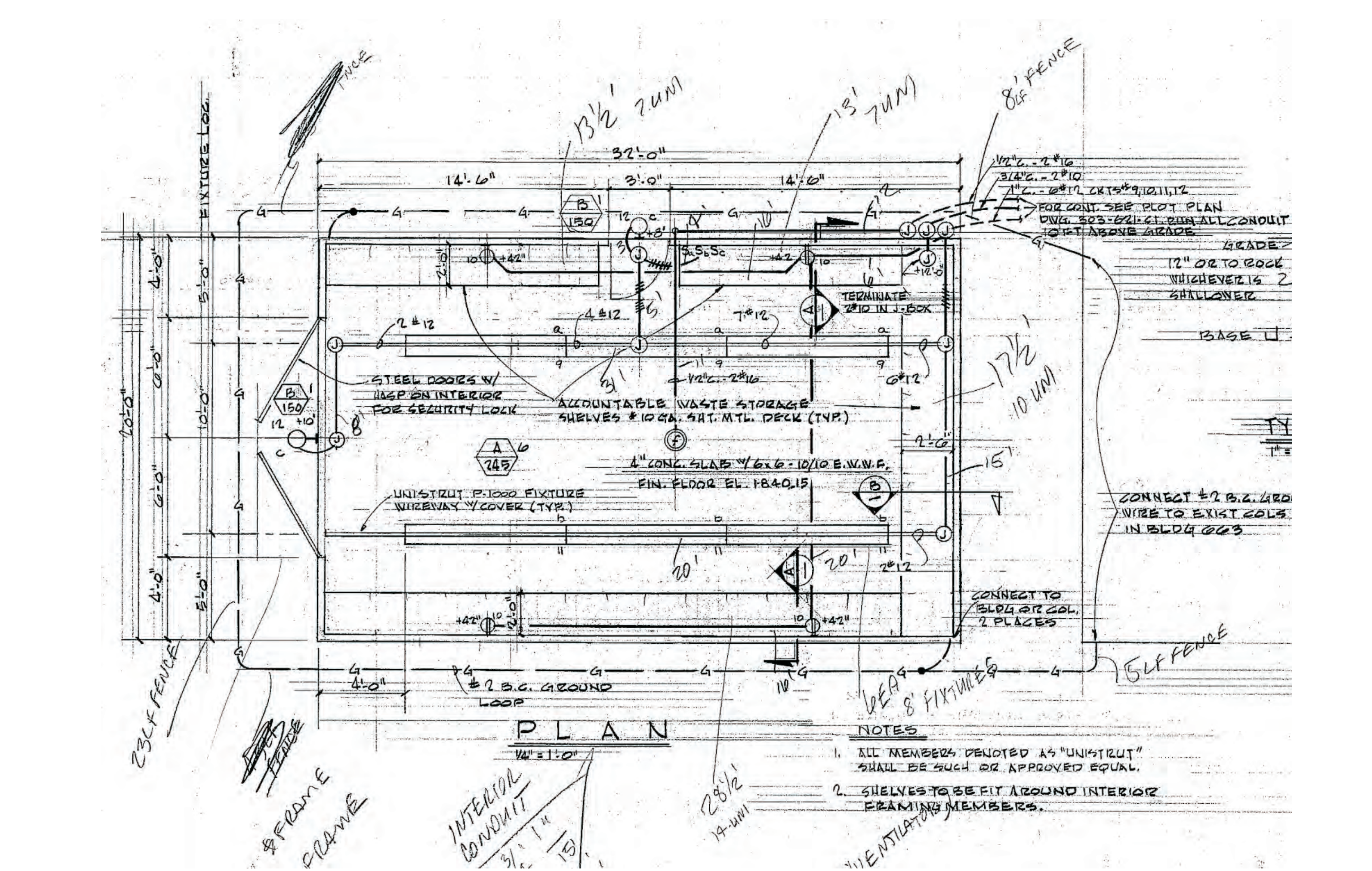

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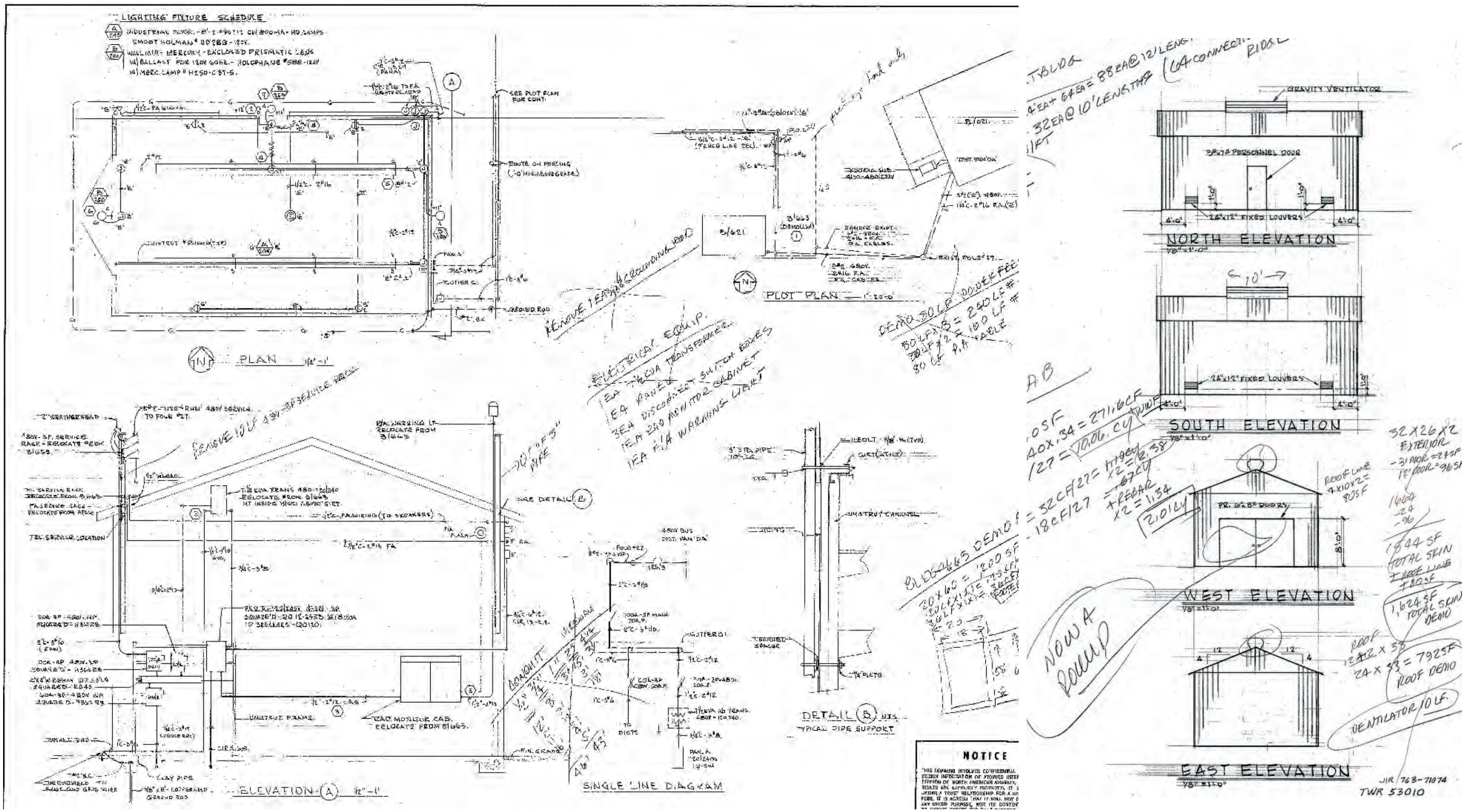
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.7c
Building 4621
Foundation Plan



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U.S. EPA Region 9

Figure 2.7d
Building 4621
Elevation Plans

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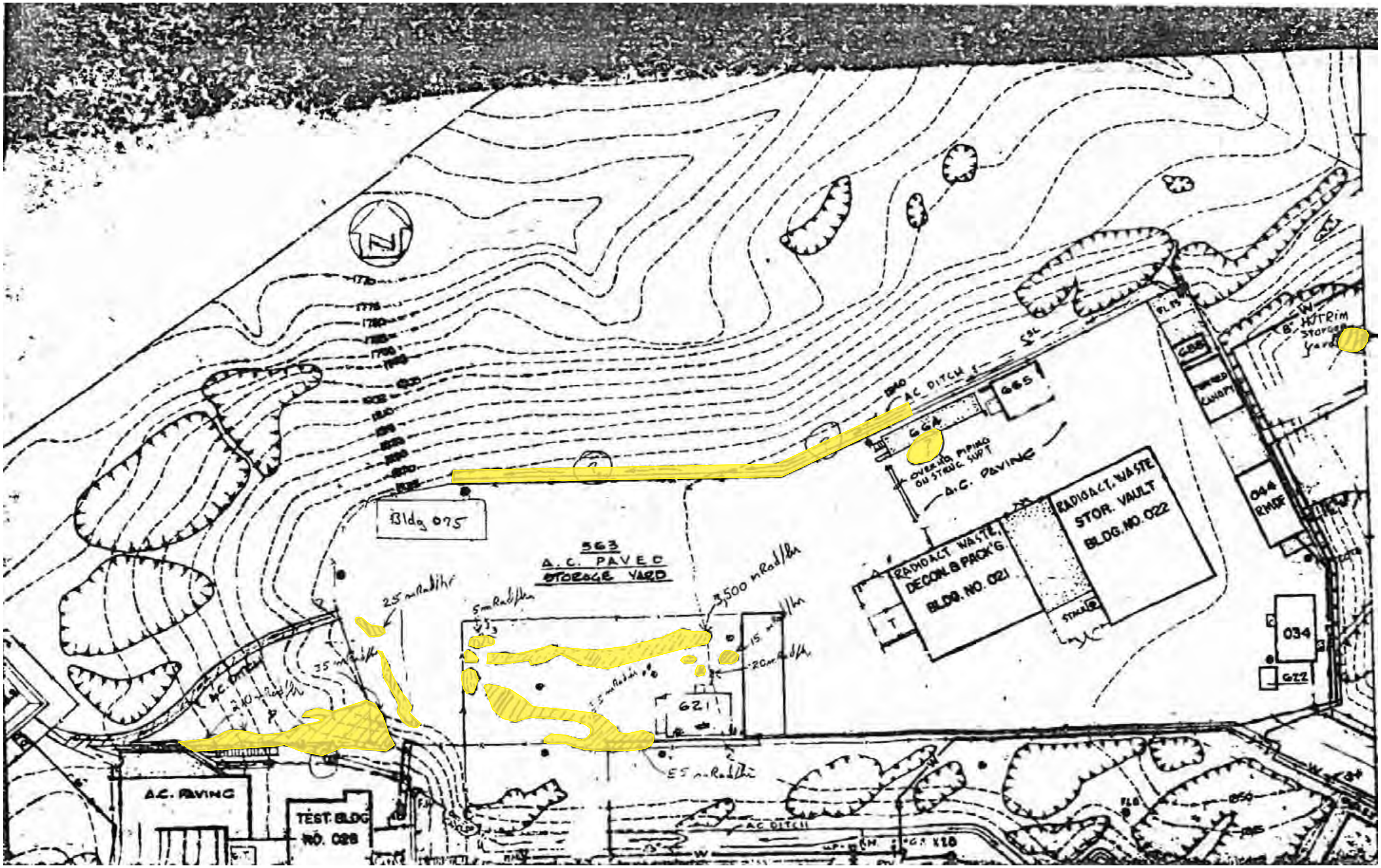

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U.S. EPA Region 9

Figure 2.7e
RMHF Storage Yard Spill Map

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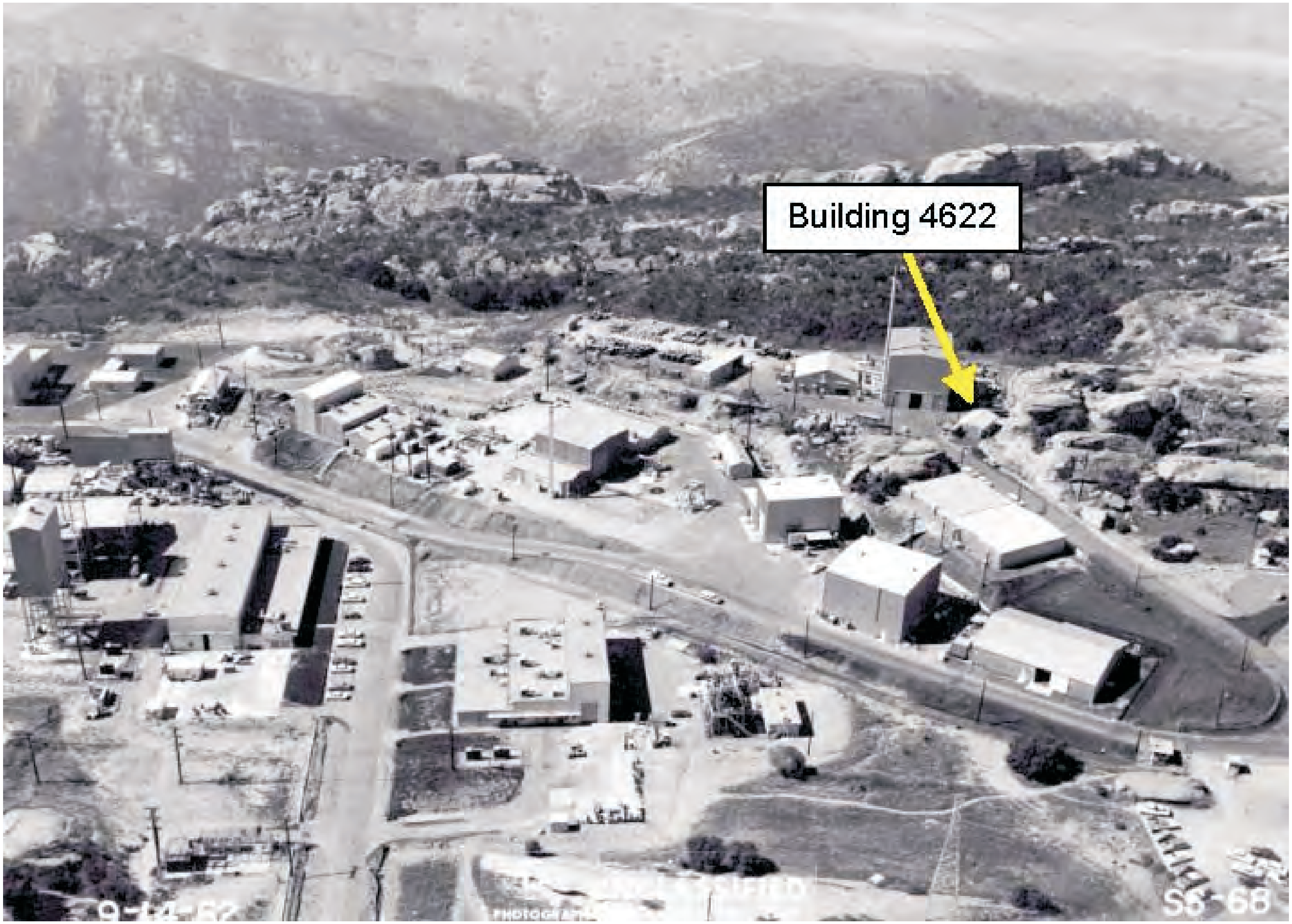

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.8
Building 4622
Site Photograph

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.9a
Building 4658
Site Photograph

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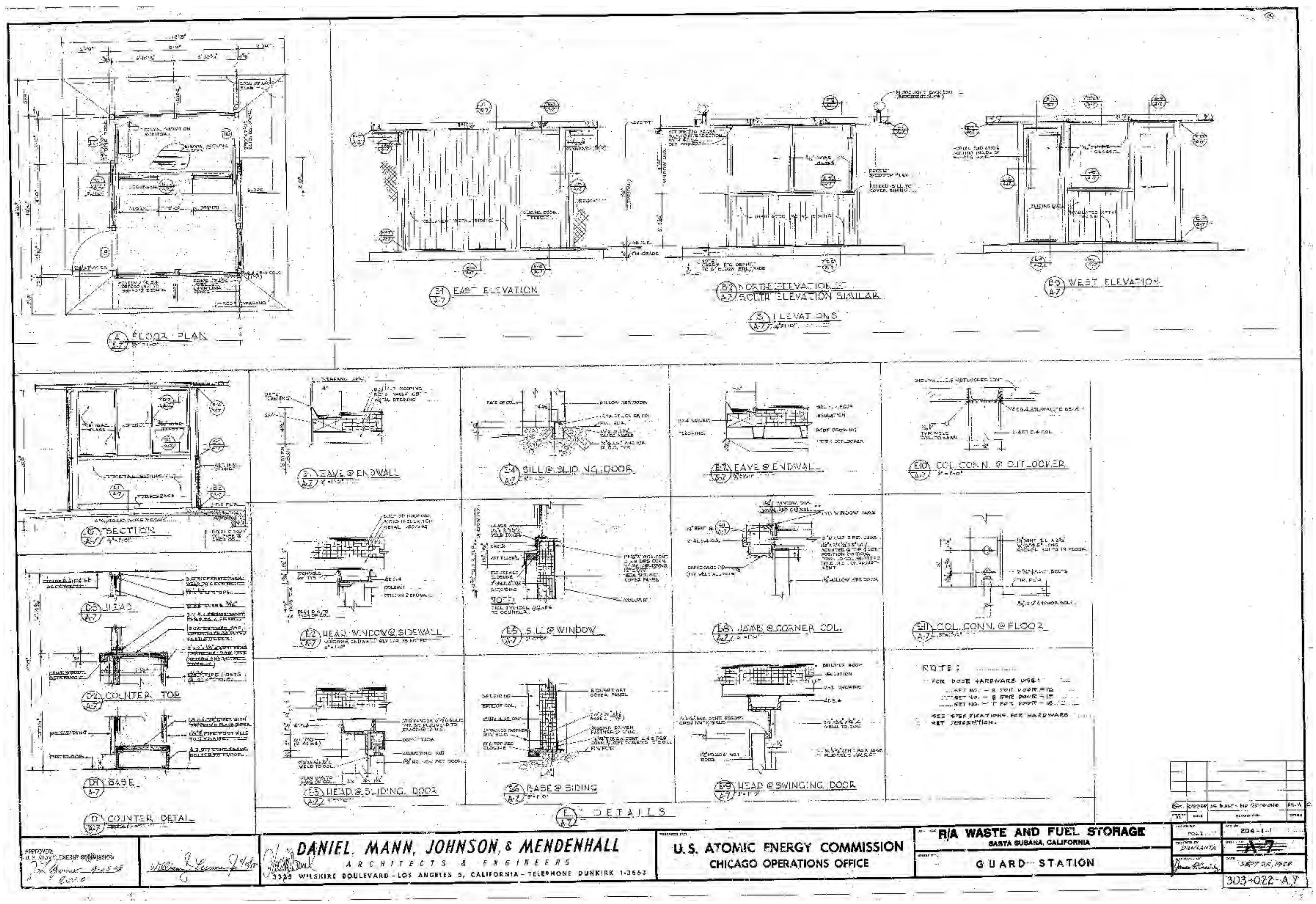

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U.S. EPA Region 9

Figure 2.9b
Building 4658
Guard Shack

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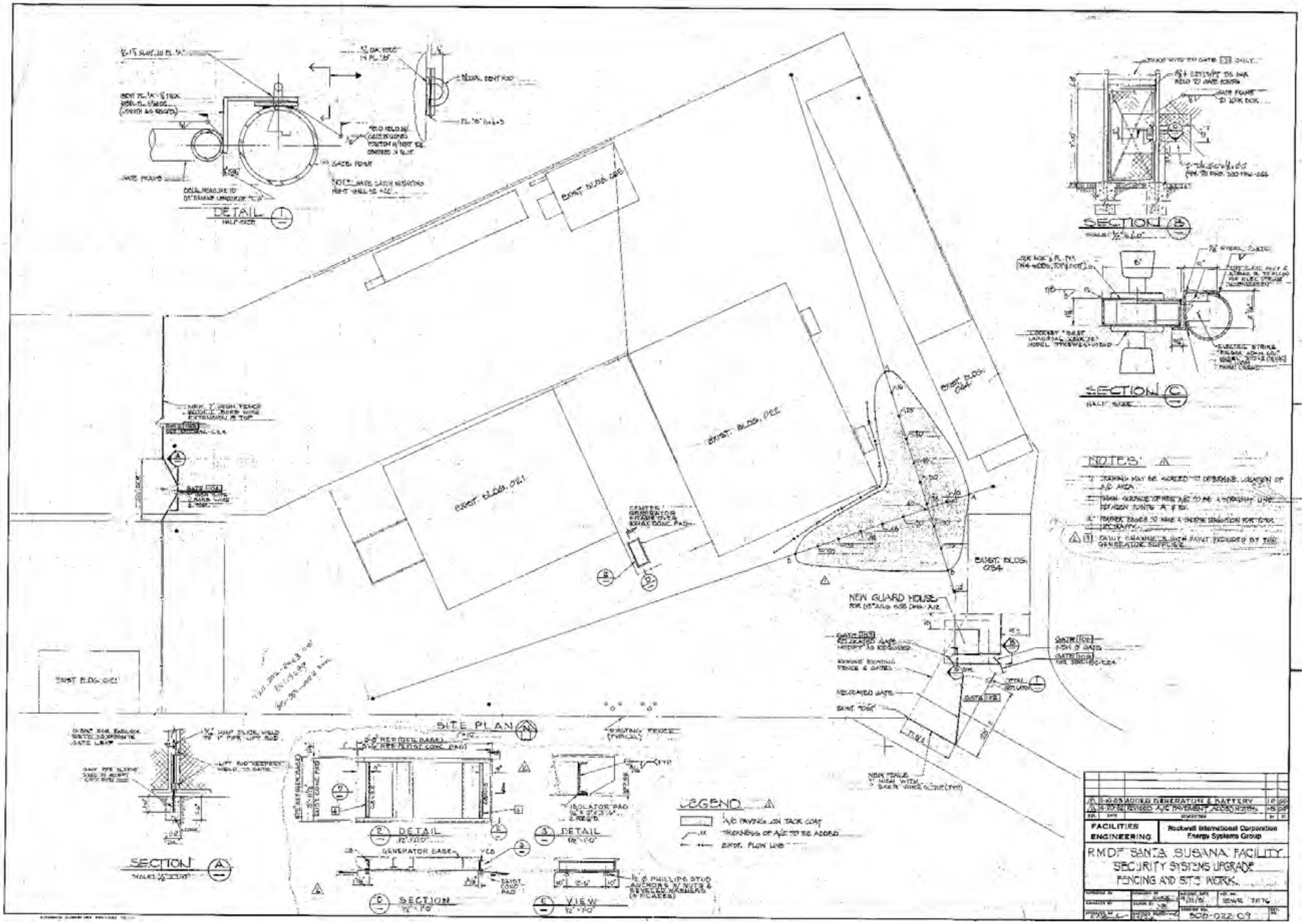

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U.S. EPA Region 9

**Figure 2.9c
Building 4658
New Guard Shack
Site Plan**

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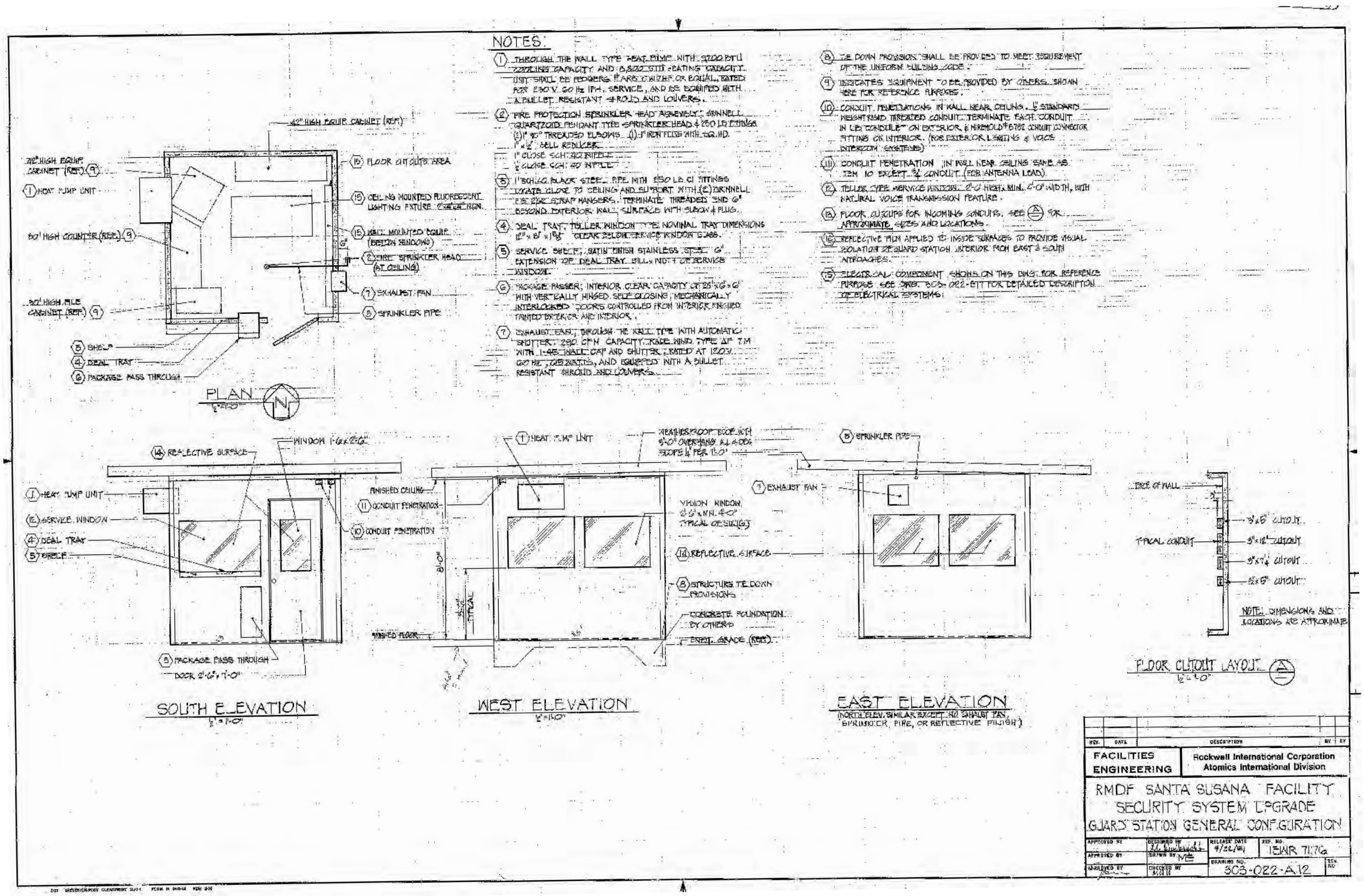

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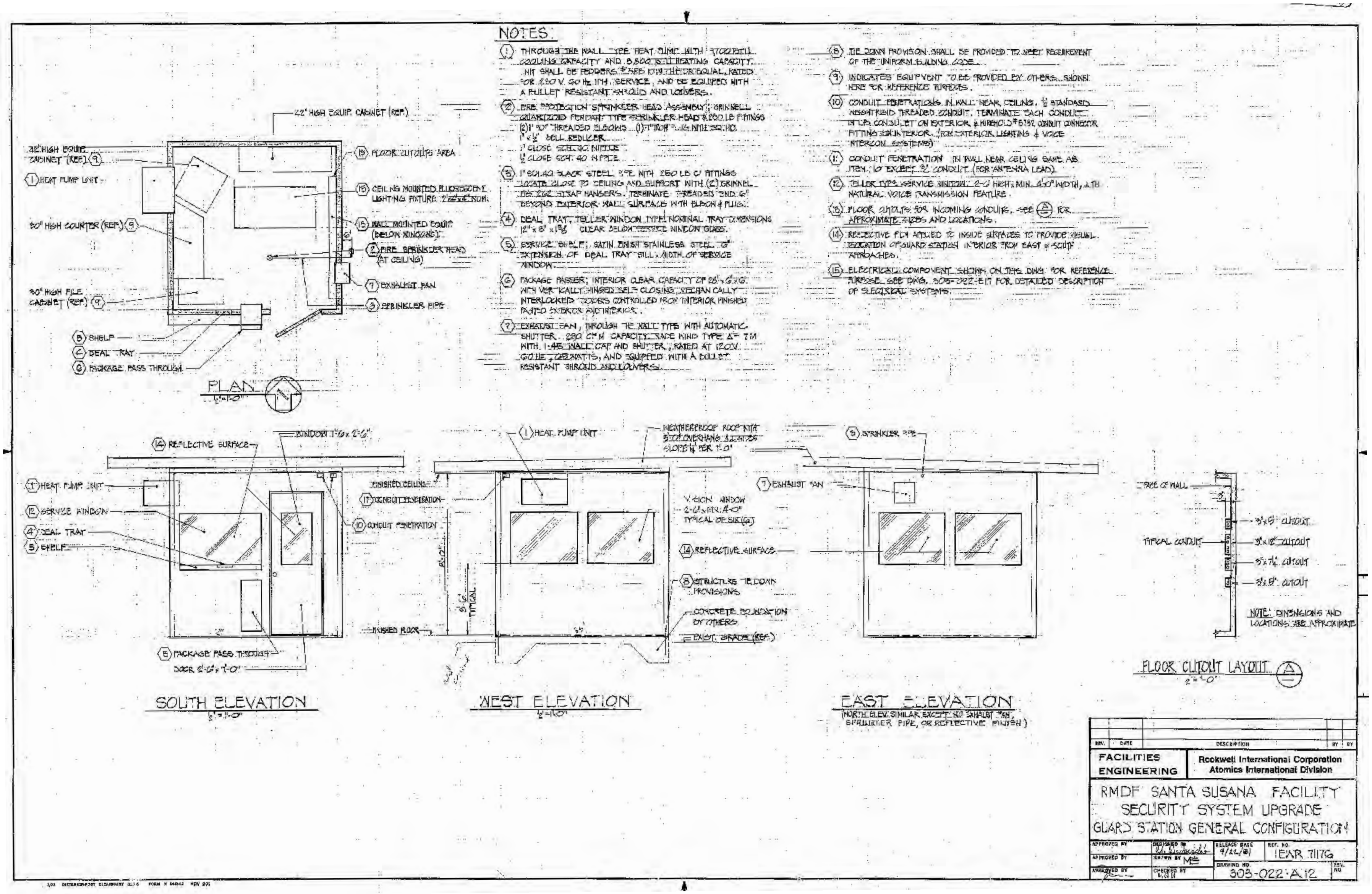
Figure 2.9d
Building 4658
New Guard Shack
Foundation
and Cabinet Details



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U.S. EPA Region 9

Figure 2.9e
Building 4658
New Guard Shack
Configuration
and Elevation Plans

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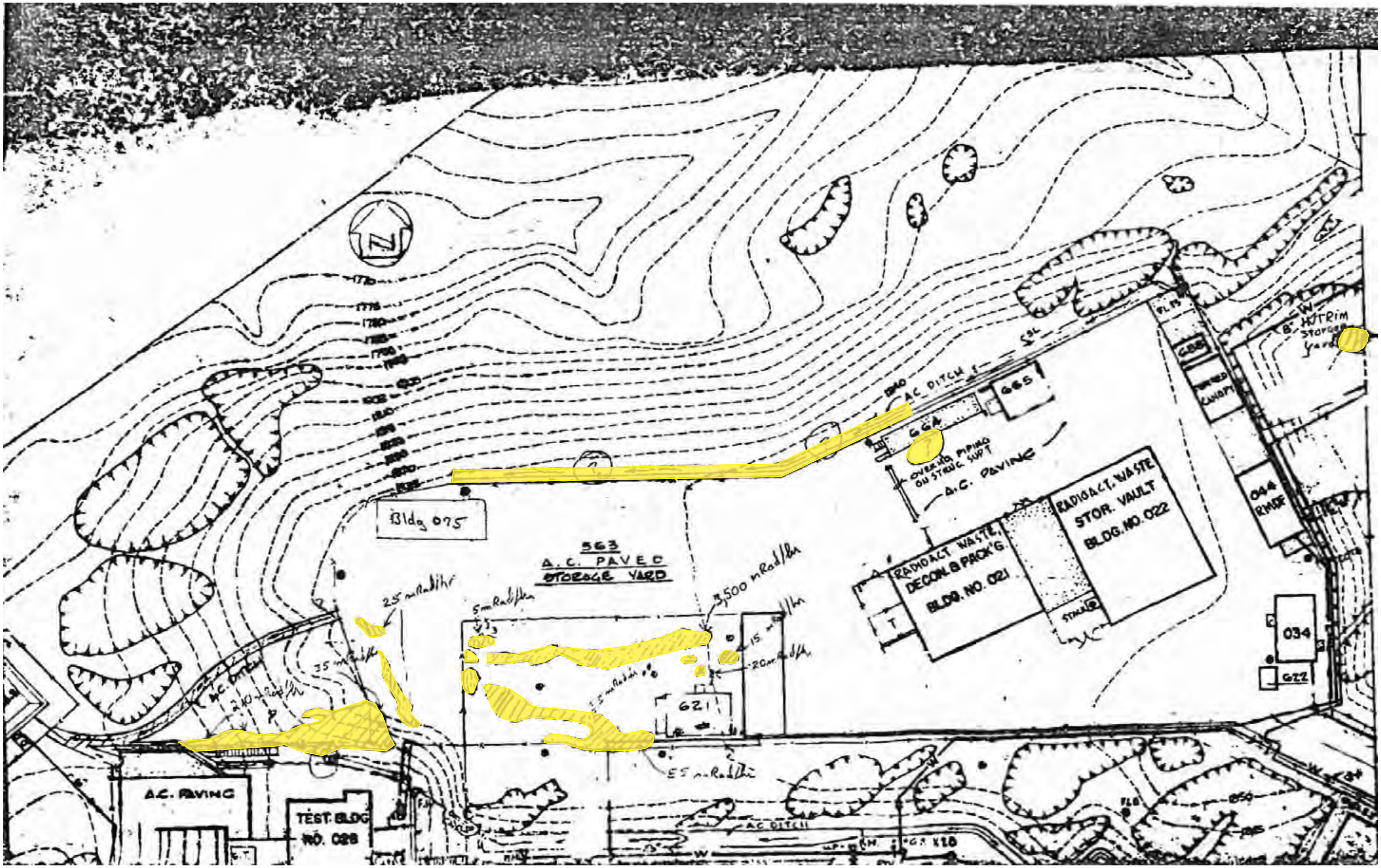
U.S. EPA Region 9

Figure 2.10a
Building 4663
Site Photograph



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U.S. EPA Region 9

Figure 2.10b
RMHF Storage Yard Spill Map

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.11a
Building 4664
Site Photograph

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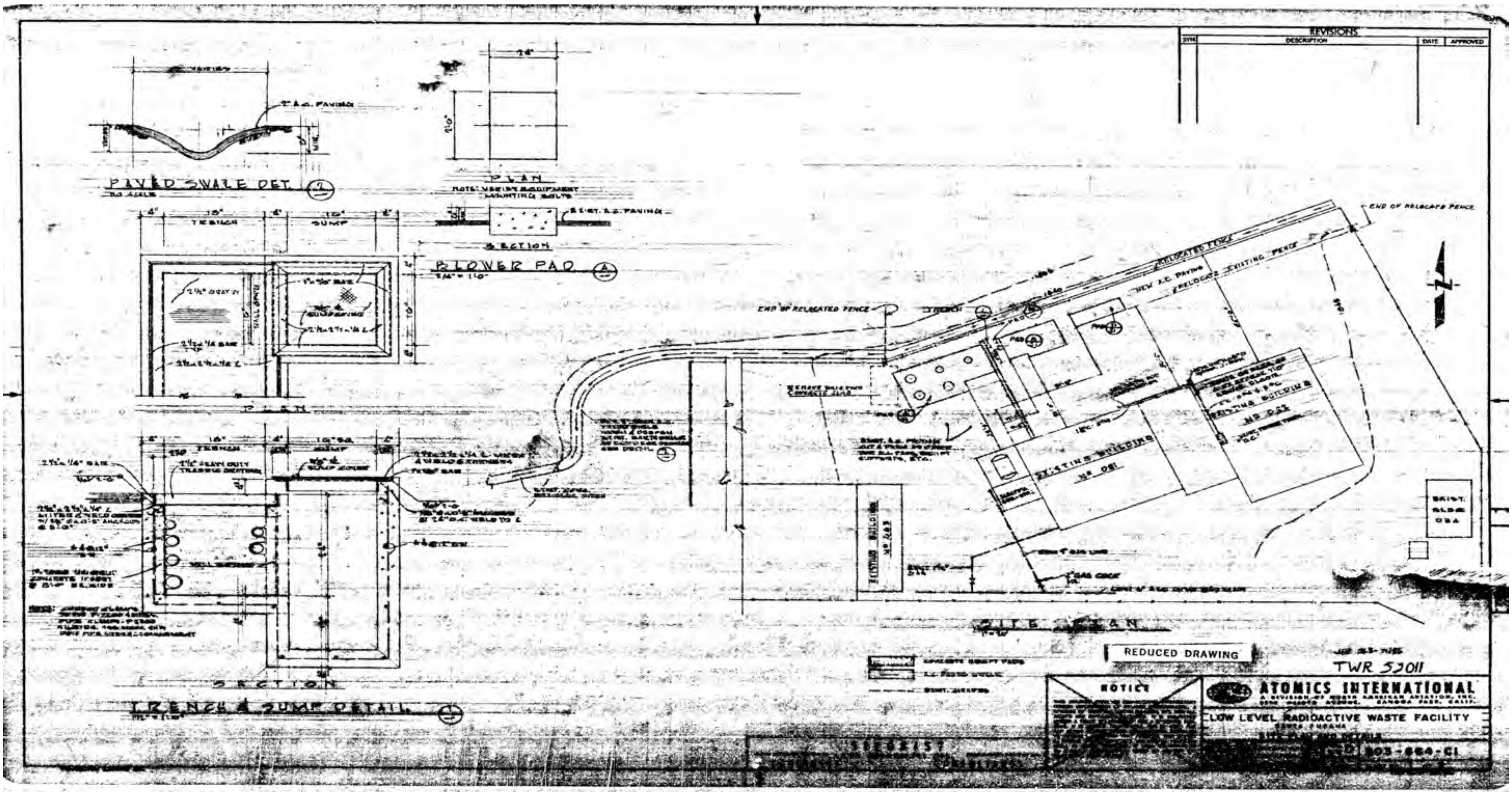

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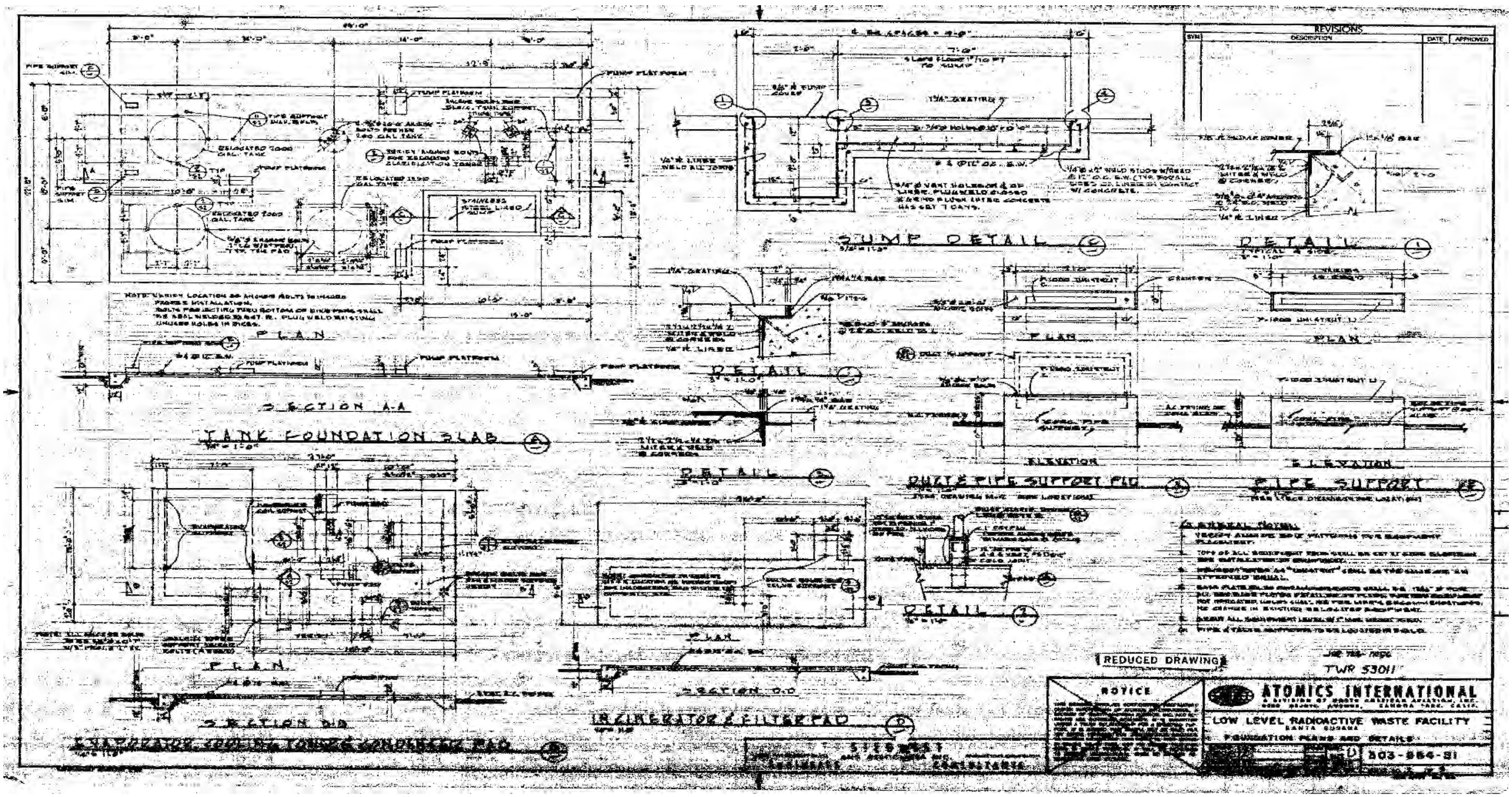
U.S. EPA Region 9

Figure 2.11b
Building 4664
Site Plan

Redacted



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U.S. EPA Region 9

Figure 2.11c
Building 4664
Foundation Plan

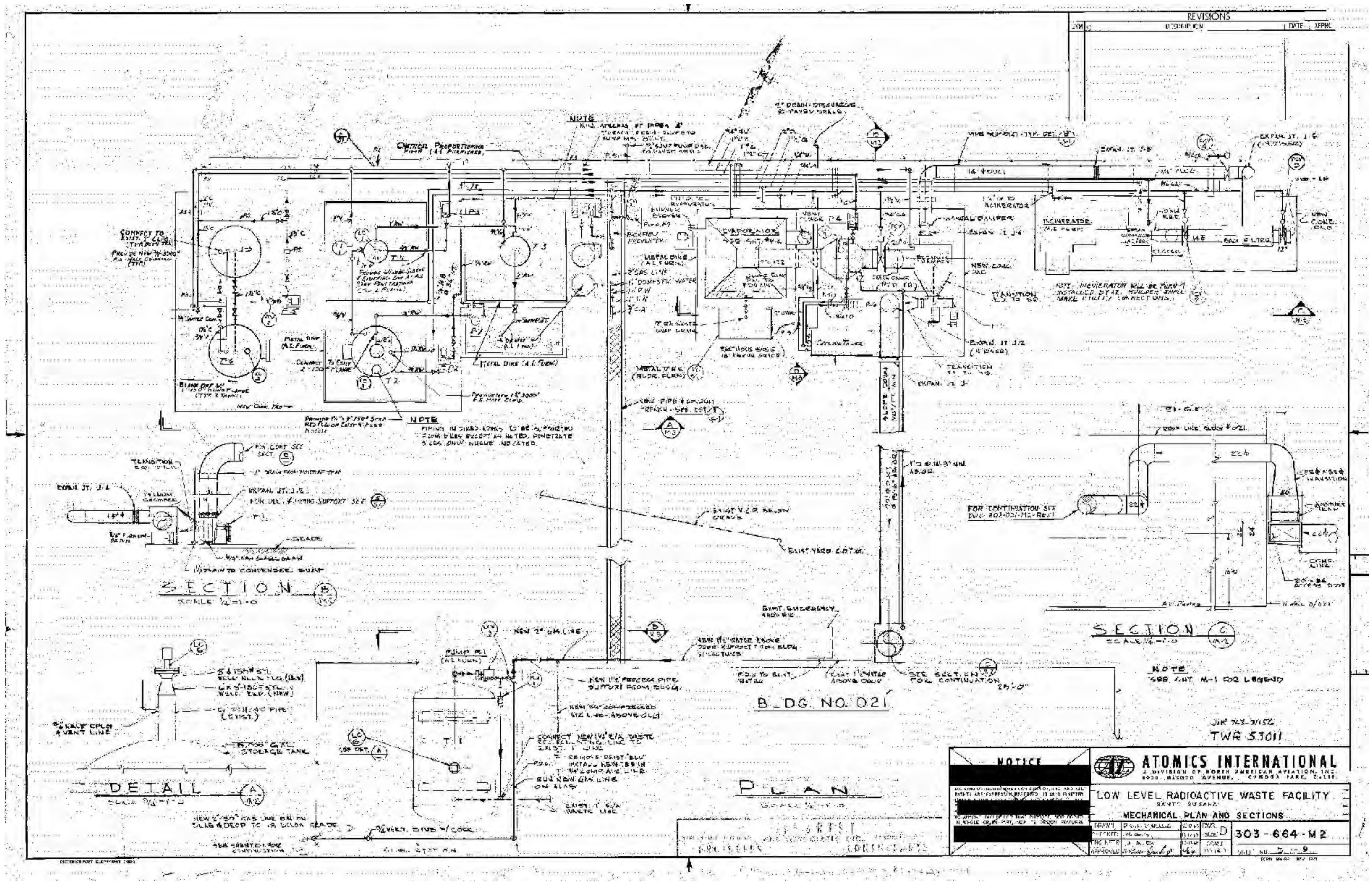

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Figure 2.11d
Building 4664
Mechanical Plan

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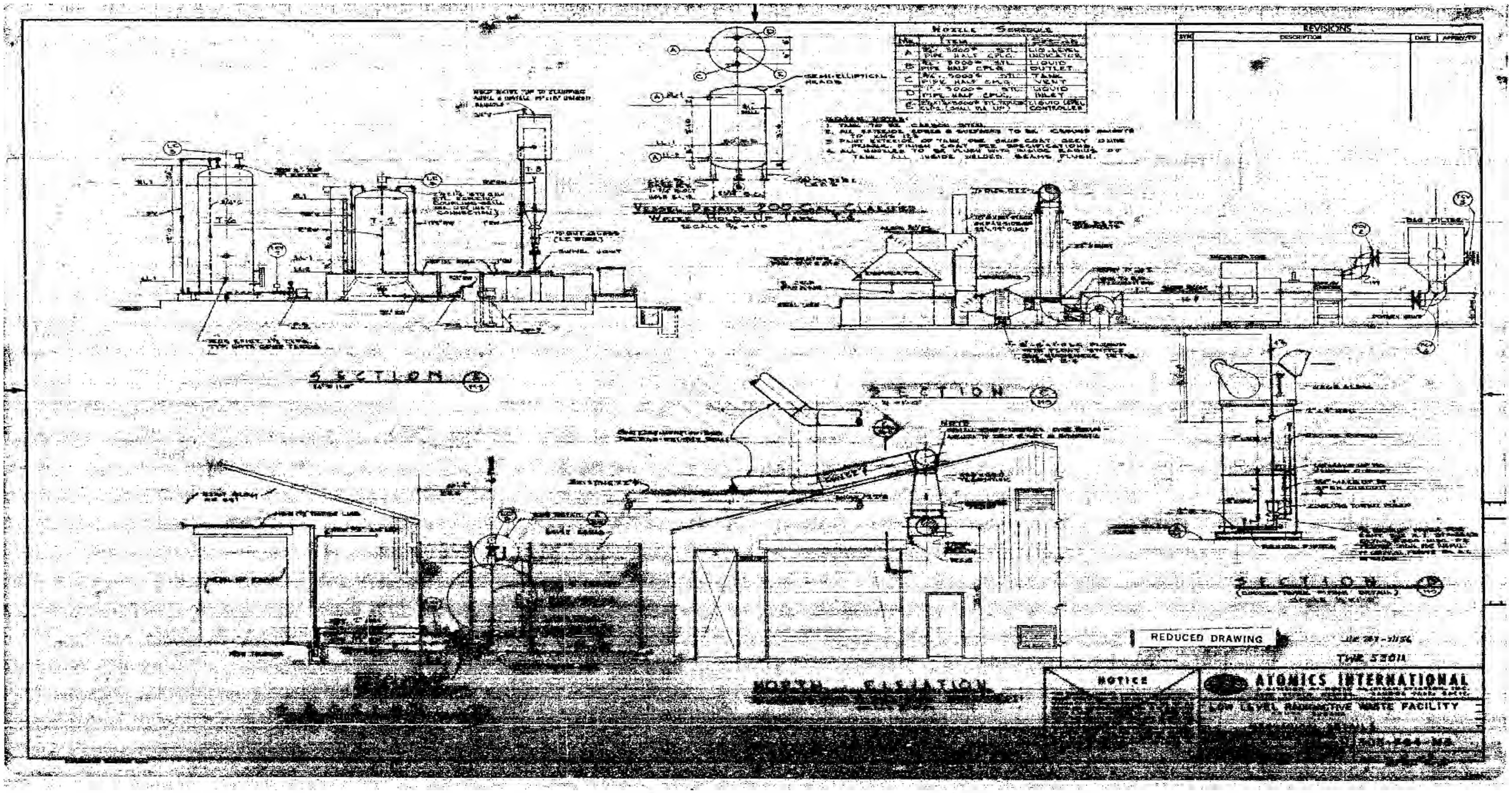

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Source: Boeing Company, 2008

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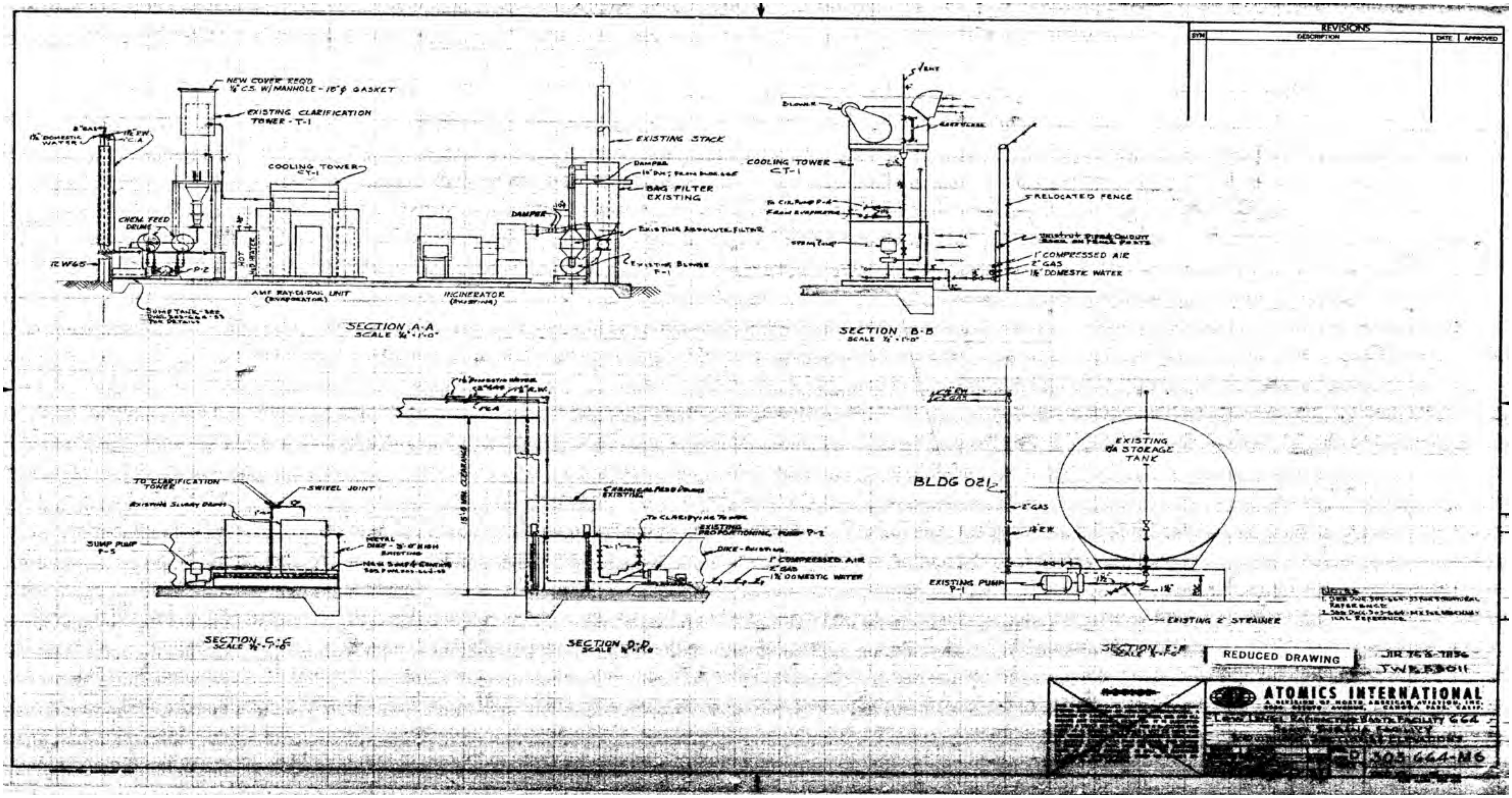
Figure 2.11e
Building 4664
Section and Elevation Plans with Tank Details

Redacted



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Revised: 07/05/11 TJ
Source: Boeing Company, 2008

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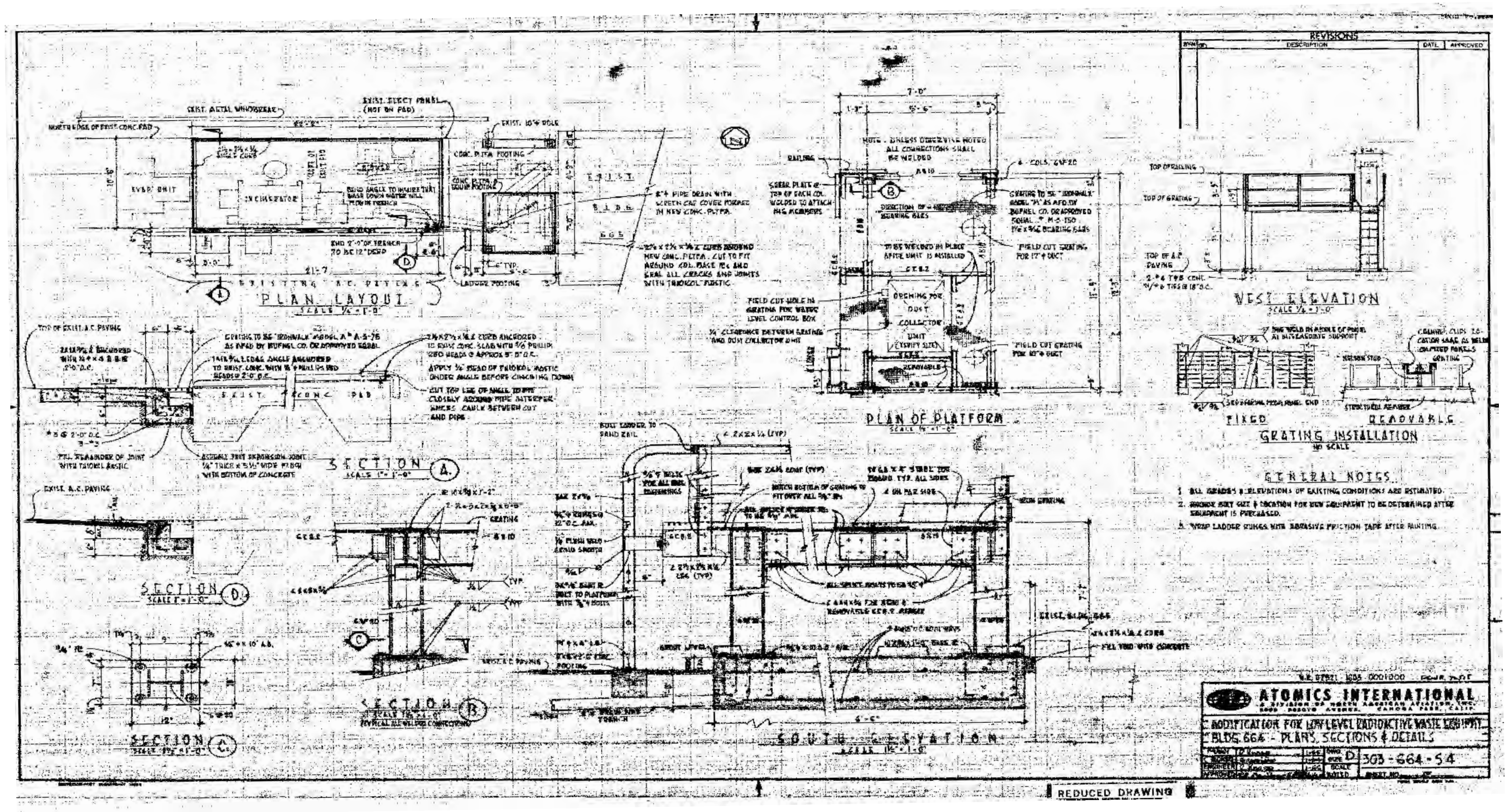
Figure 2.11f
Building 4664
Section and Elevation Plans

Redacted



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Source: Boeing Company, 2008

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Figure 2.11g
Building 4664 Floor and Elevation Plans

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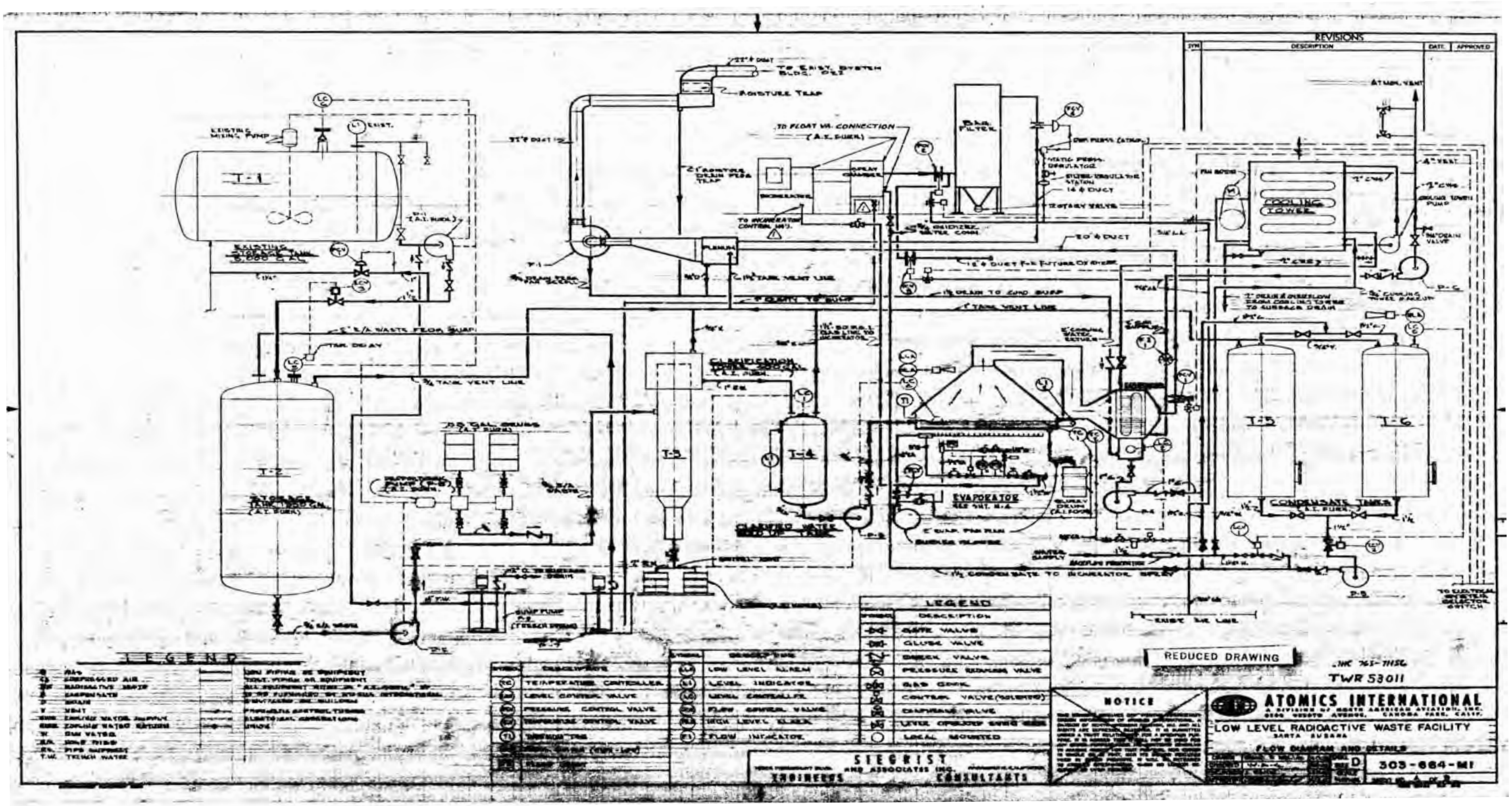

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Figure 2.11h
Building 4664
Flow Diagram with
Tank Details

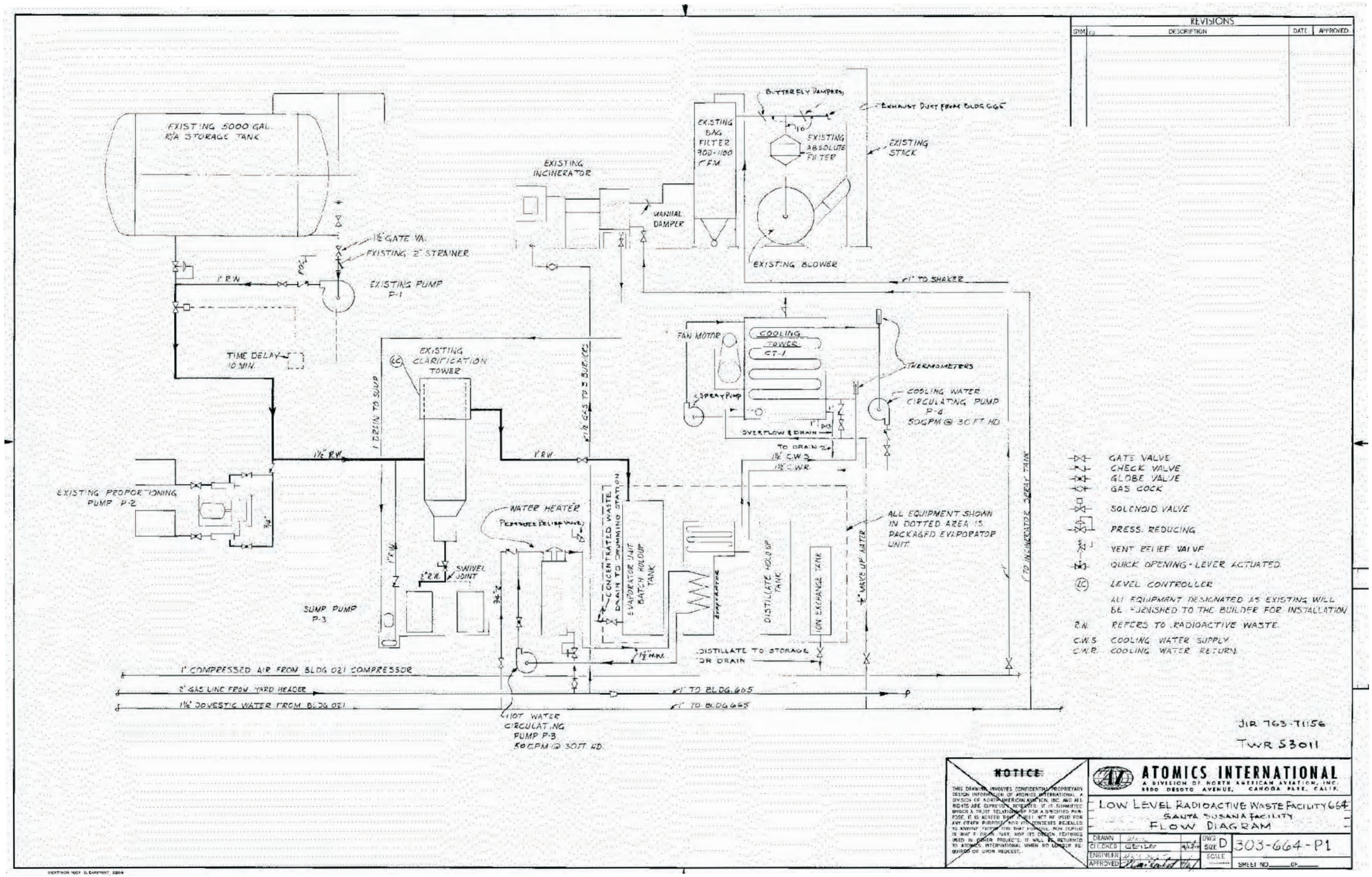

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Figure 2.11i
Building 4664
Flow Diagram

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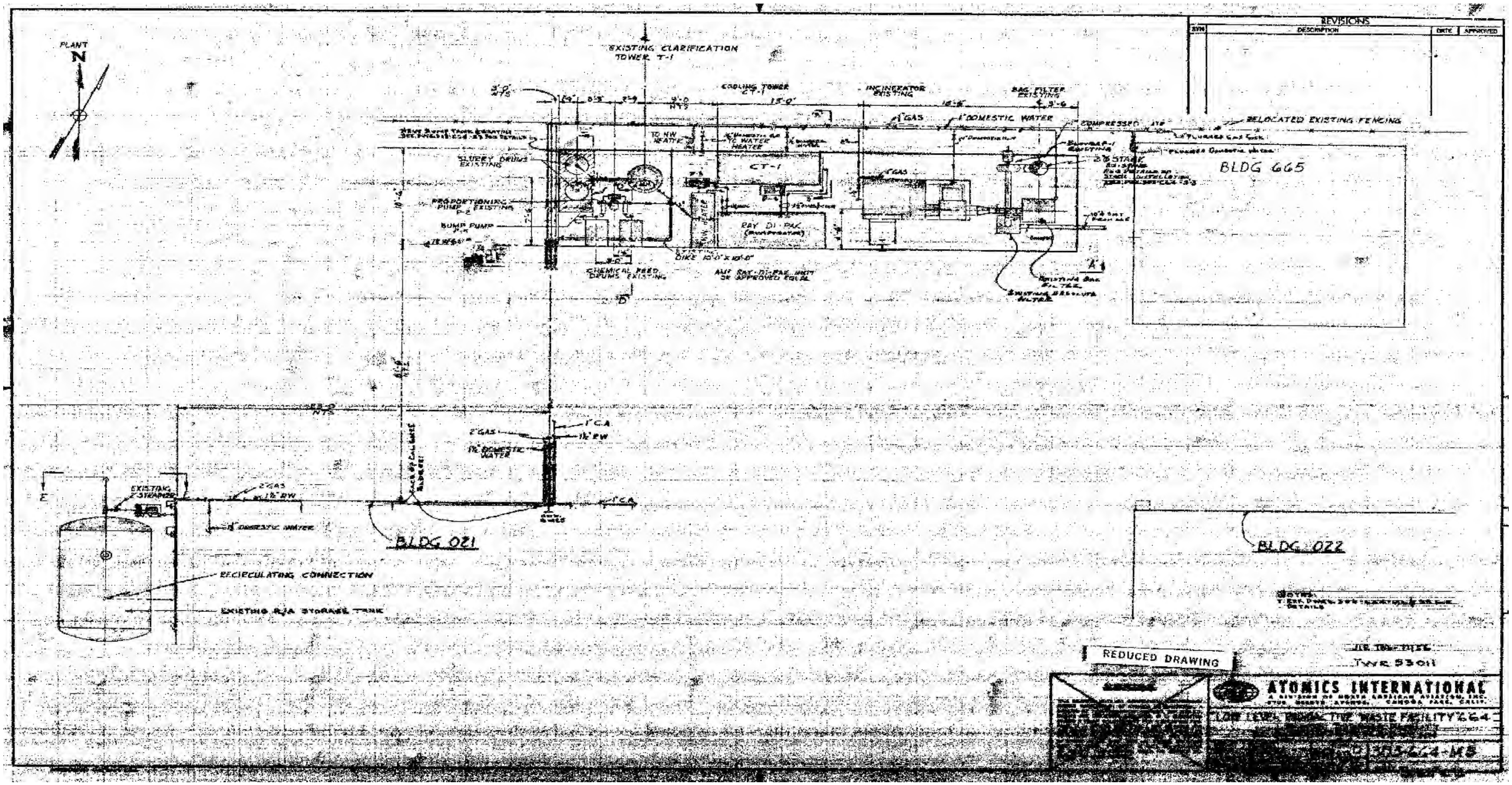

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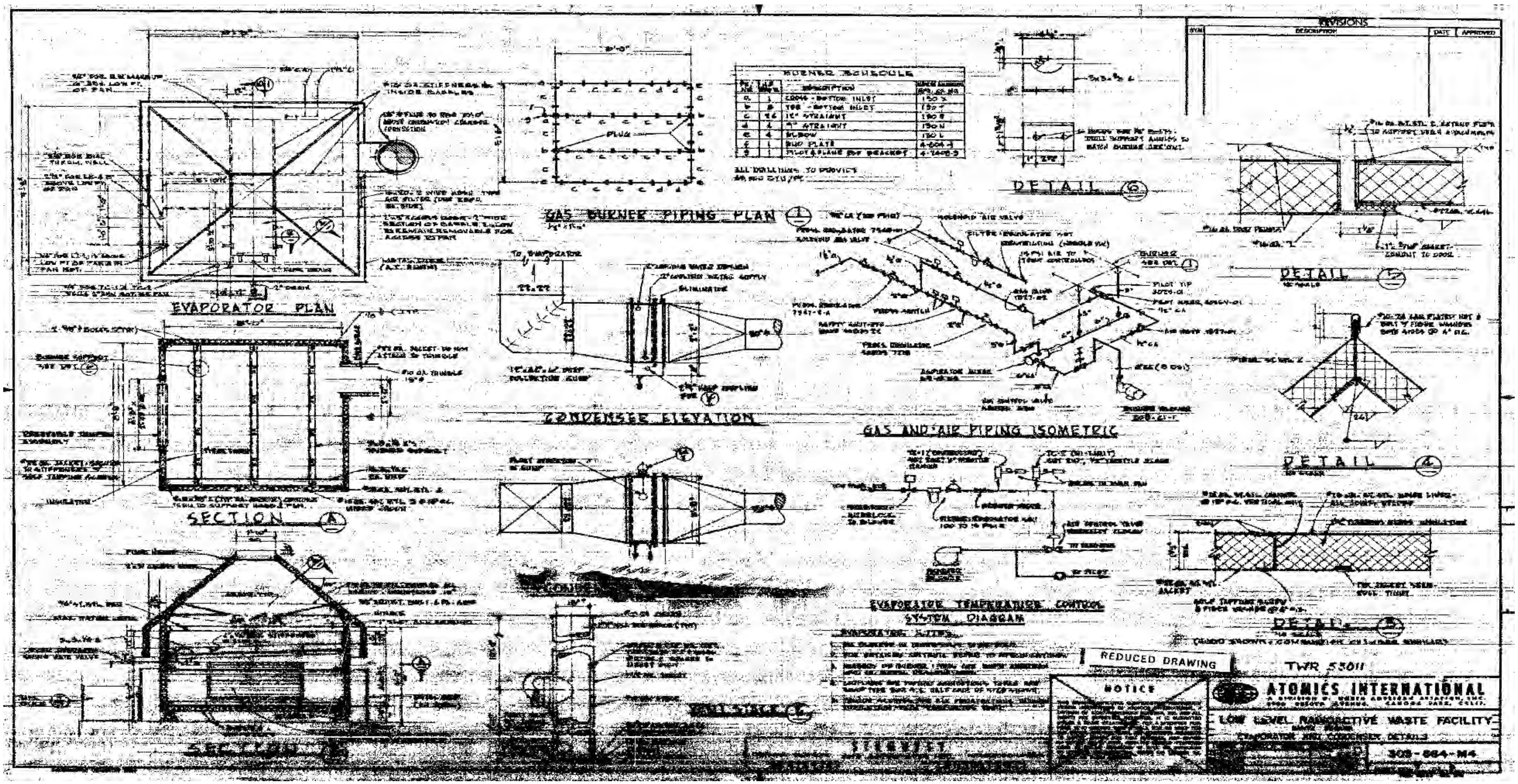
Figure 2.11j
Building 4664
Piping Plan



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Source: Boeing Company, 2008

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Figure 2.11k
Building 4664
Evaporator and Condenser Details

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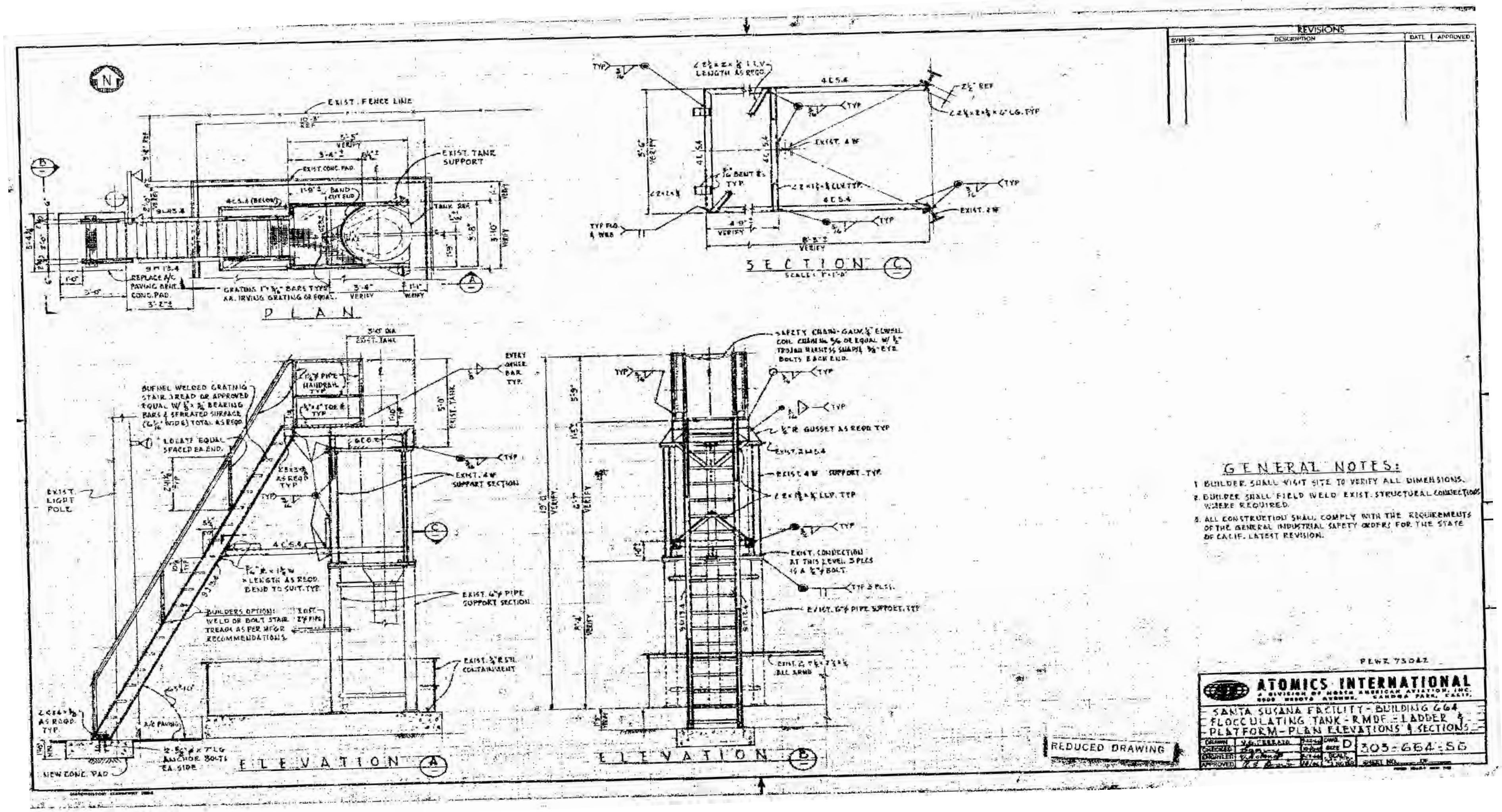

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Figure 2.11l
Building 4664
Flocculation Tank
Elevation and
Section Plans

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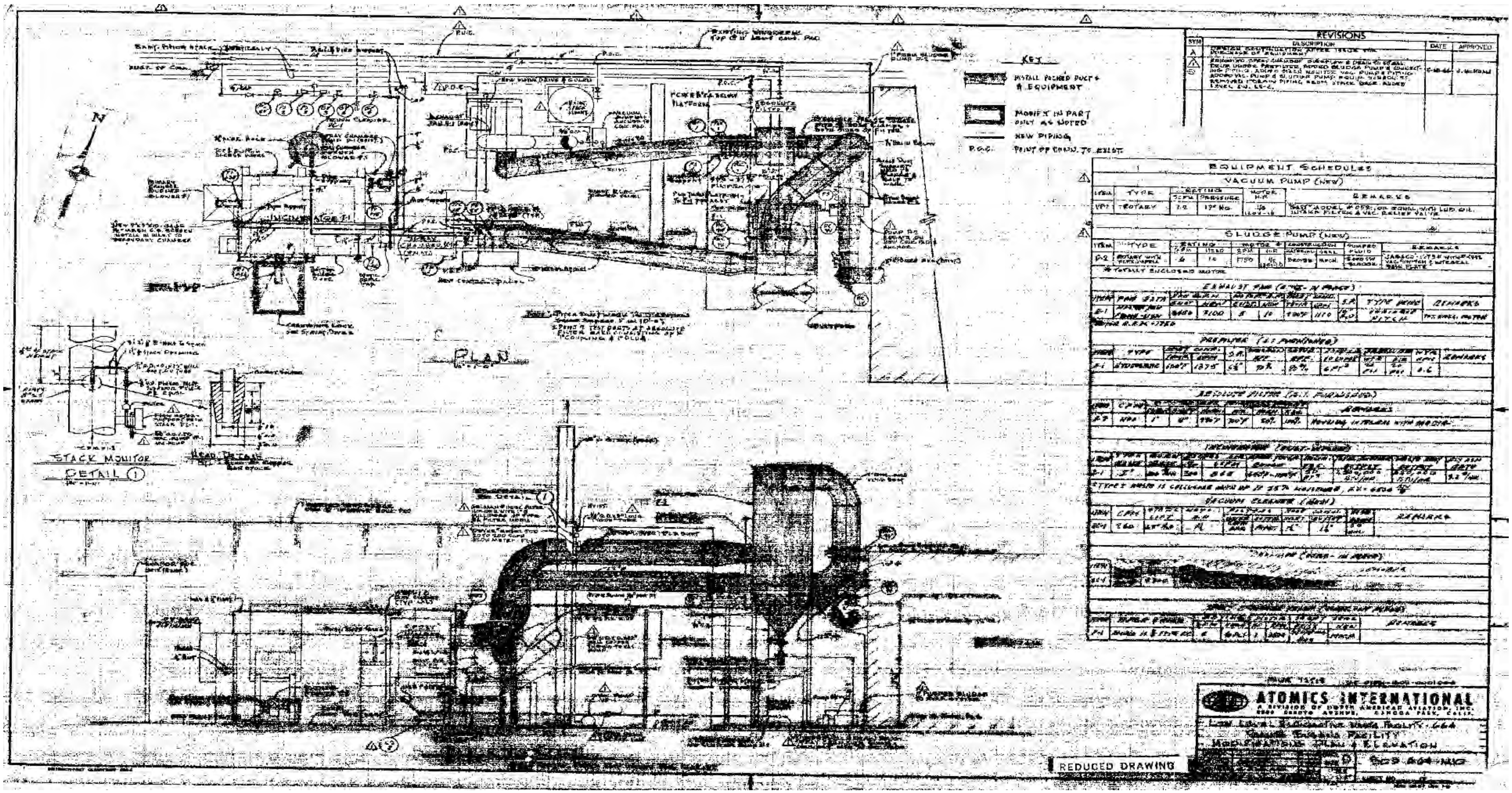

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Figure 2.11m
Building 4664
Modification Plan

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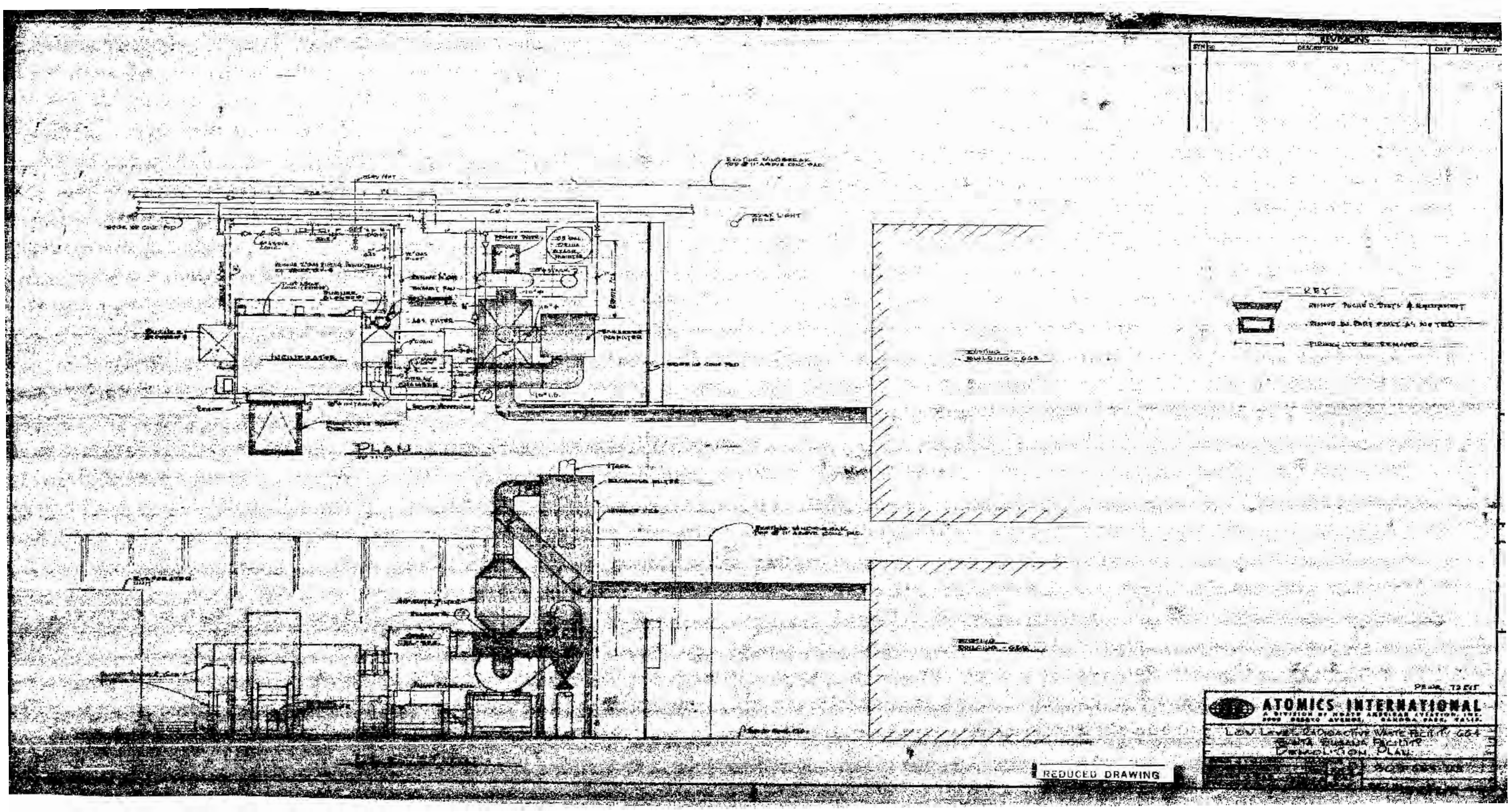

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Figure 2.11n
Building 4664
Demolition Plan

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Source: Boeing Company, 2008

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Figure 2.11o
Building 4664
Disturbed
Soil Area

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Source: Boeing Company, 2008

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Figure 2.12a
Building 4665
Site Photograph

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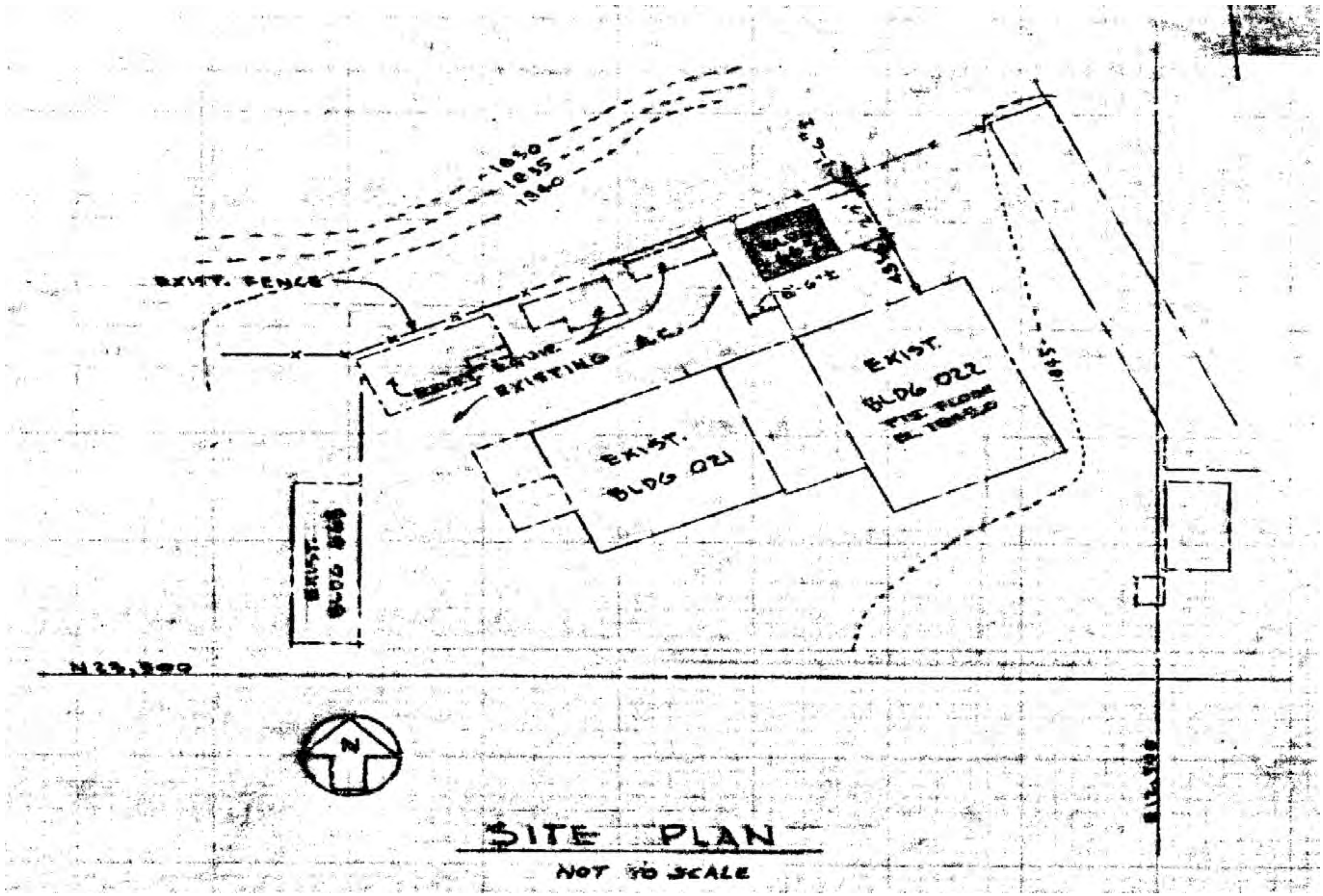

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Source: Boeing Company, 2008

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Figure 2.12b
Building 4665
Site Plan

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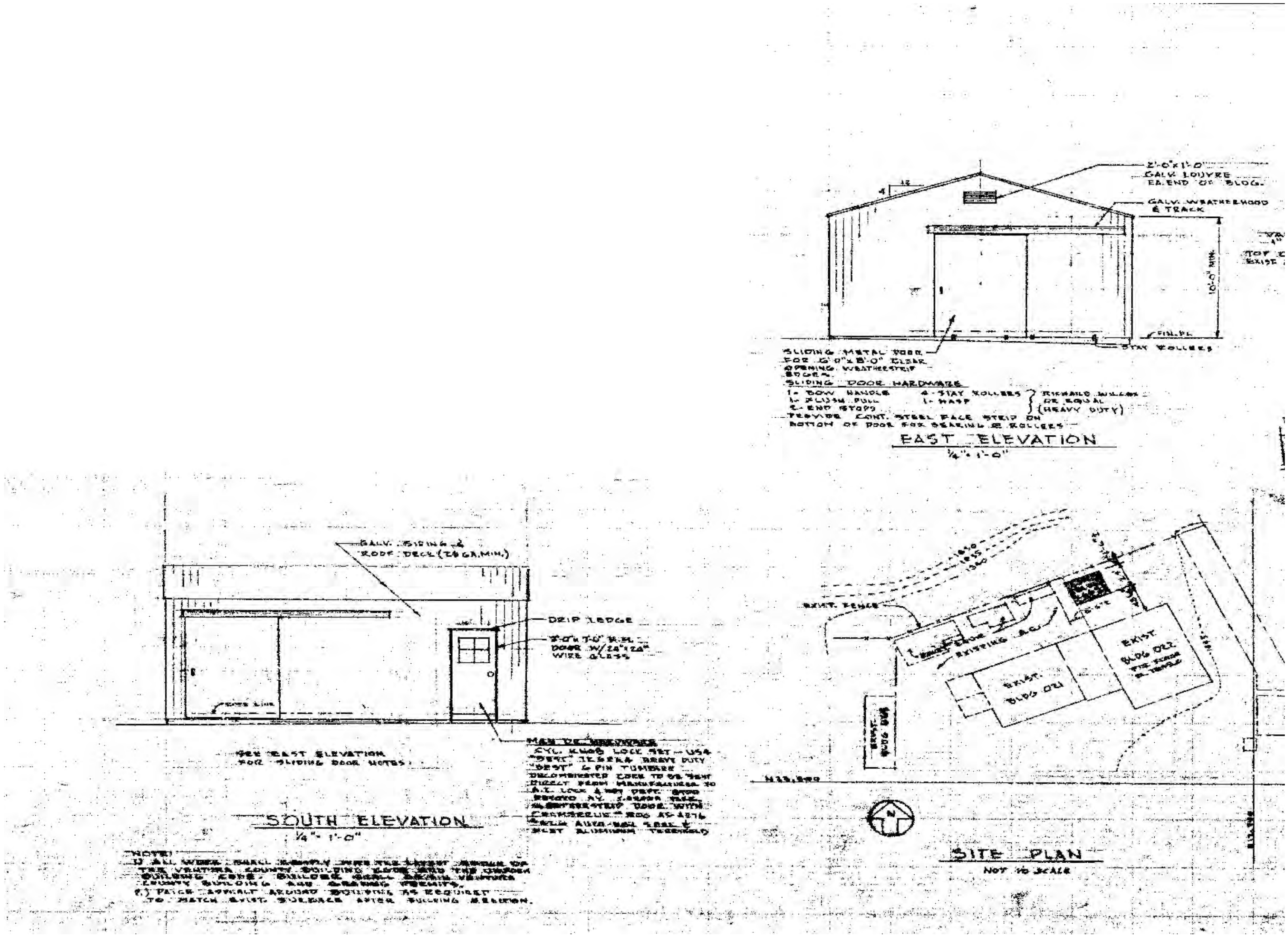

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Source: Boeing Company, 2008

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Figure 2.12c
Building 4665
Floor and
Elevation Plans

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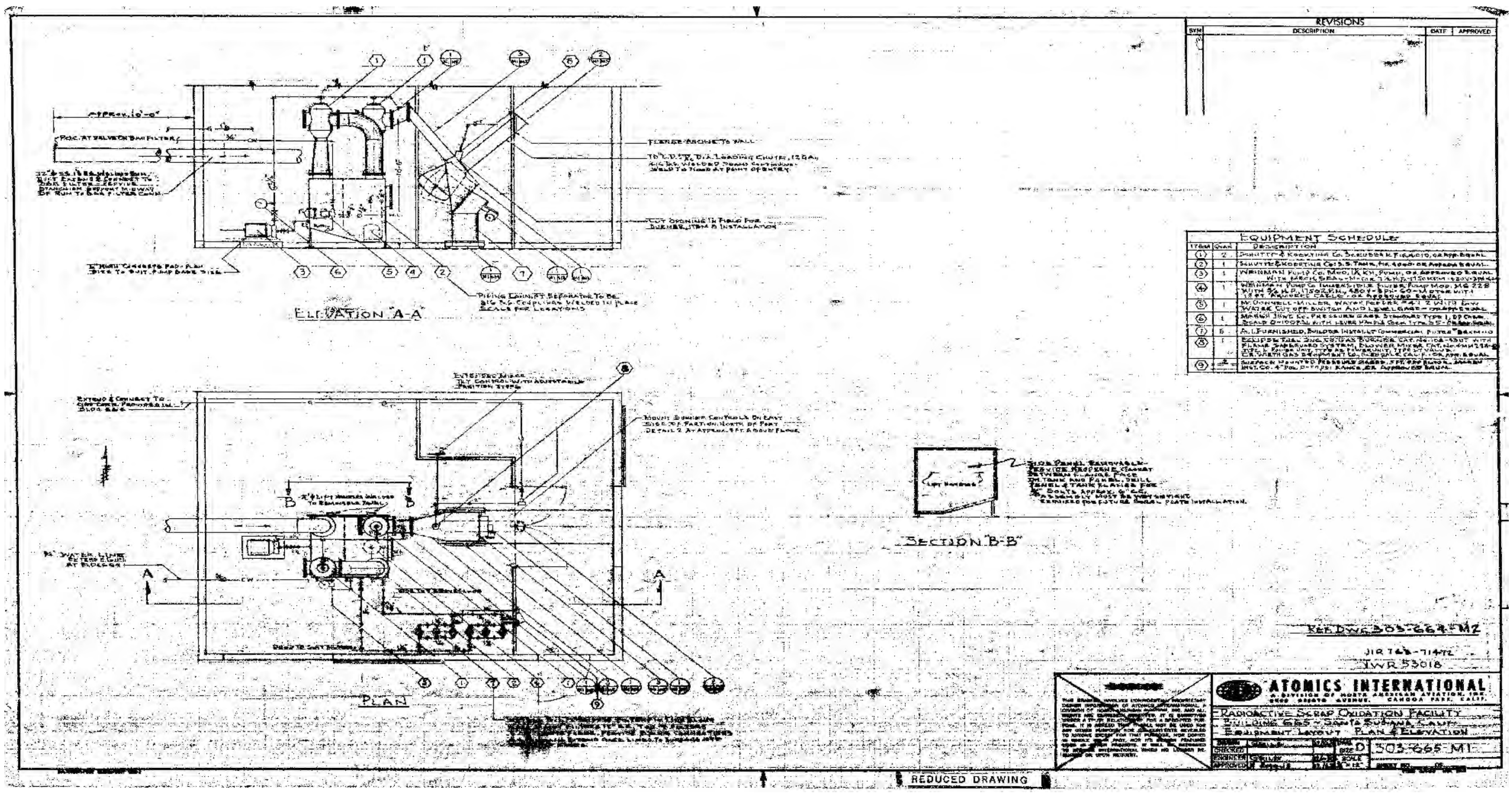

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**Figure 2.12d
Building 4665
Equipment Layout**

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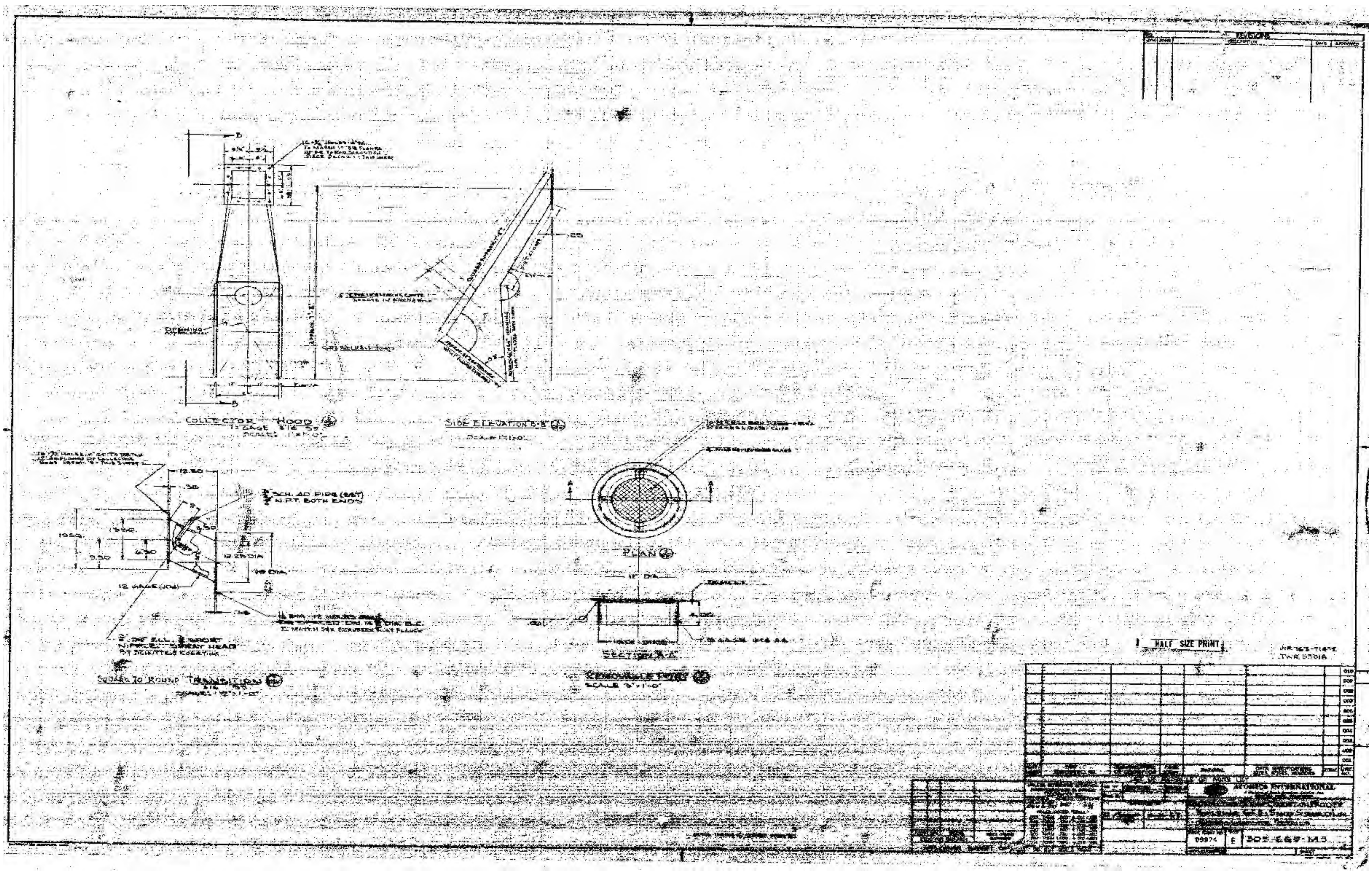

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Source: Boeing Company, 2008

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Figure 2.12e
Building 4665
Collection Hood
Details

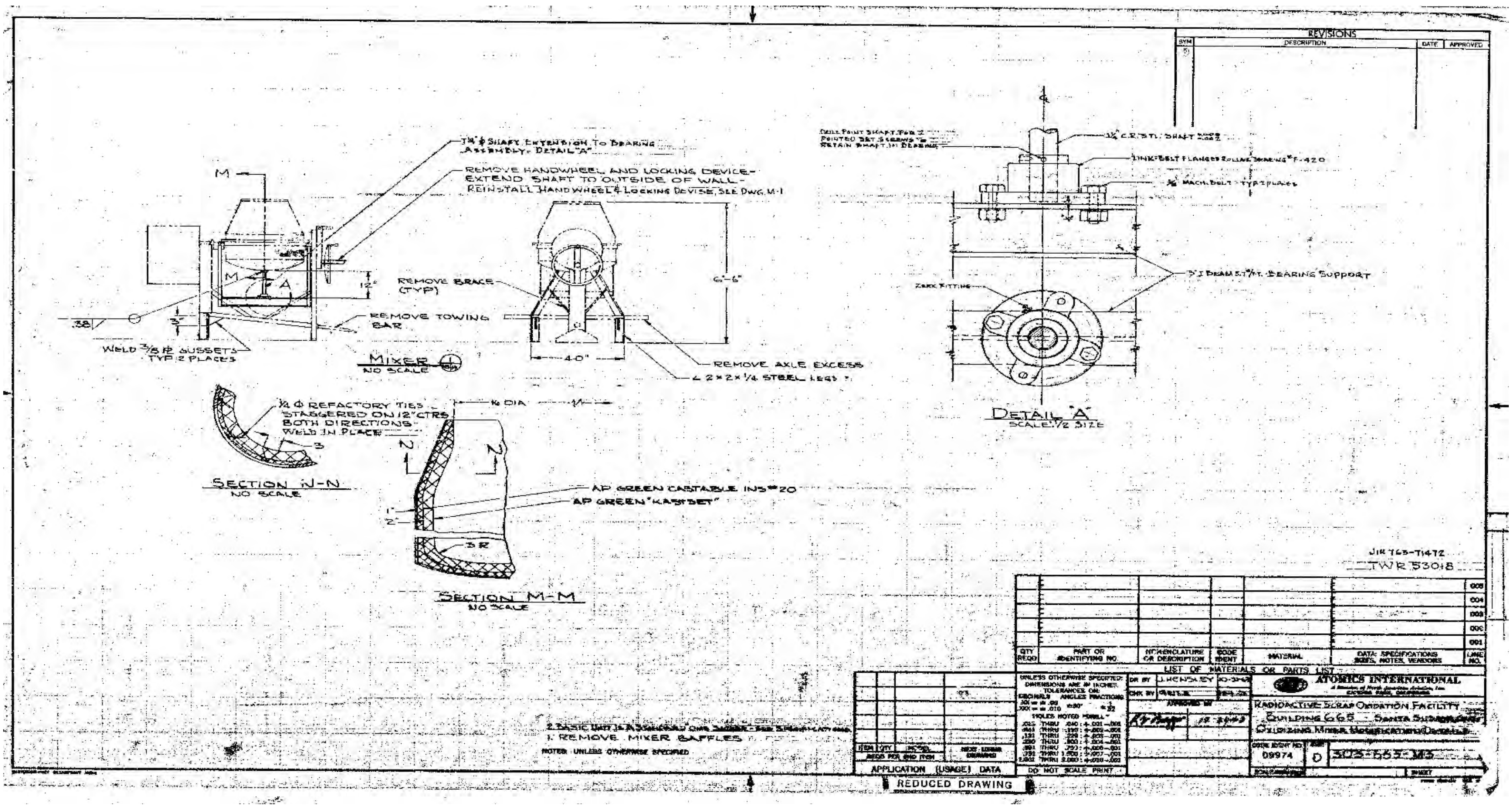

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**Figure 2.12f
Building 4665
Oxidizing Mixer
Details**

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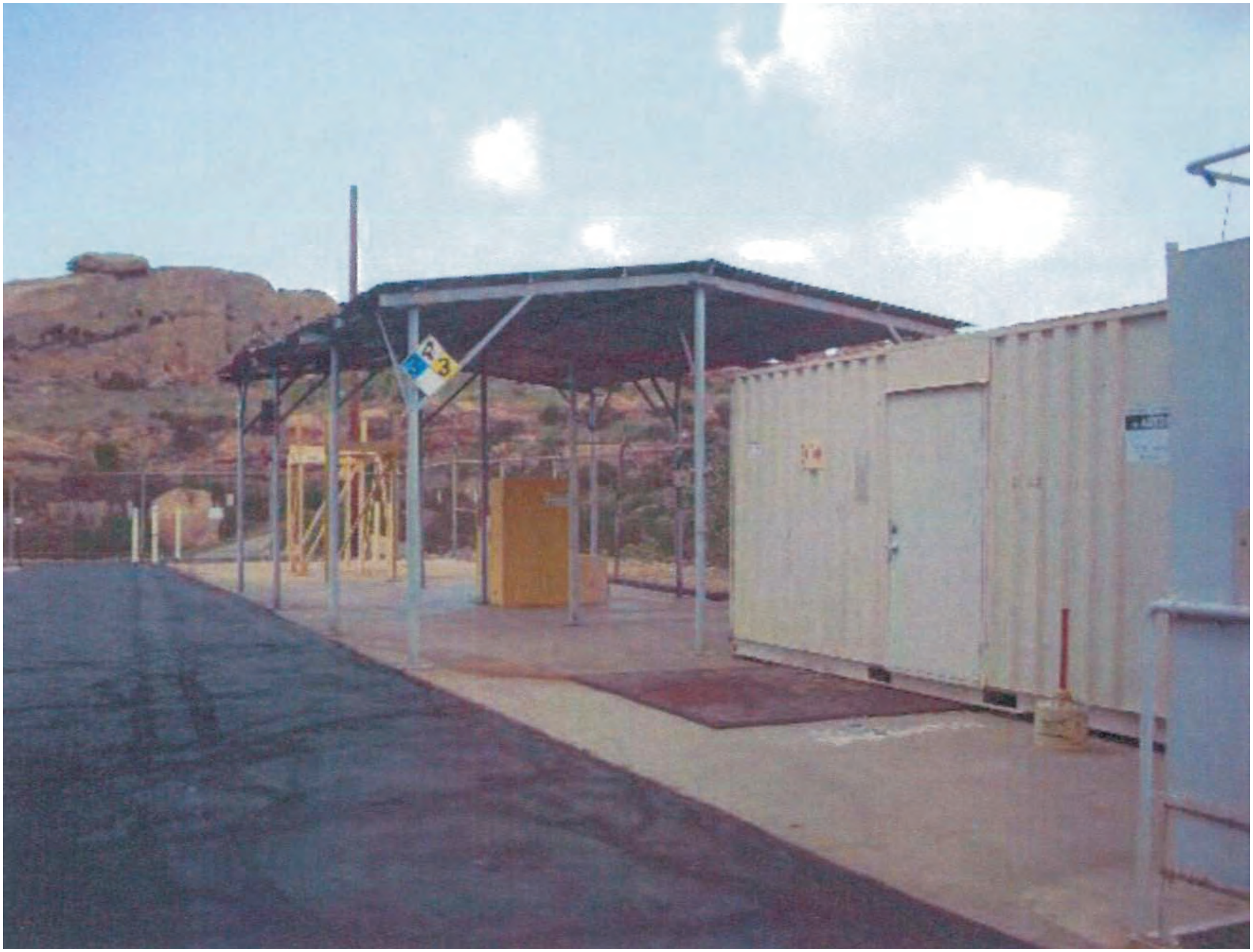

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Source: Boeing Company, 2008

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Figure 2.13a
Building 4688
Site Photograph

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Source: Boeing Company, 2008

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Figure 2.13b
Building 4688
Pouring Concrete Slab
1959

Redacted

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Revised: 07/05/11 TJ
Source: Boeing Company, 2008

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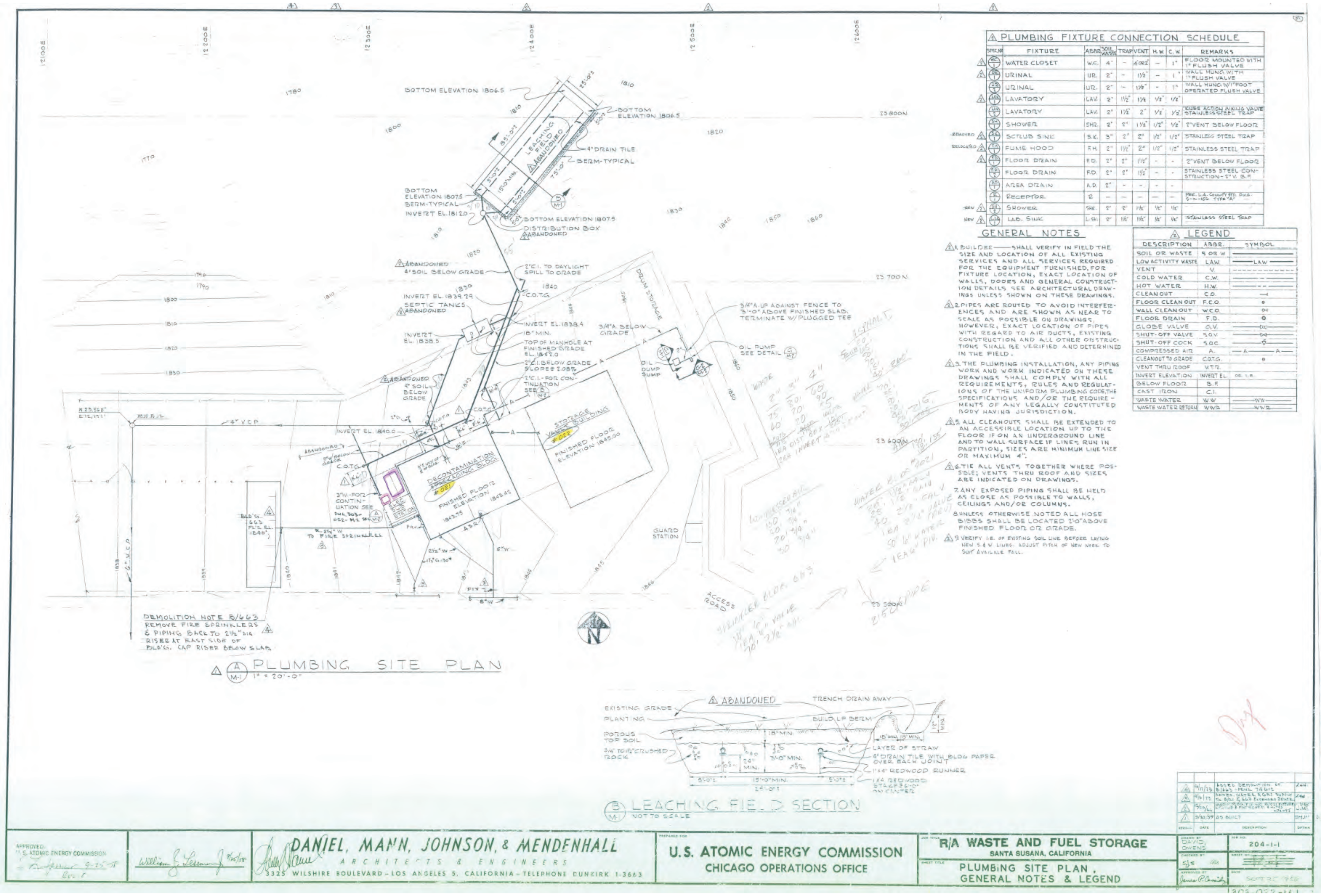
Figure 2.14a
RMHF Leach Field
Site Photograph



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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.14b
RMHF Leach Field Site Plan

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Revised: 07/05/11 TJ
Source: Boeing Company, 2008

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Figure 2.14c
RMHF Leach Field Excavation Aerial Views 1978

Redacted

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Revised: 07/05/11 TJ
Source: Boeing Company, 2008

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Figure 2.14d
RMHF Leach Field Excavation Photographs 1978

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Source: Boeing Company, 2008

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Figure 2.14e
RMHF Leach Field Grading Photograph 1978

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Source: Boeing Company, 2008

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Figure 2.14f
RMHF Leach Field Excavation Photograph 1978 Looking South

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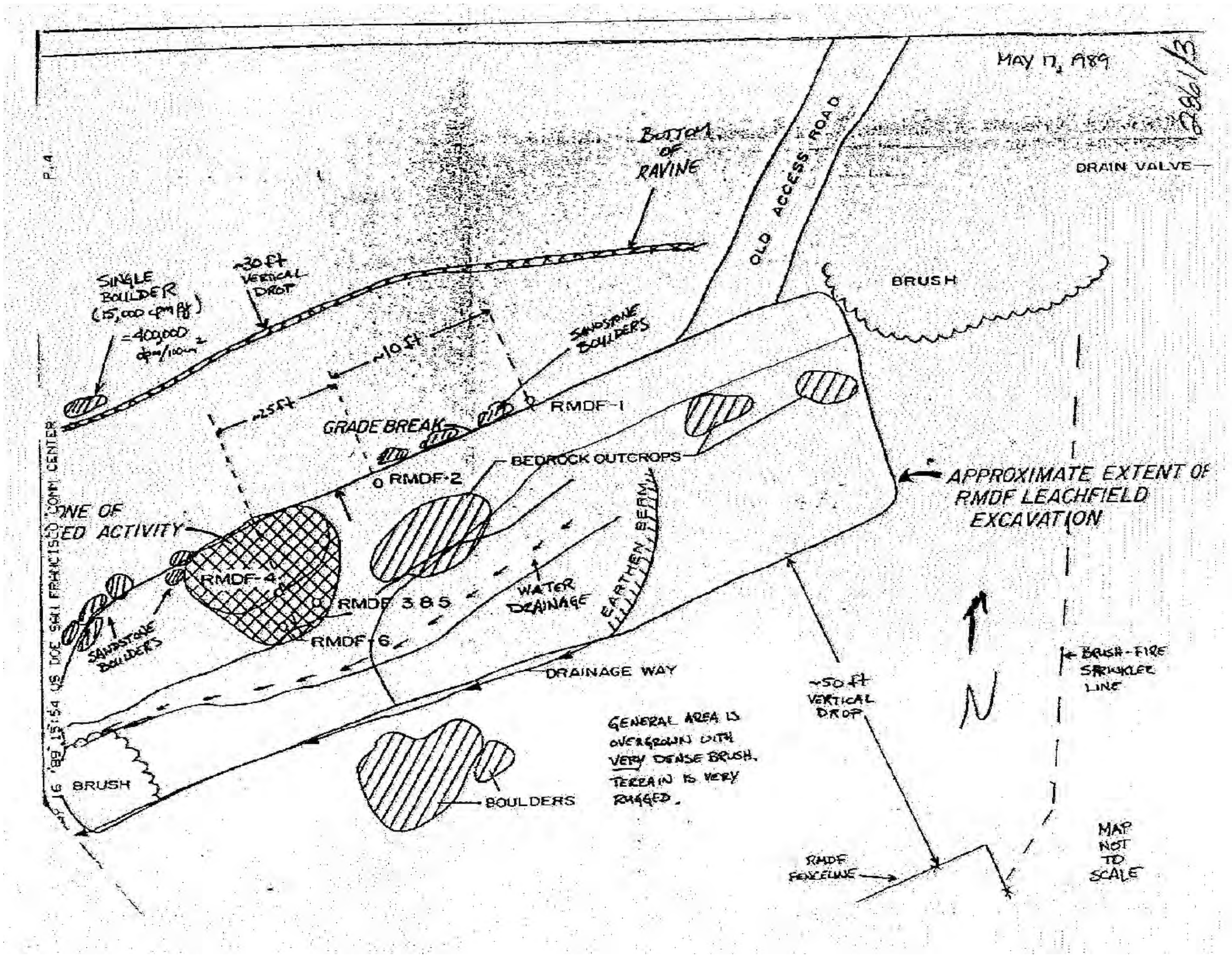

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Source: Boeing Company, 2008

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Figure 2.14g
RMHF Leach Field Sampling Map
1989

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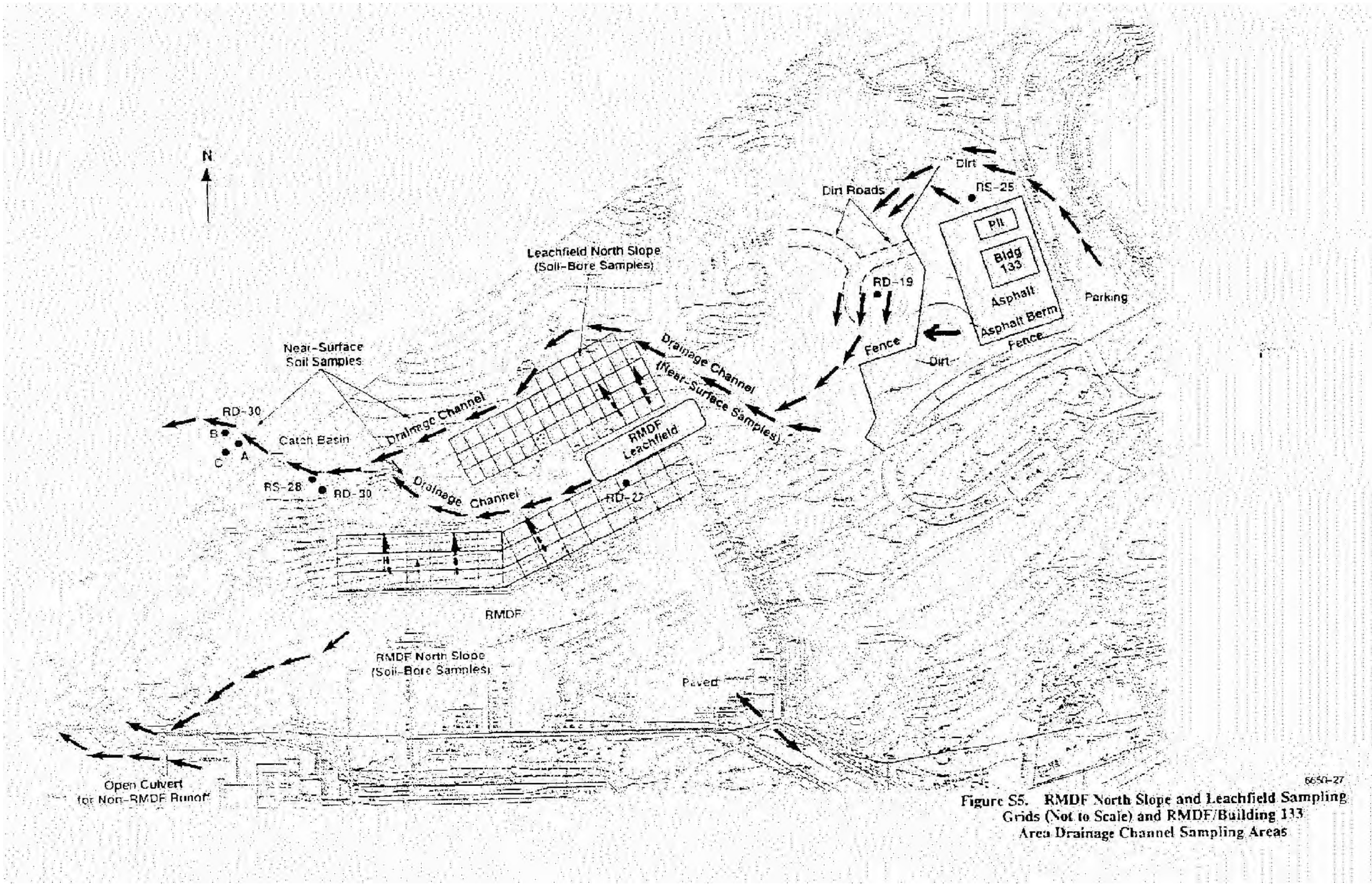

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Figure 2.14h
RMHF Leach Field Surface Drainage Diagram

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Source: Boeing Company, 2008

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Figure 2.15a
Building 4133
Site Photographs

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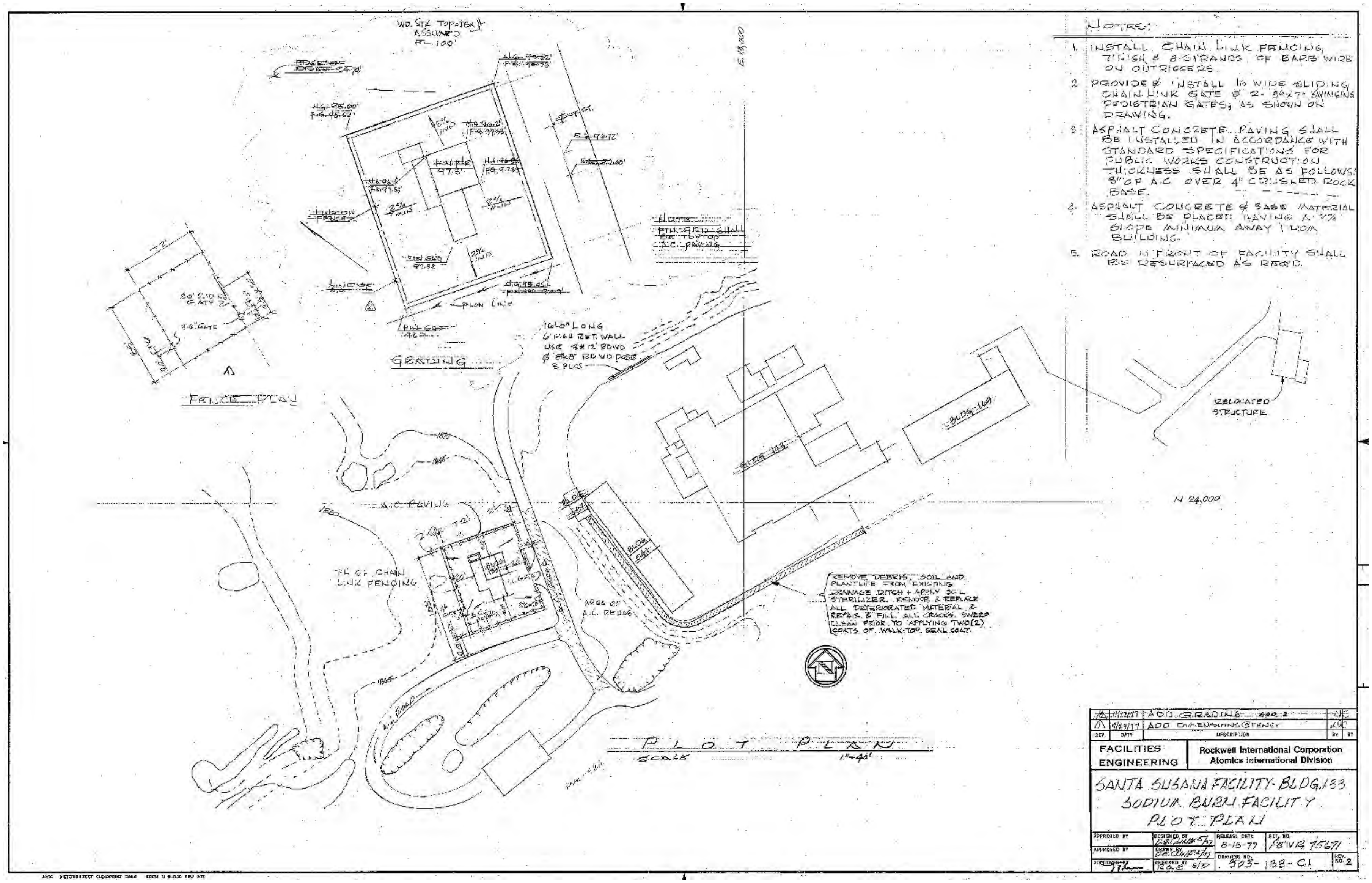
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.15b
Building 4133
Tank T-1
Photograph



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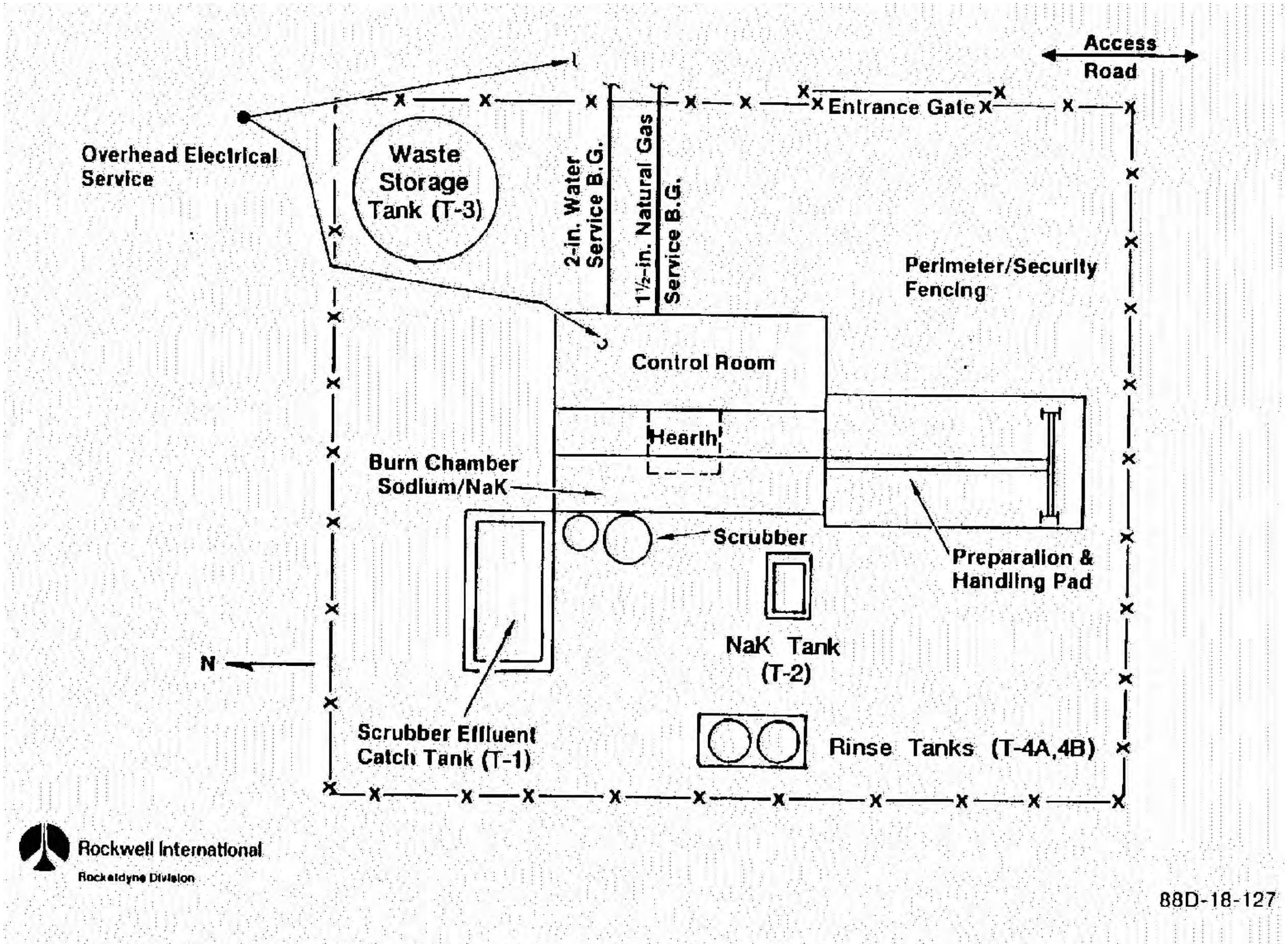

II-9 TREATMENT BUILDING T133 PLOT PLAN

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U.S. EPA Region 9

Figure 2.15d
Building 4133
Plot Plan
Schematic

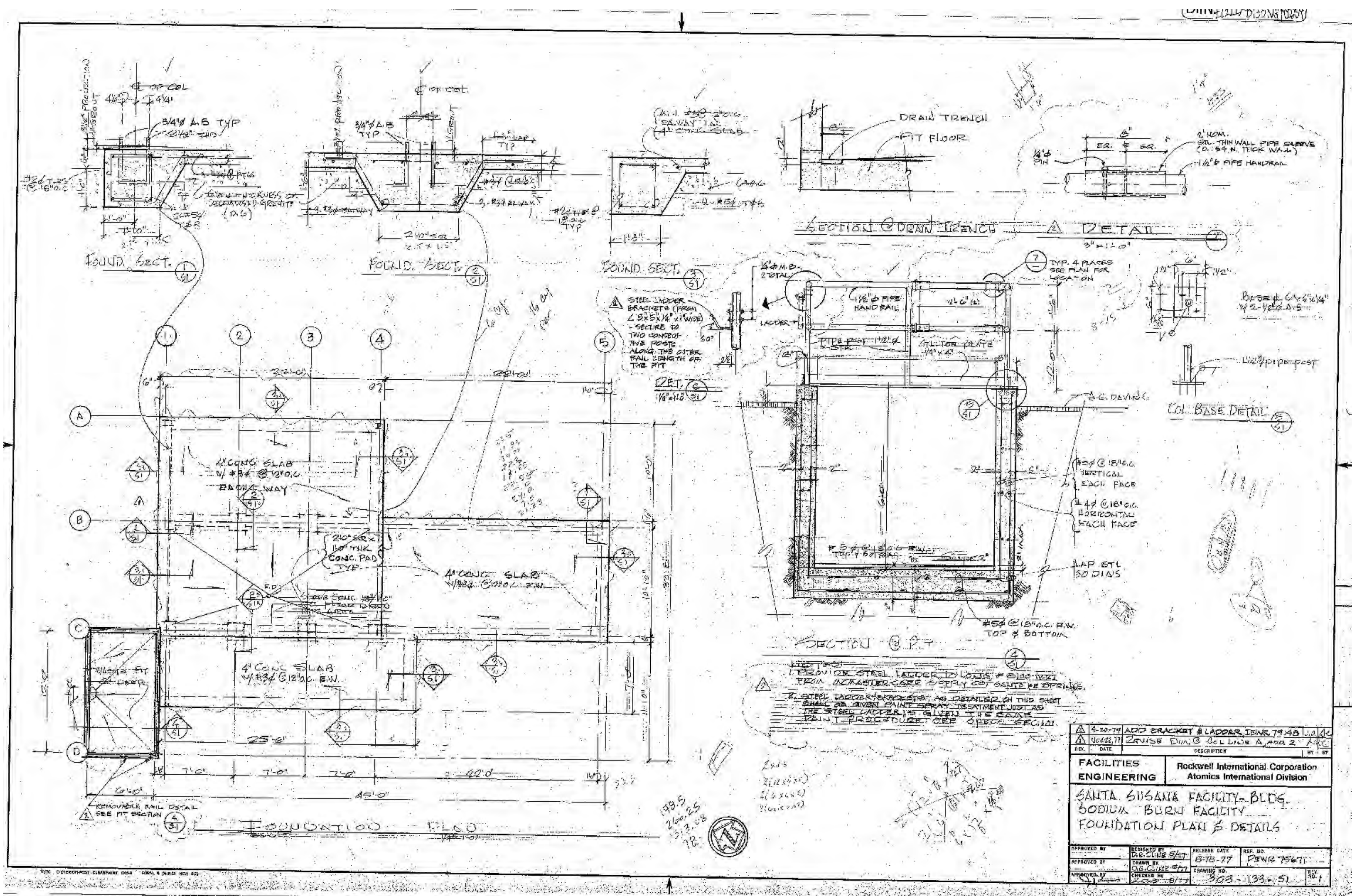

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Figure 2.15e
Building 4133
Foundation Plan

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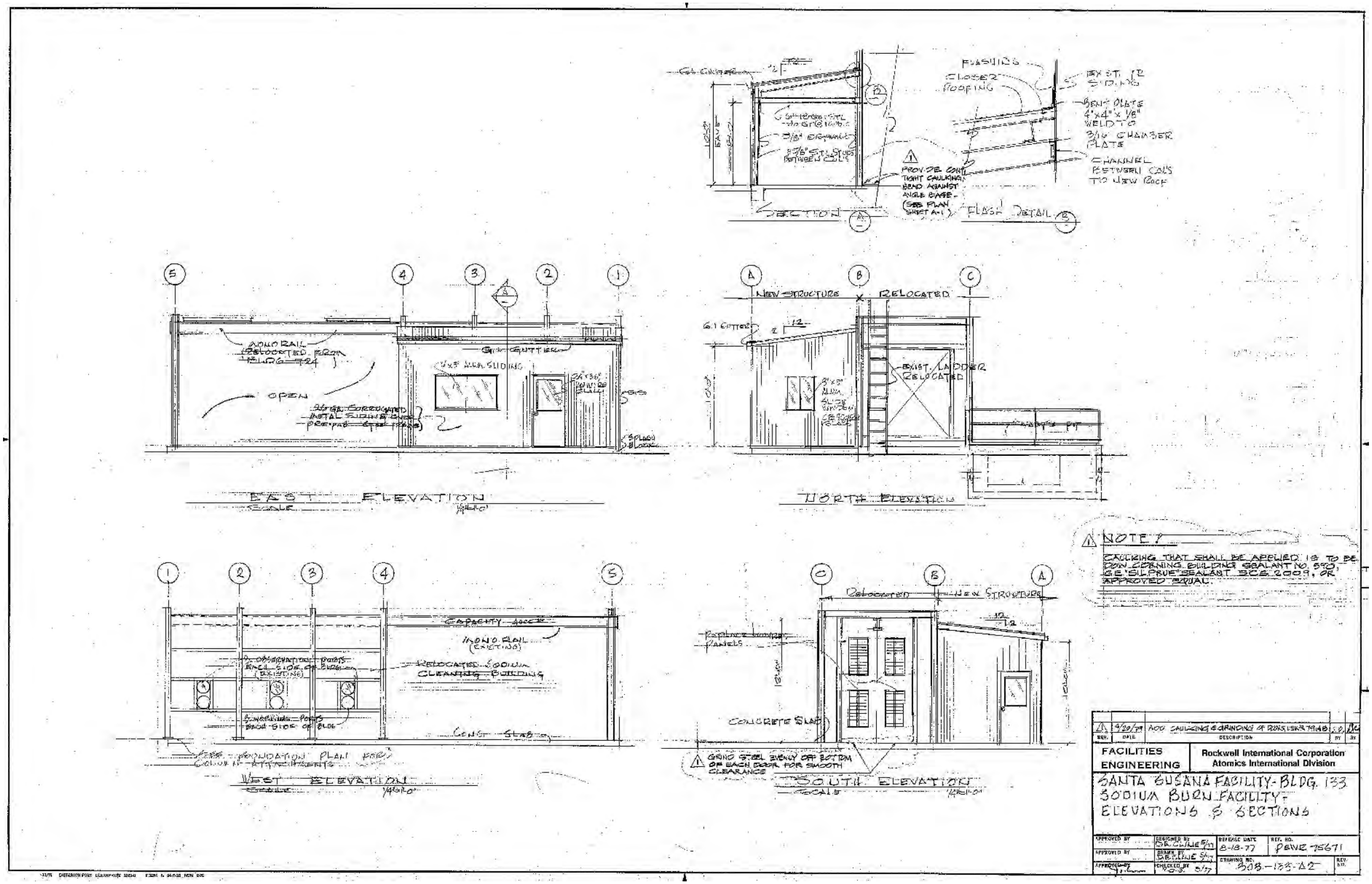

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U.S. EPA Region 9

Figure 2.15f
Building 4133
Elevation and Section Plan

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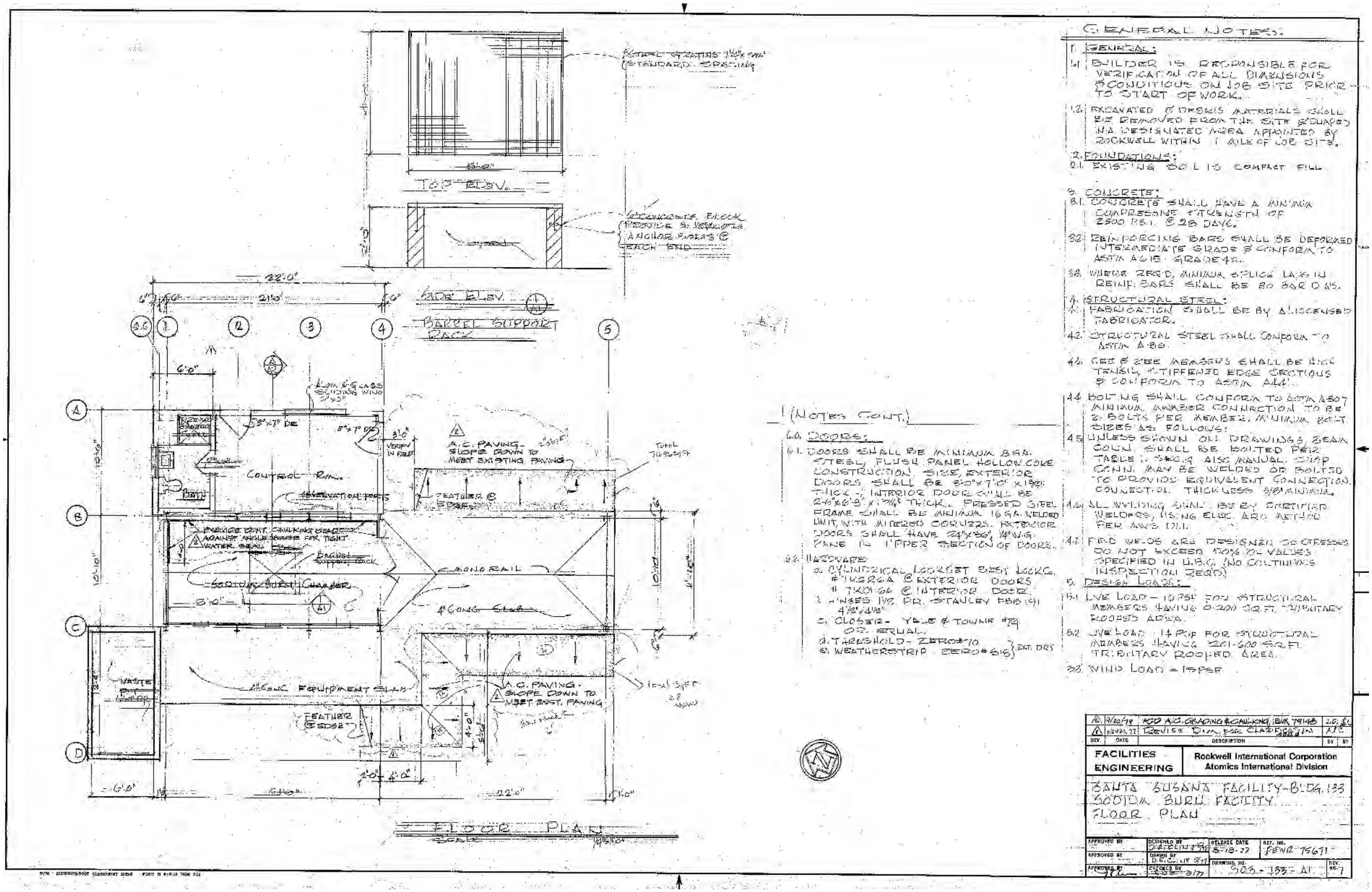

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Source: Boeing Company, 2008

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Figure 2.15g
Building 4133
Floor Plan

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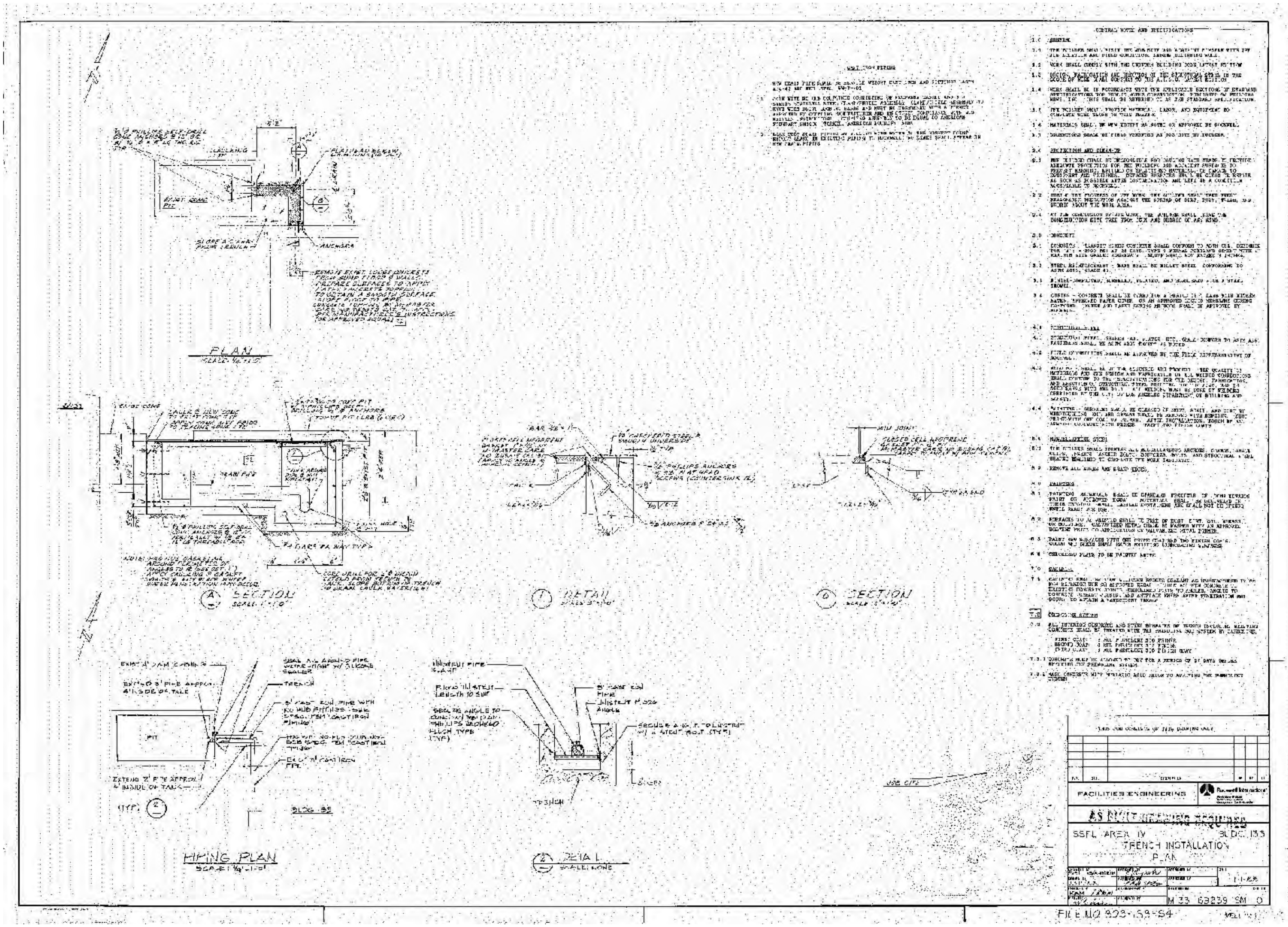

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Figure 2.15h
Building 4133
Trench Installation

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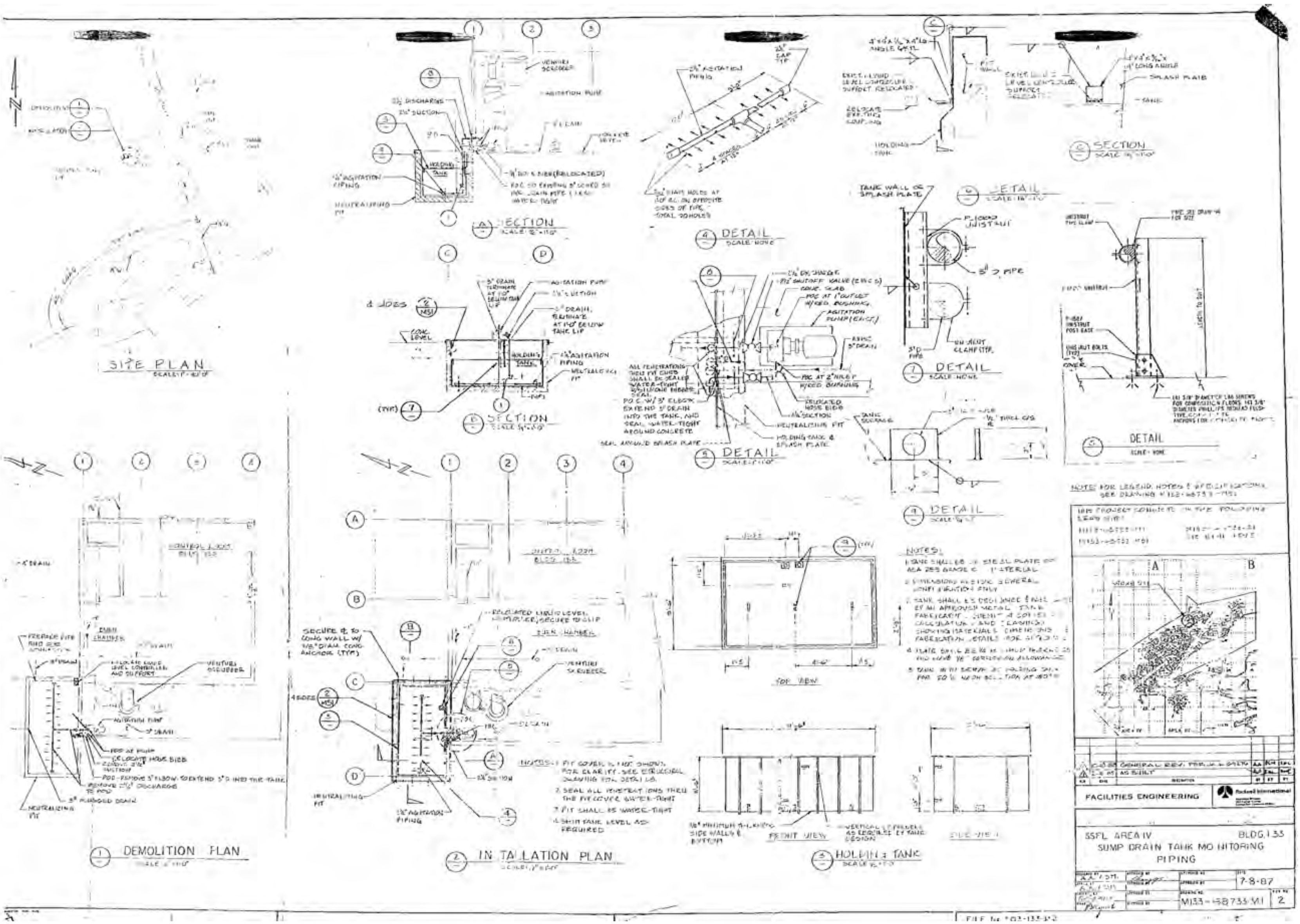

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Figure 2.15i
Building 4133
Sump Drain Tank
and Piping

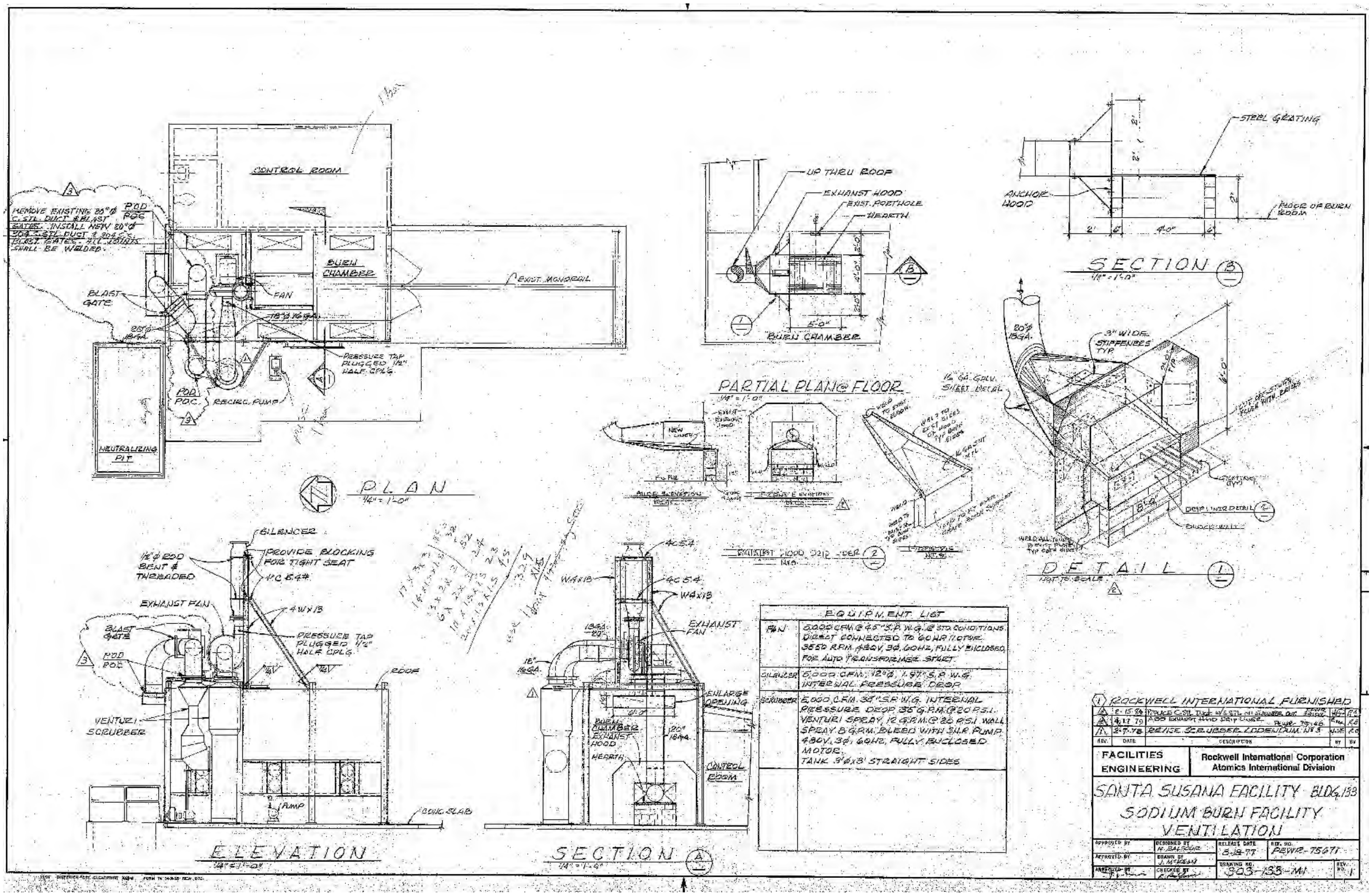

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Figure 2.15j
Building 4133
Ventilation Plan

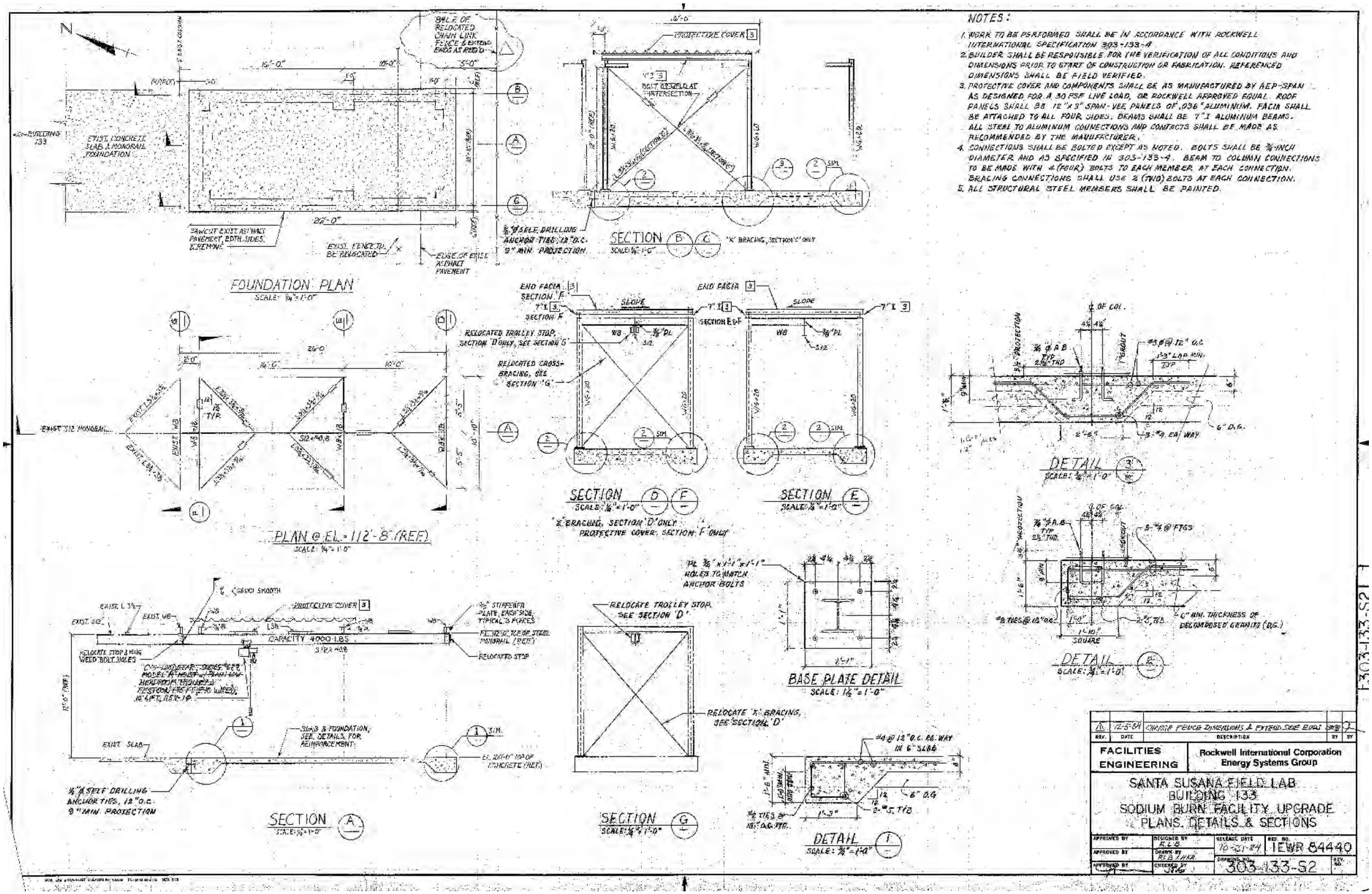

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Figure 2.15k
Building 4133
Upgrade Plans

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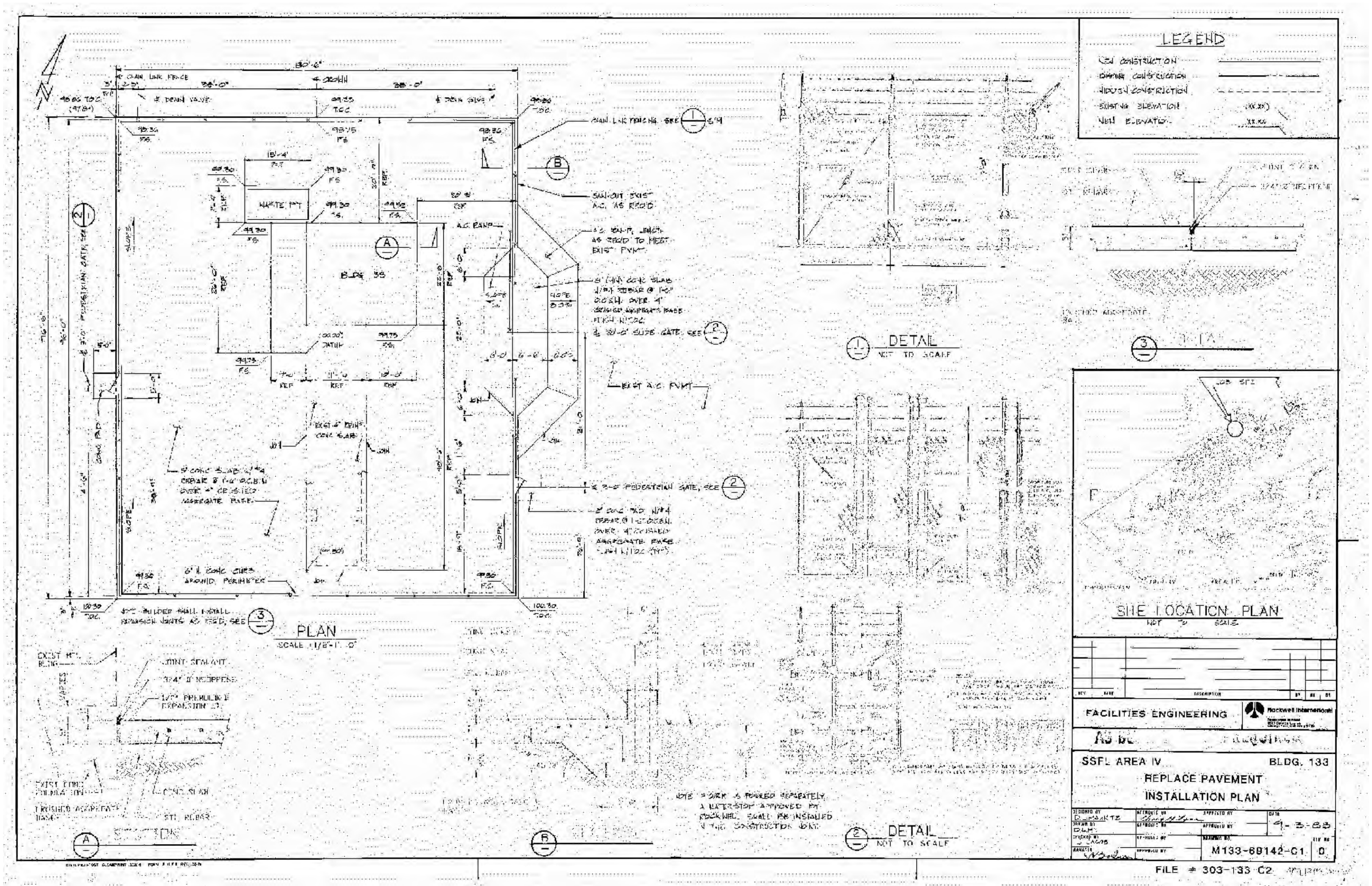

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Figure 2.15l
Building 4133
Pavement
Reinstallation Plan

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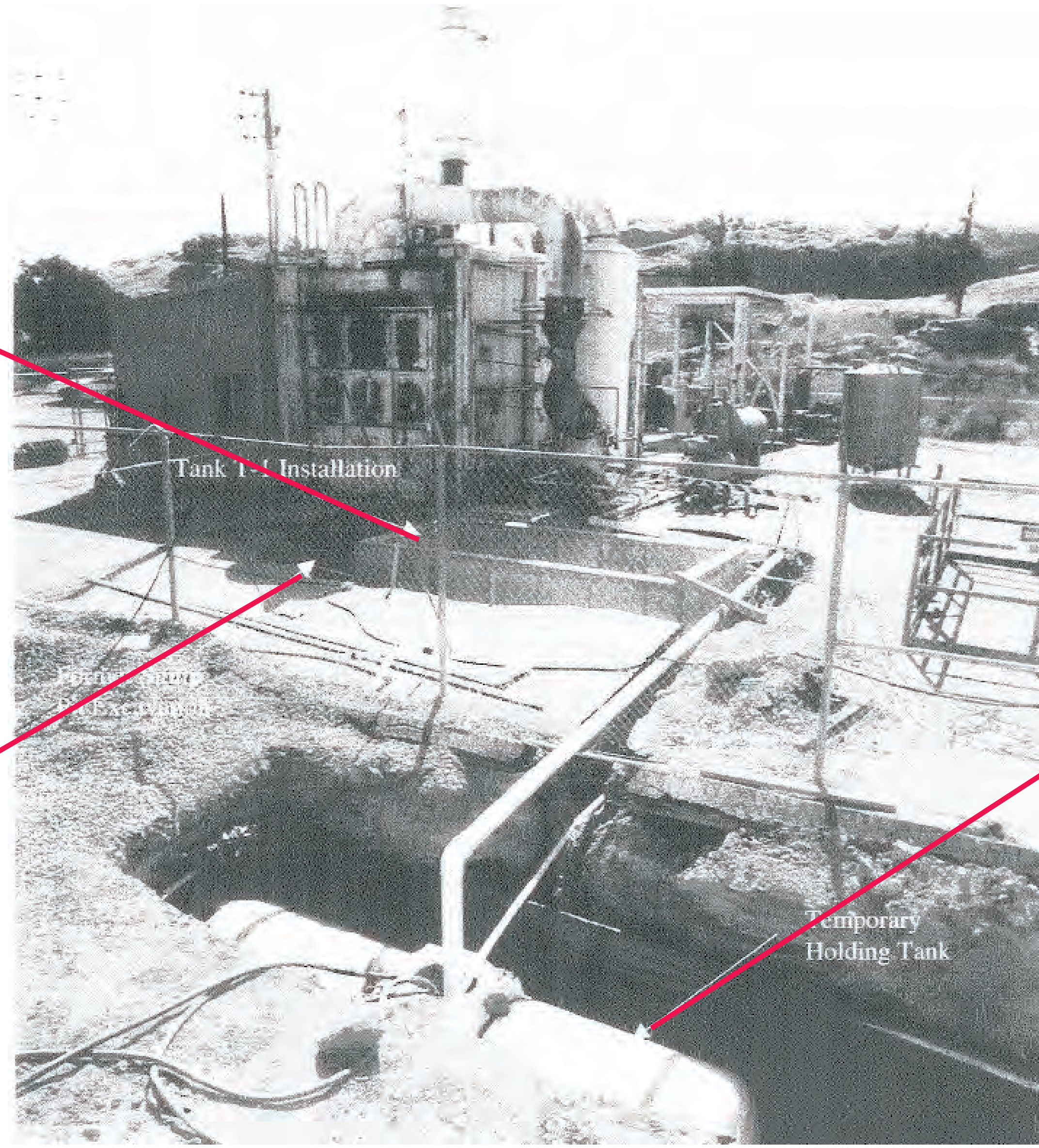

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Figure 2.15m
Building 4133
Tank T-1
Installation

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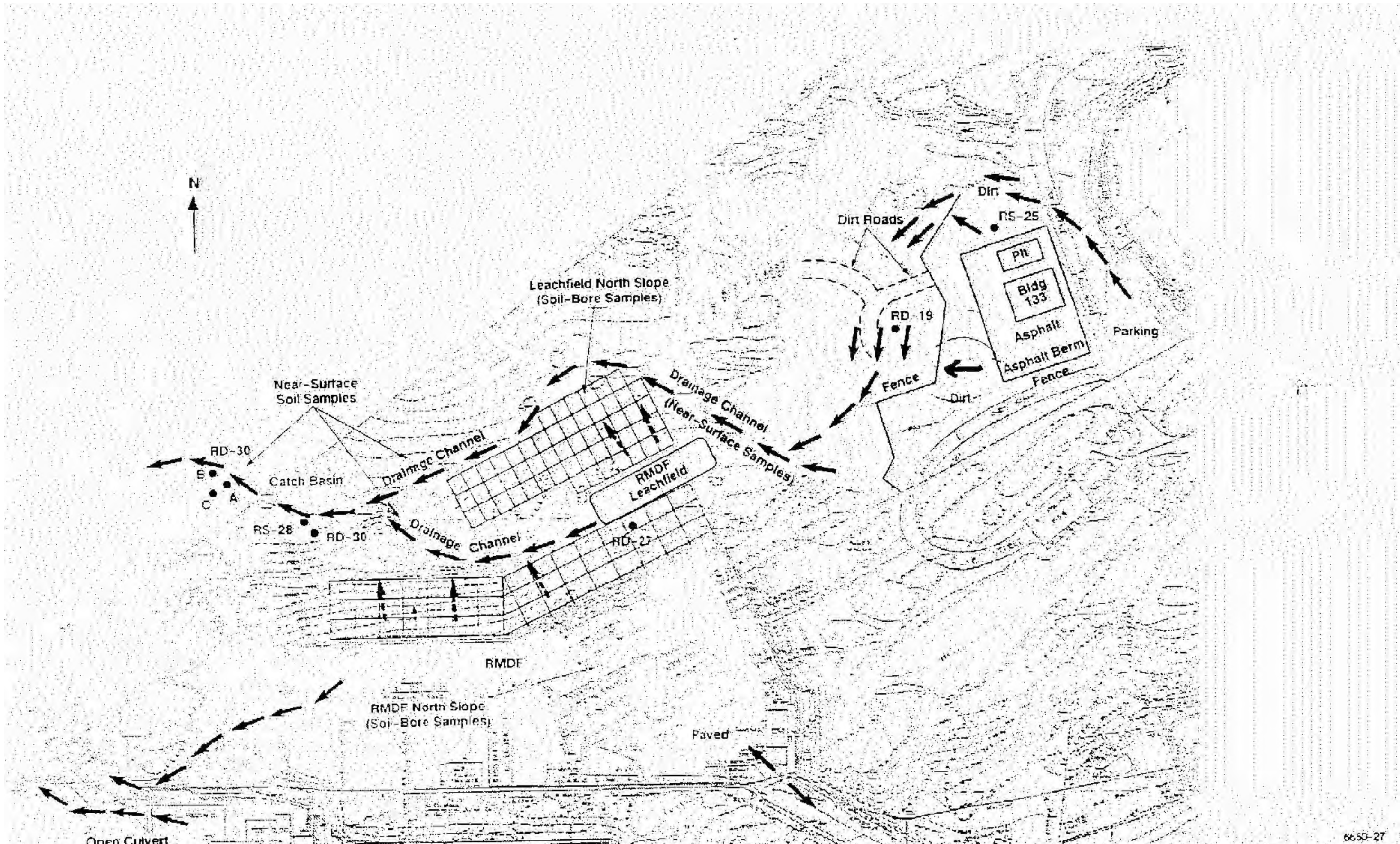

Figure S5. RMDF North Slope and Leachfield Sampling Grids (Not to Scale) and RMDF/Building 133 Area Drainage Channel Sampling Areas

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Source: Boeing Company, 2008

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Figure 2.15n
Building 4133
Surface Drainage
Diagram

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Revised: 07/05/11 TJ
Source: Boeing Company, 2008

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Figure 2.16a
Building 4654
Site Photograph
2011

Redacted

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Source: Boeing Company, 2008

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Figure 2.16b
Building 4654
Site Photograph
1983

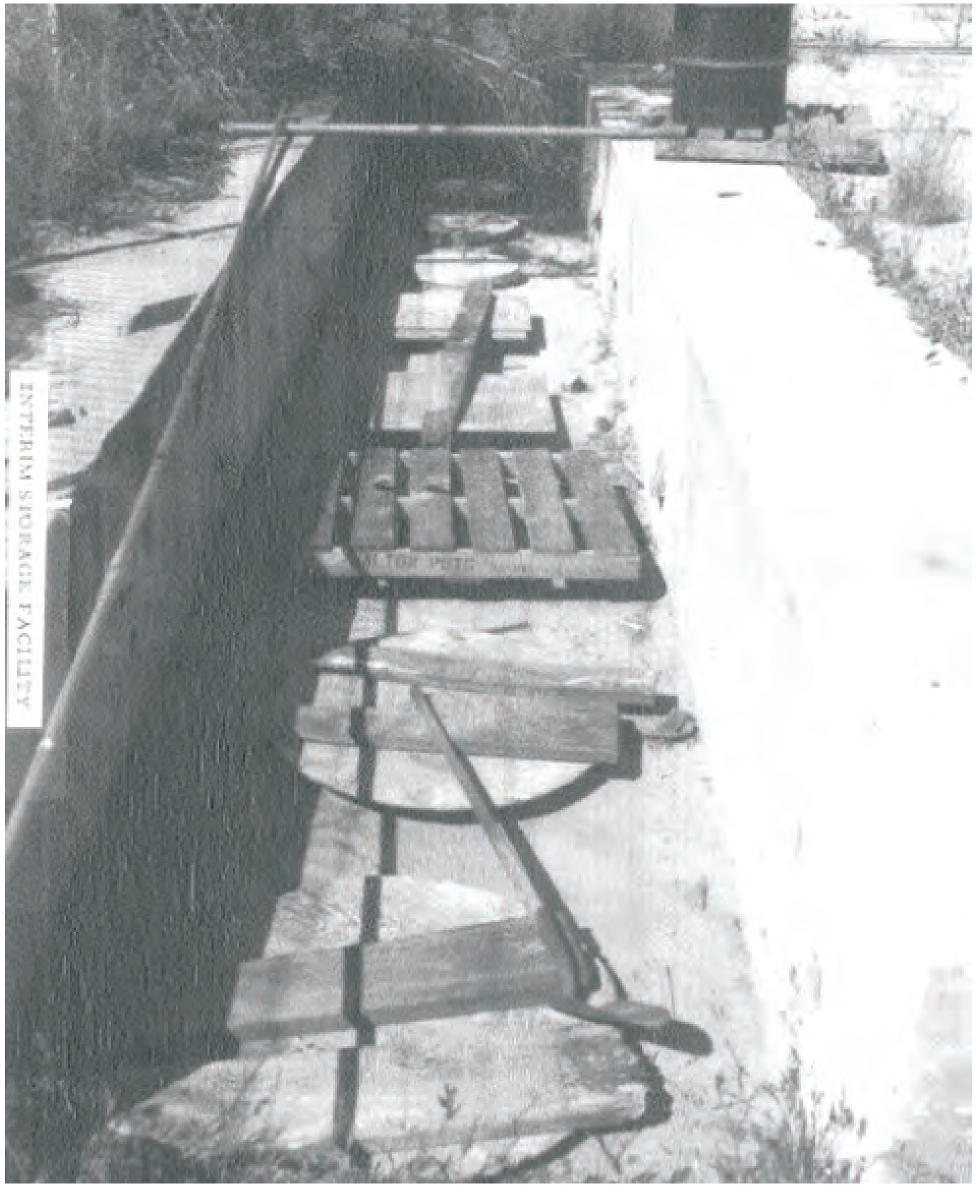

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Figure 2.16c
Building 4654
Trench Photograph

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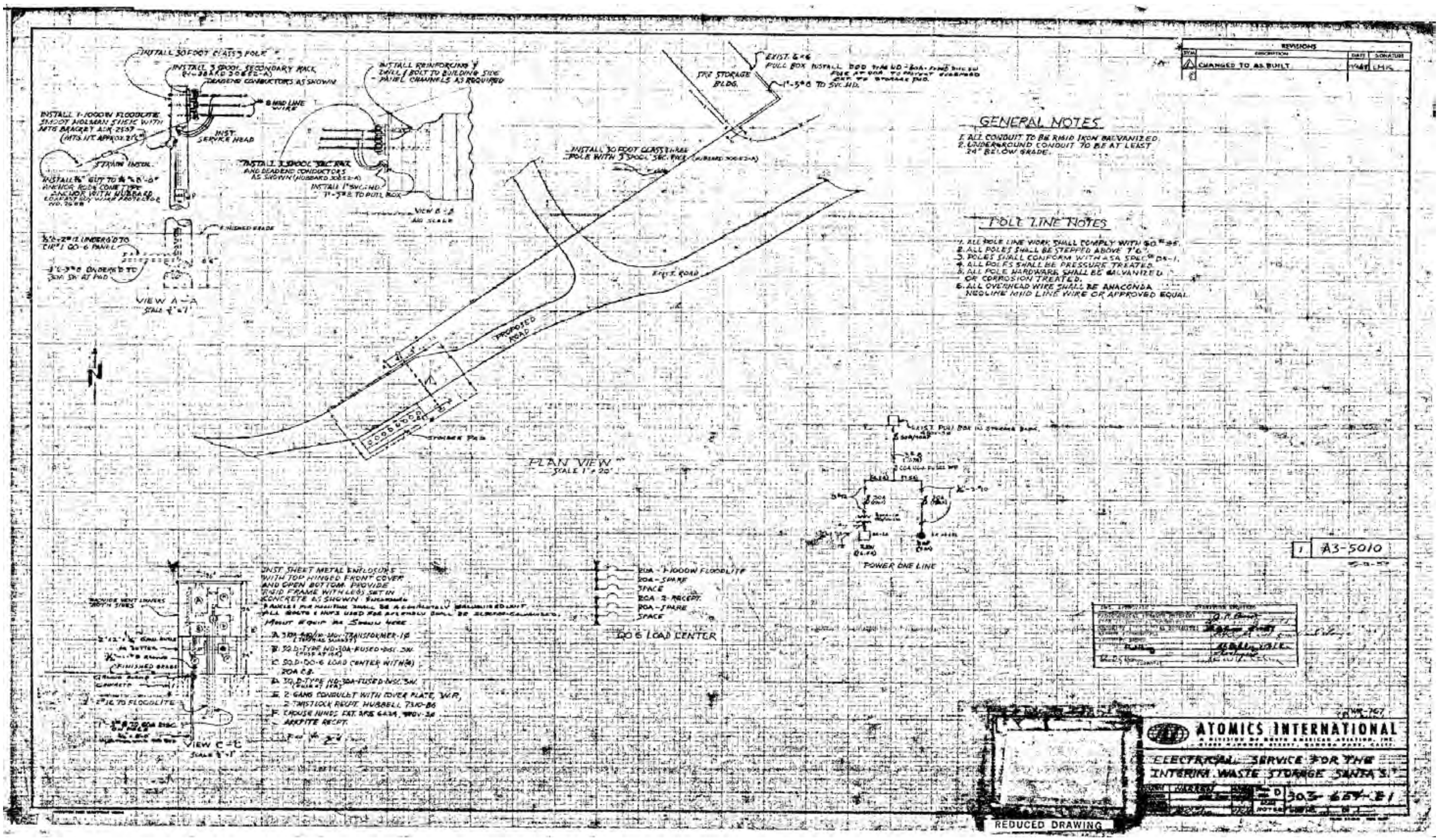

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Figure 2.16d
Building 4654
Plot Plan

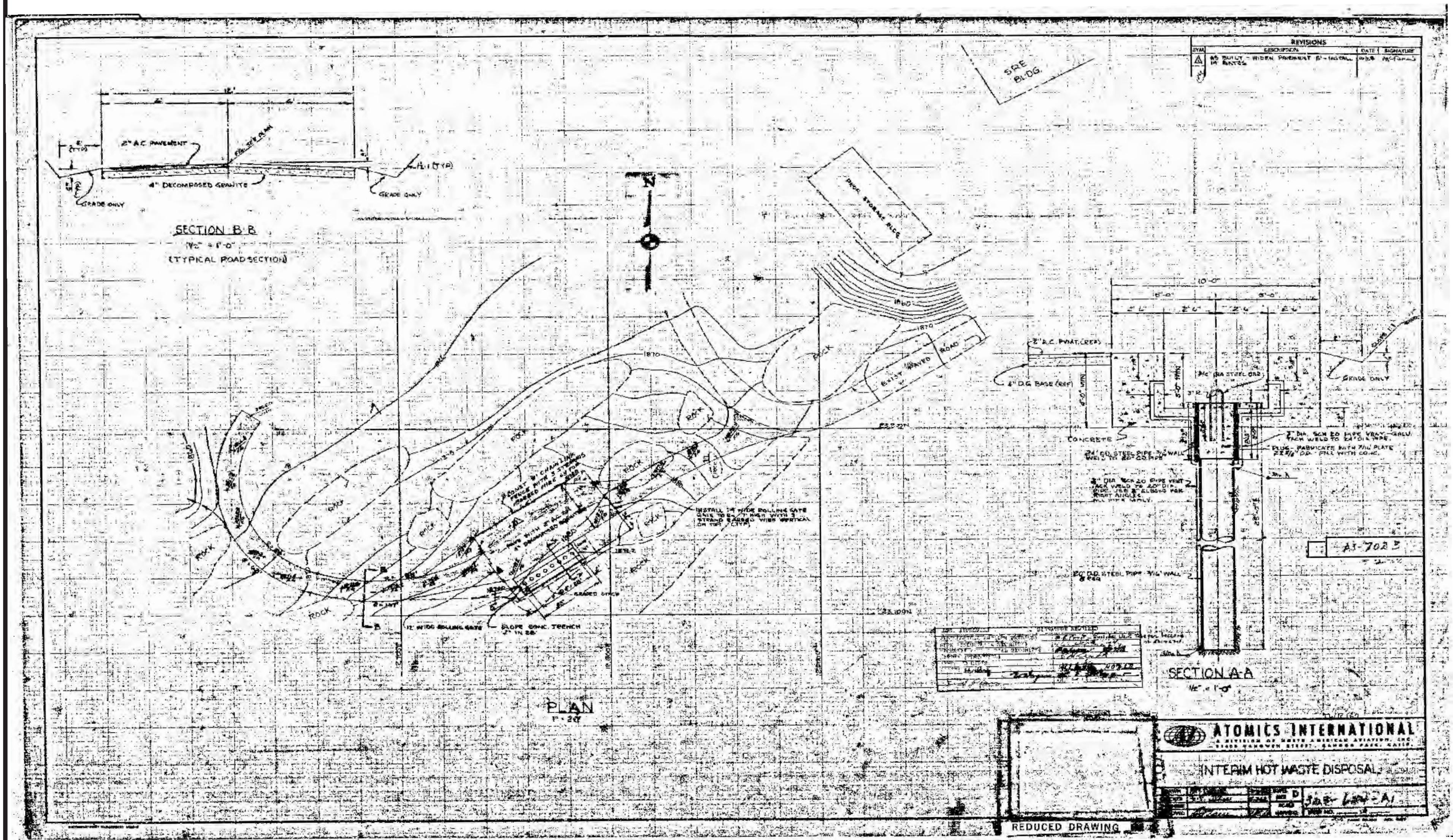

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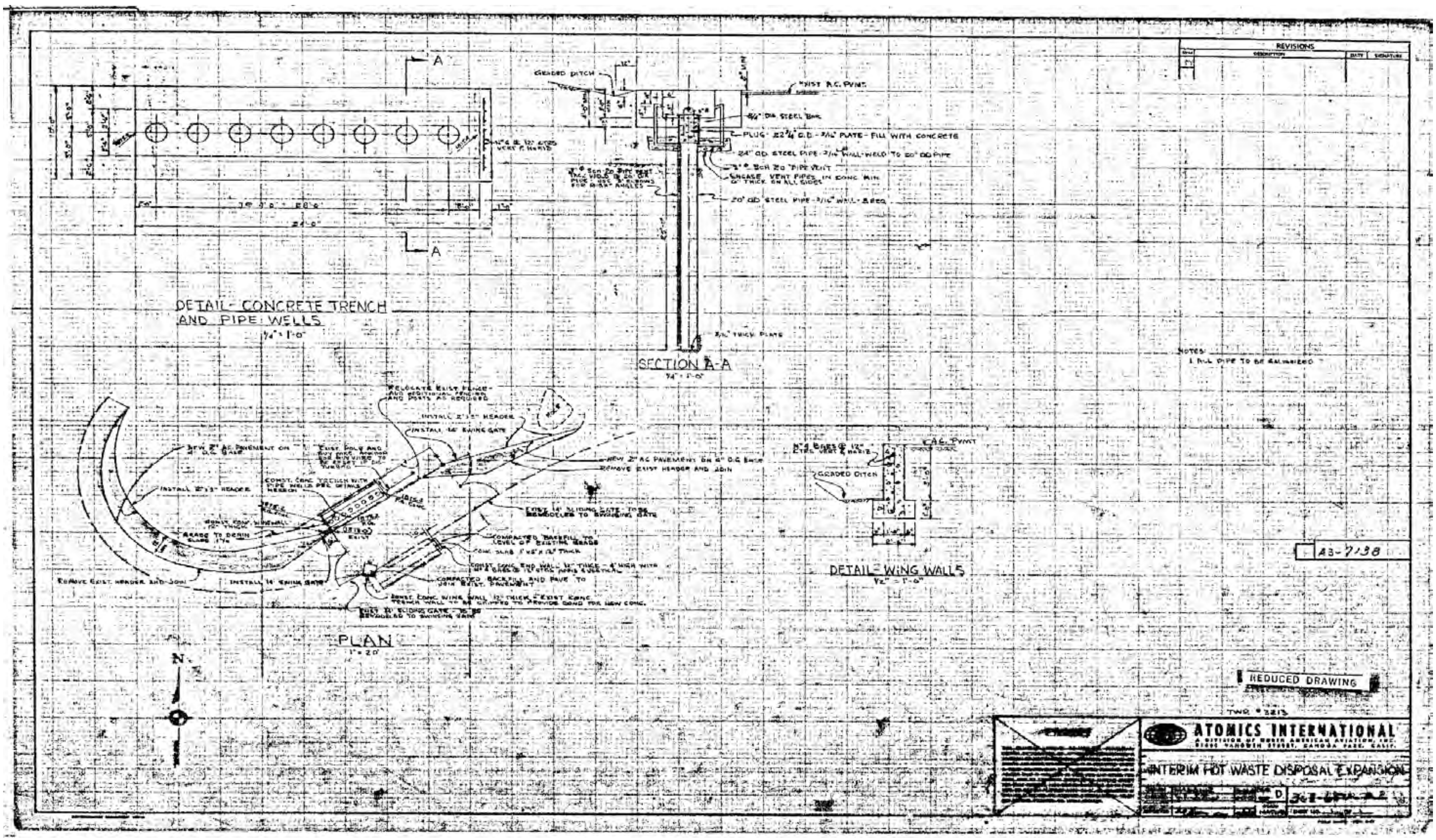
Figure 2.16e
Building 4654
Site Plan

Redacted



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Project:EP9038
Revised: 07/05/11 TJ
Source: Boeing Company, 2008

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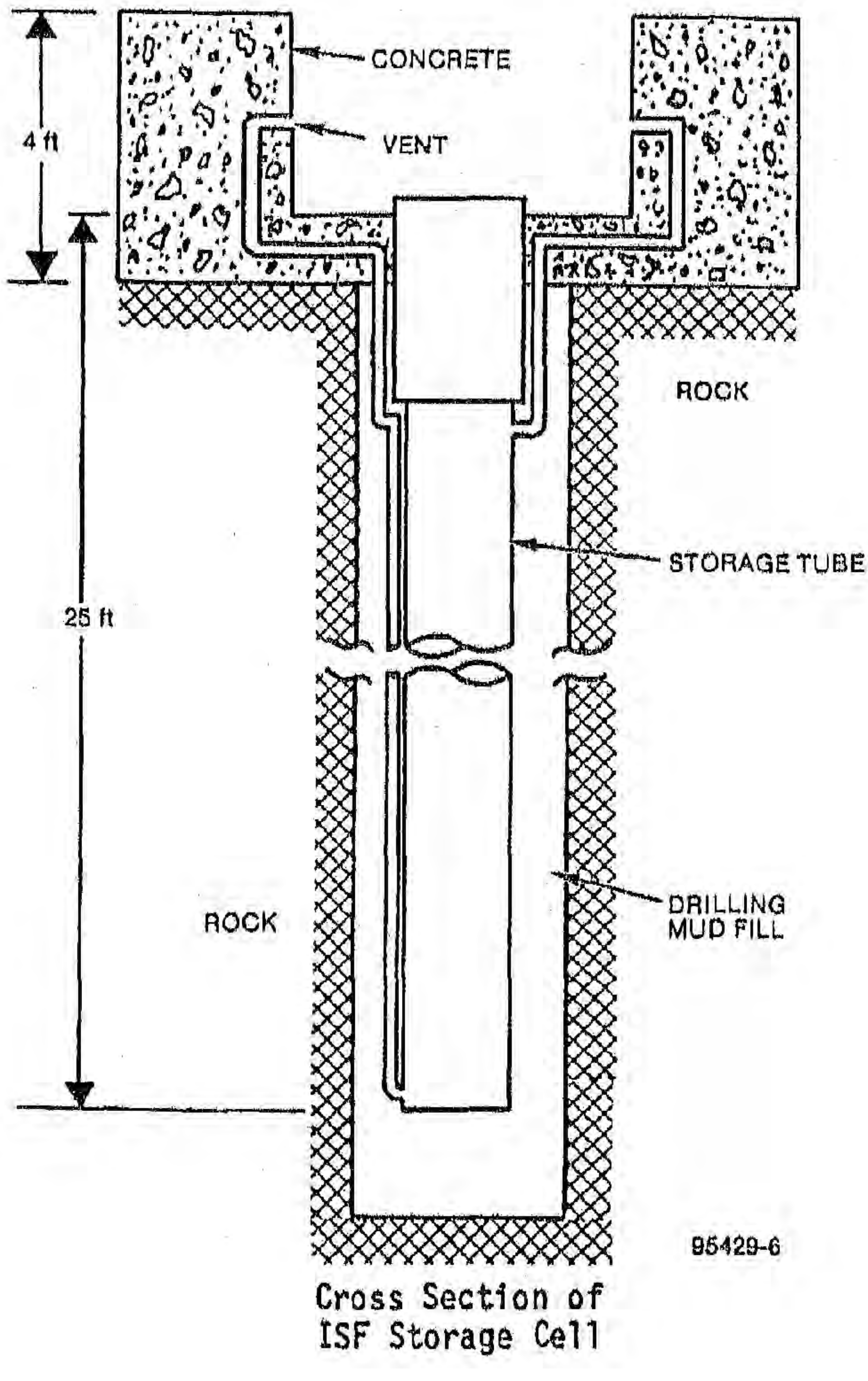
Figure 2.16f
Building 4654
Trench and Pipe
Well Plan

Redacted



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Revised: 07/14/11 TB
Source: Boeing Company, 2008

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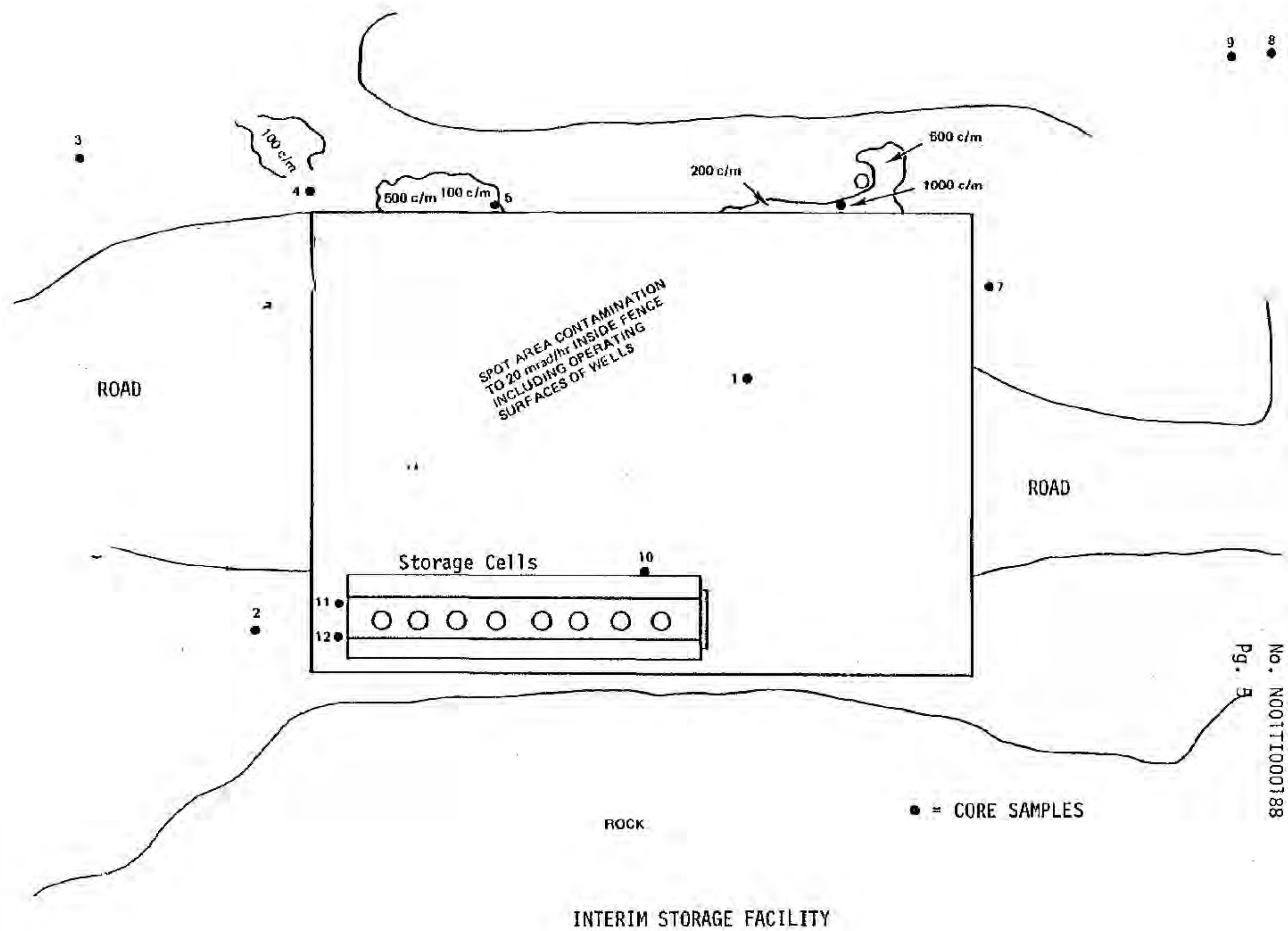
Figure 2.16g
Building 4654
Storage Tube Cross
Section Schematic



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Source: Boeing Company, 2008

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Figure 2.16h
Building 4654
Surface Contamination
1983

Redacted

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Revised: 07/15/11 TB
Source: Boeing Company, 2008

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Figure 2.16i
Building 4654
Excavation of
Storage Tubes

Redacted

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Project:EP9038
Revised: 07/15/11 TB
Source: Boeing Company, 2008

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Figure 2.16j
Building 4654
Removal of
Storage Tubes

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Revised: 07/15/11 TB
Source: Boeing Company, 2008

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Figure 2.16k
Building 4654
Damage to Tube 7
During Excavation

Redacted

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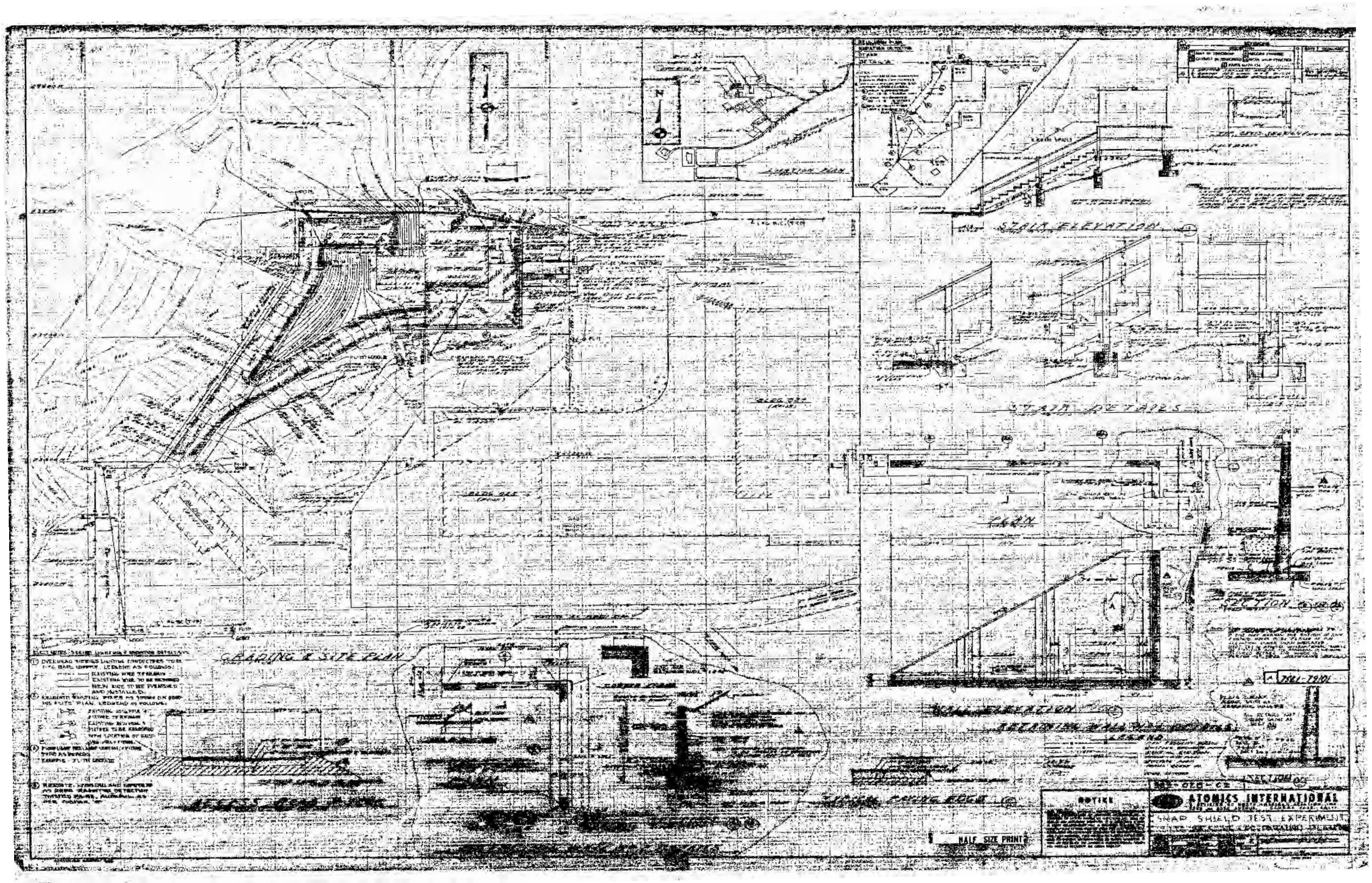
Project:EP9038
Revised: 07/05/11 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Note:
Building 4075 is in the Background

Figure 2.17a
Building 4028
Site Photograph

Redacted



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Revised: 07/05/11 TJ
Source: Boeing Company, 2008

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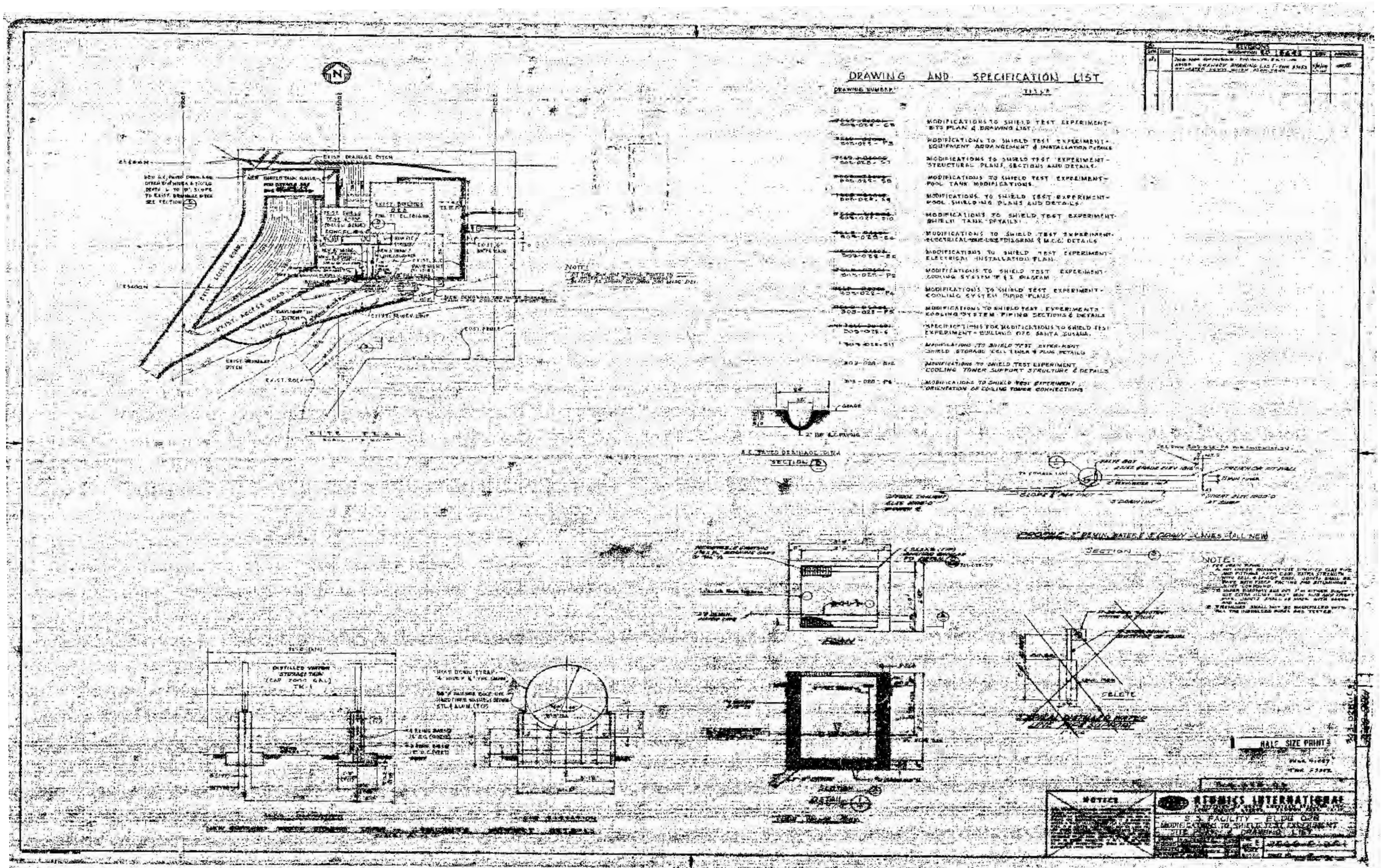
Figure 2.17b
Building 4028
Site Grading Plan

Redacted



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Revised: 07/05/11 TJ
Source: Boeing Company, 2008

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Figure 2.17c
Building 4028
Site Plan

Redacted

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Revised: 07/05/11 TJ
Source: Boeing Company, 2008

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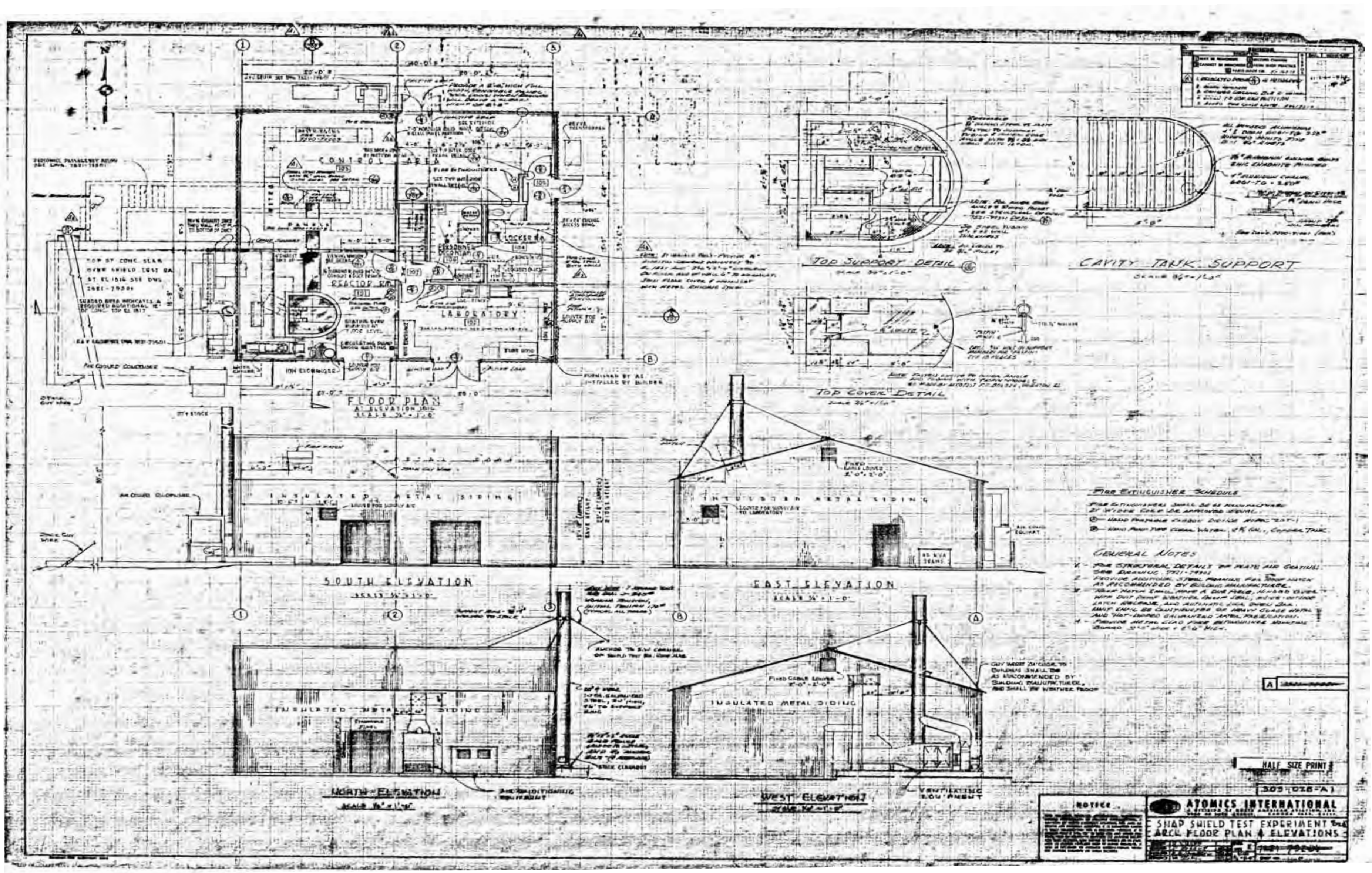
Figure 2.17d
Building 4028
Foundation and Section Plan



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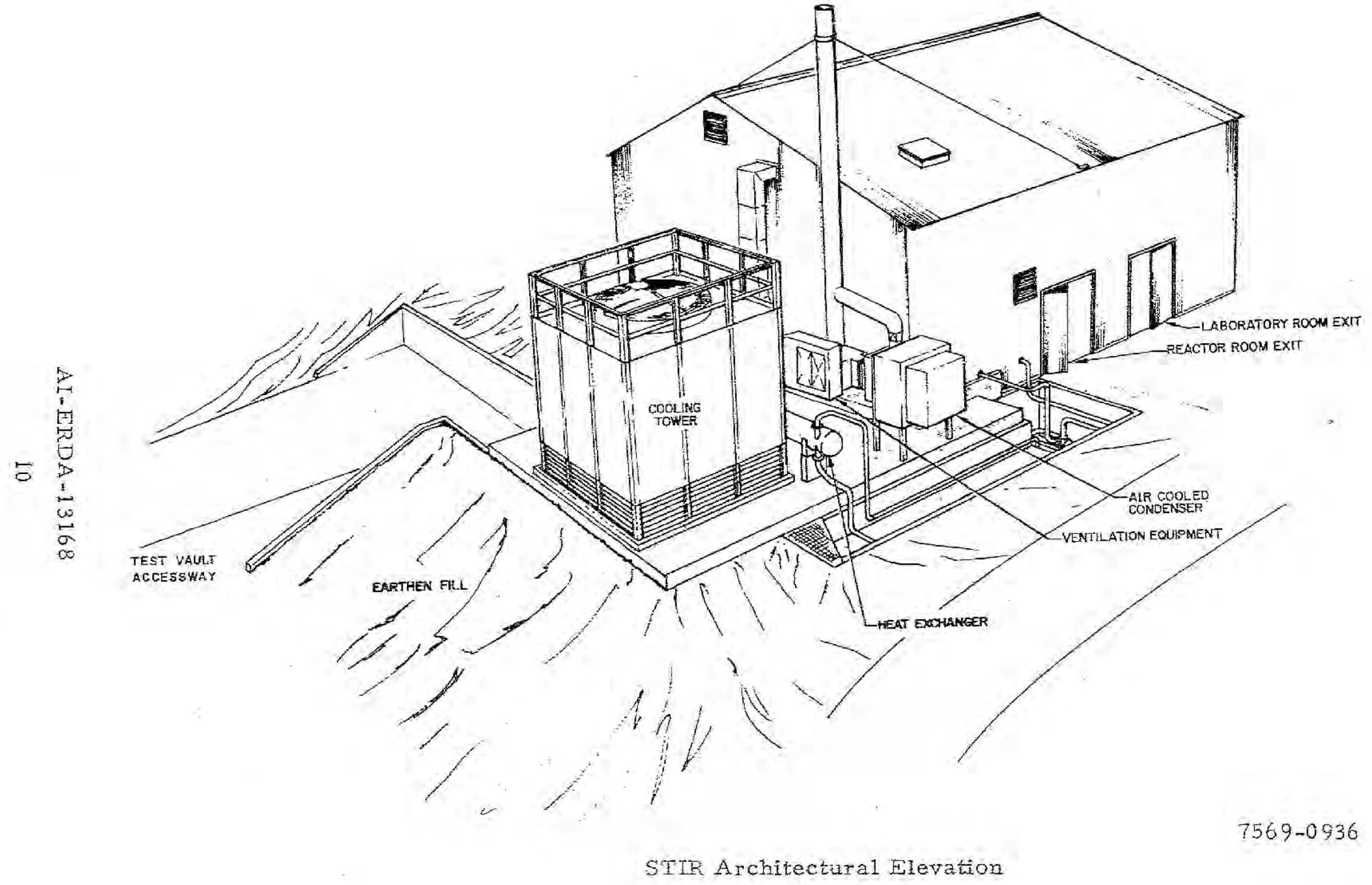
Revised: 07/05/11 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.17e
Building 4028
Floor and
Elevation Plan



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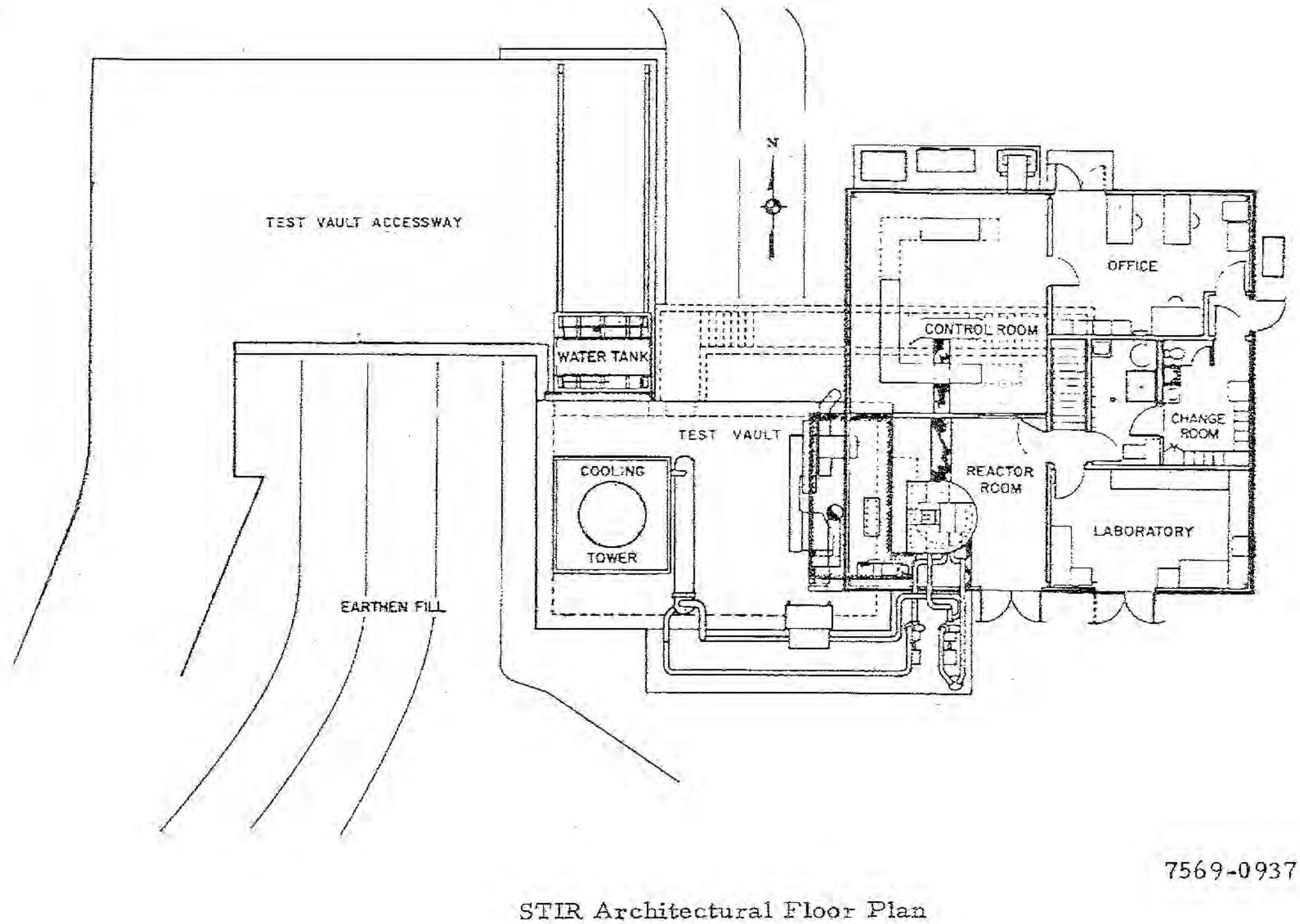
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.17f
Building 4028 Architectural Elevation Plan



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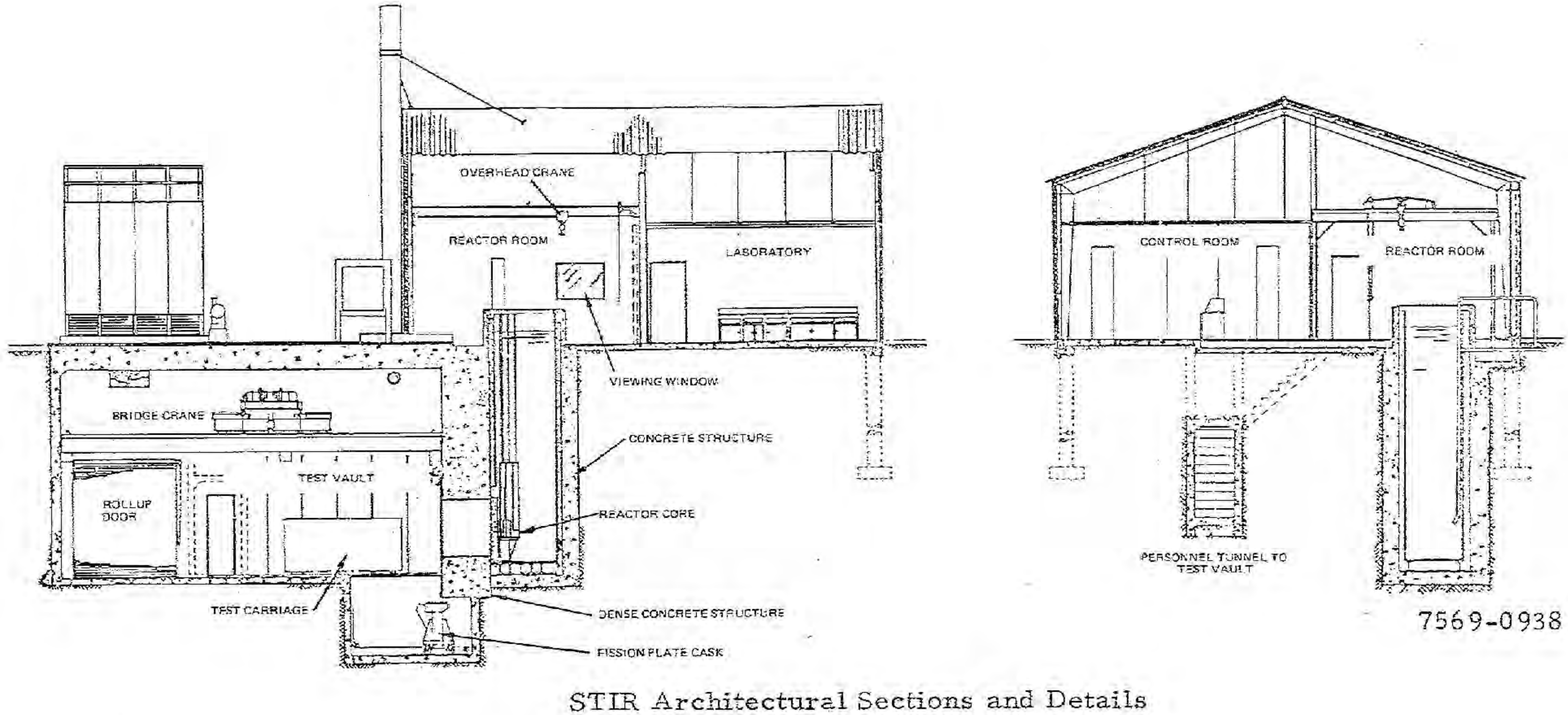
Revised: 07/15/11 TB
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.17g
Building 4028
Architectural
Floor Plan



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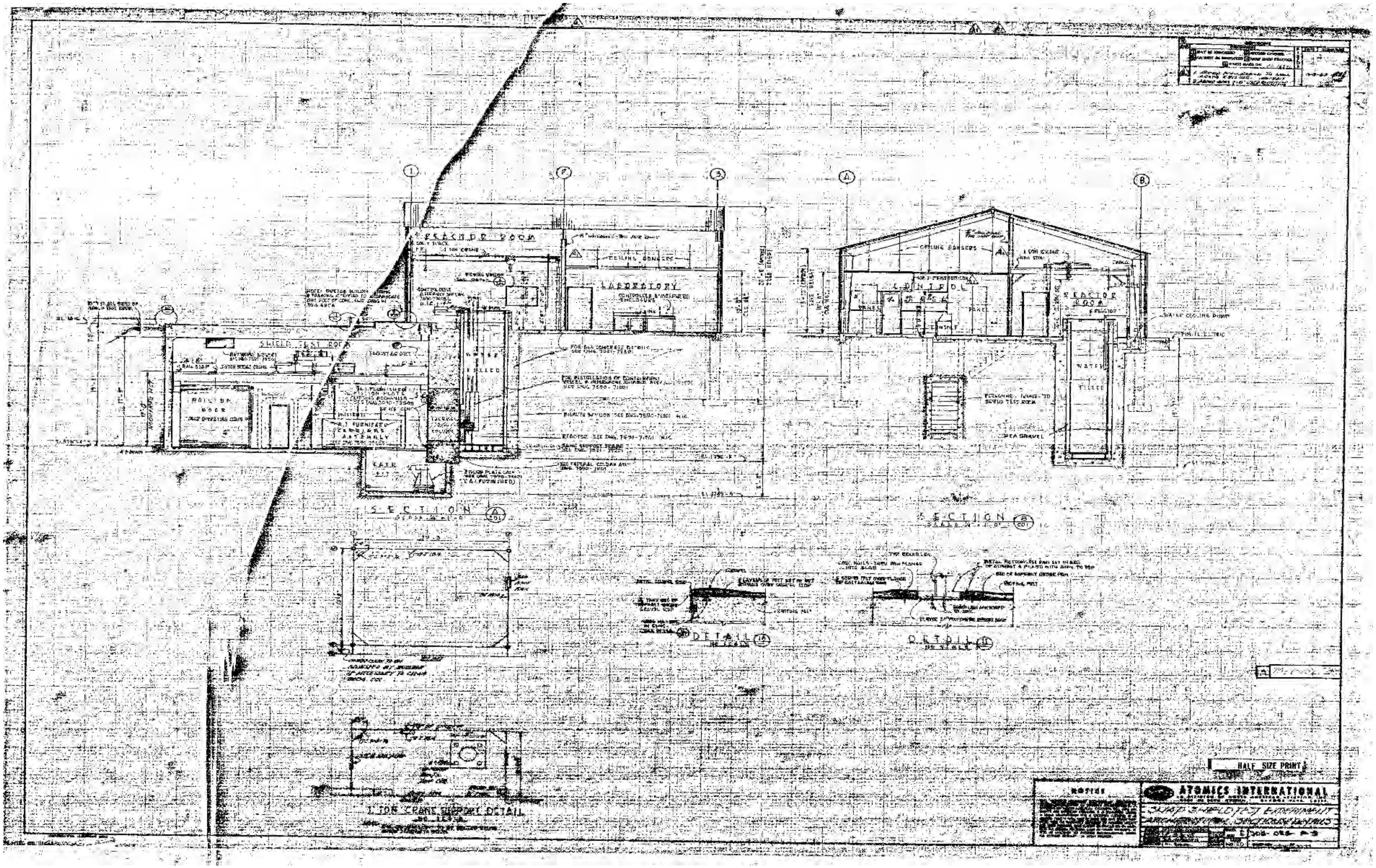
Revised: 07/15/11 TB
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.17h
Building 4028
Architectural
Section Plan



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Revised: 07/15/11 TB
Source: Boeing Company, 2008

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**Figure 2.17i
Building 4028
Section Plan
With Details**

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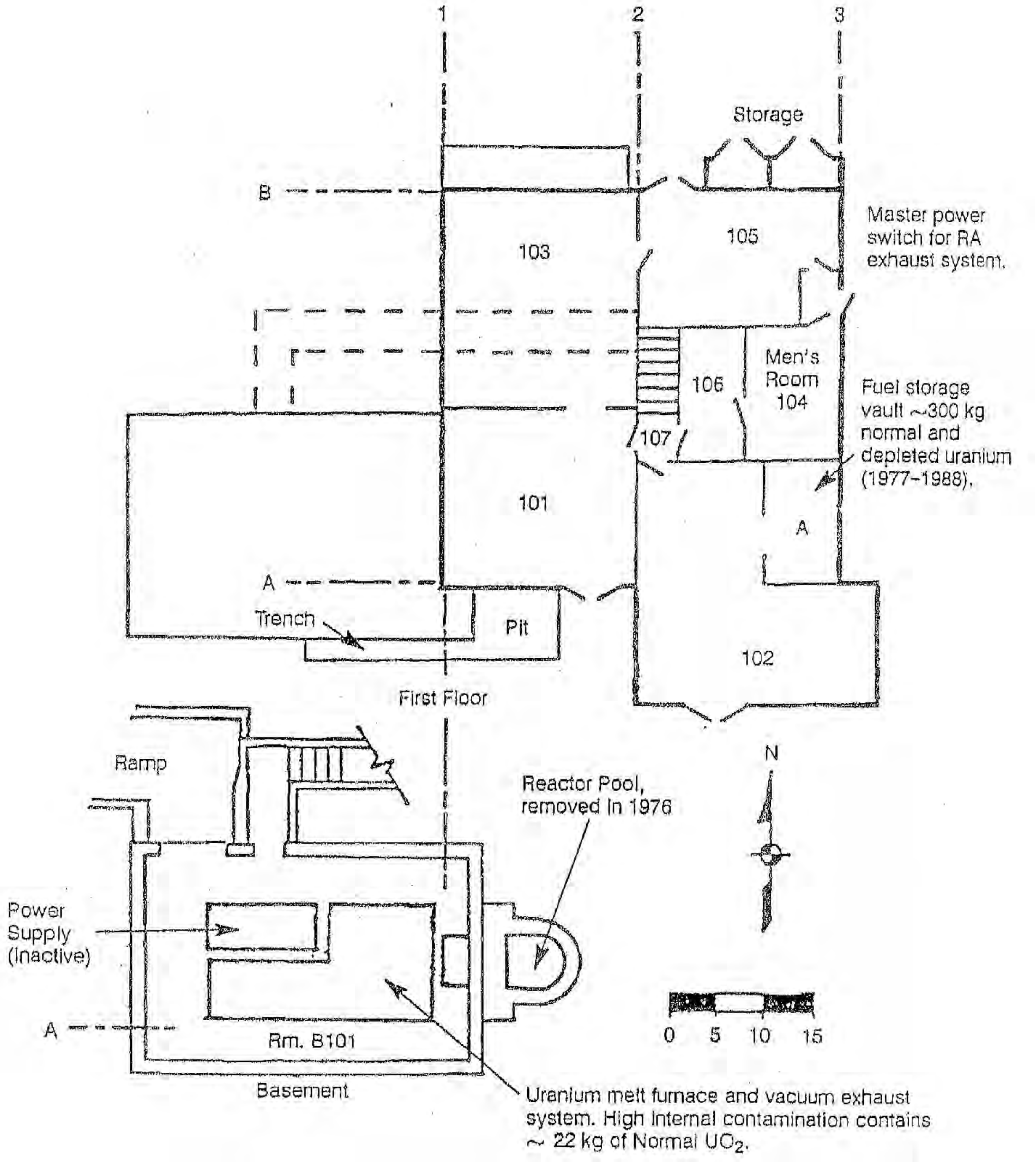

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Source: Boeing Company, 2008

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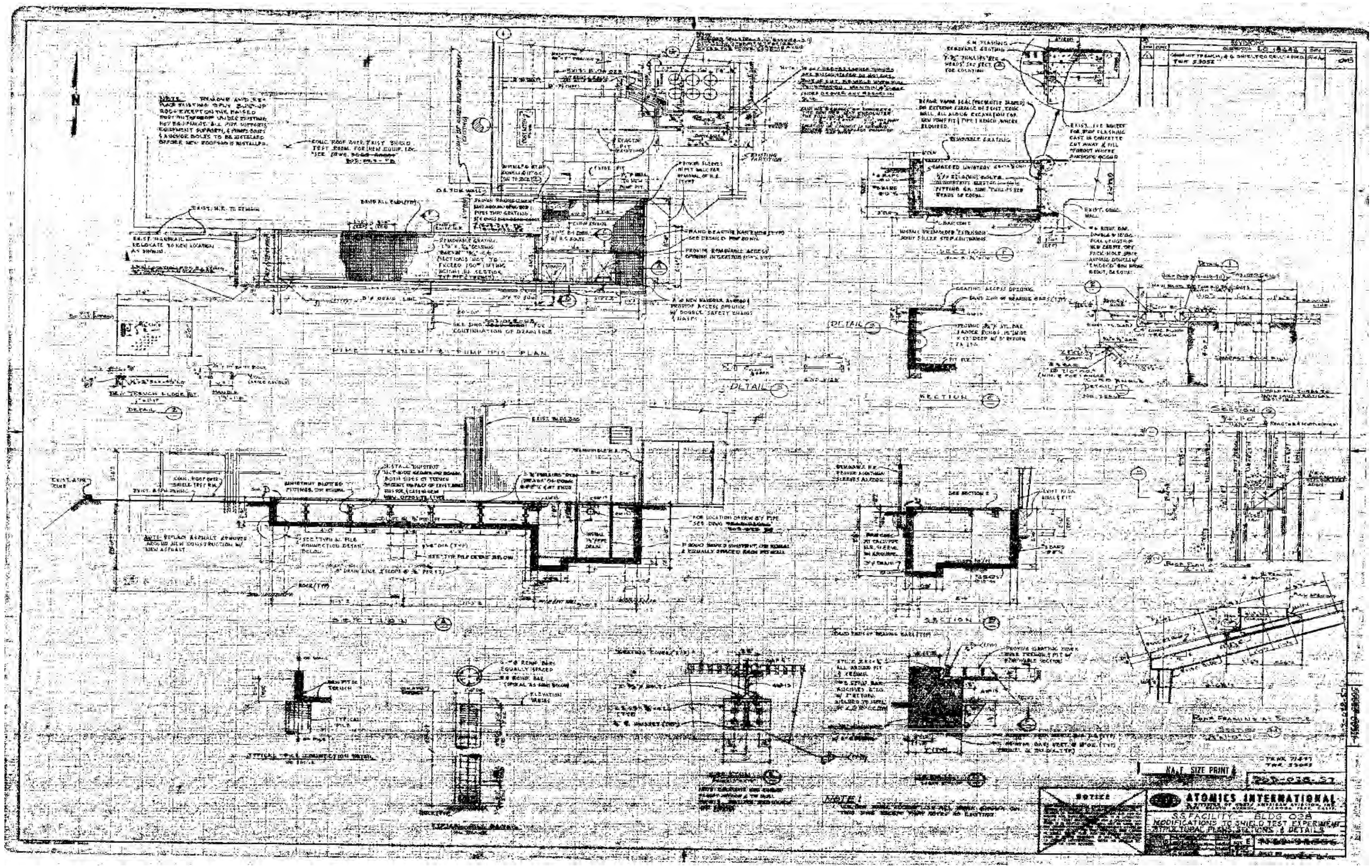
Figure 2.17j
Building 4028
General Floor Plan
1977-1988

Redacted



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Source: Boeing Company, 2008

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Figure 2.17k
Building 4028
Pipe Trench and
Pump Pit Section Plan

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Revised: 07/15/11 TB
Source: Boeing Company, 2008

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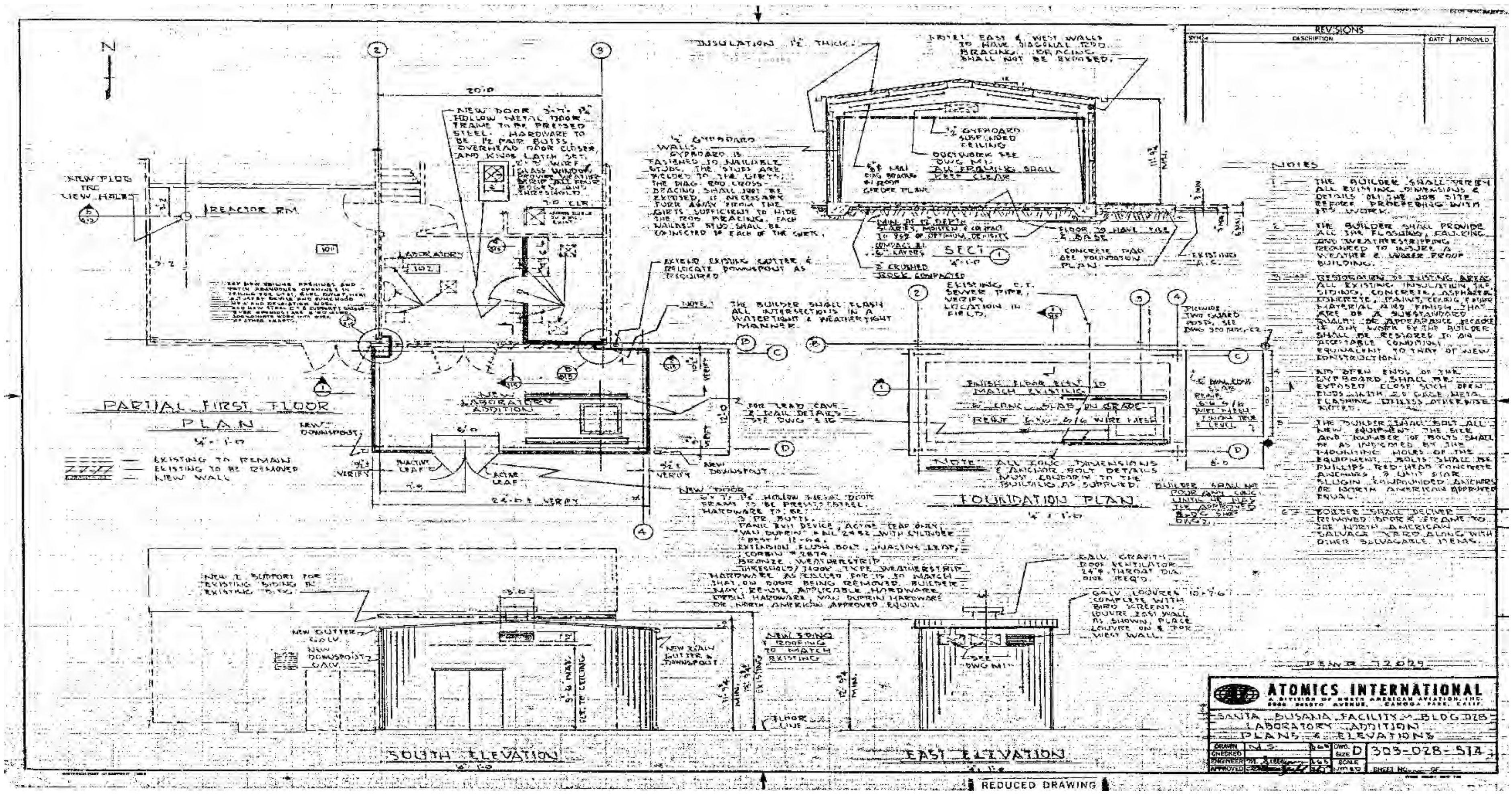
Figure 2.17l
Building 4028
Cooling System
Piping Plan



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Source: Boeing Company, 2008

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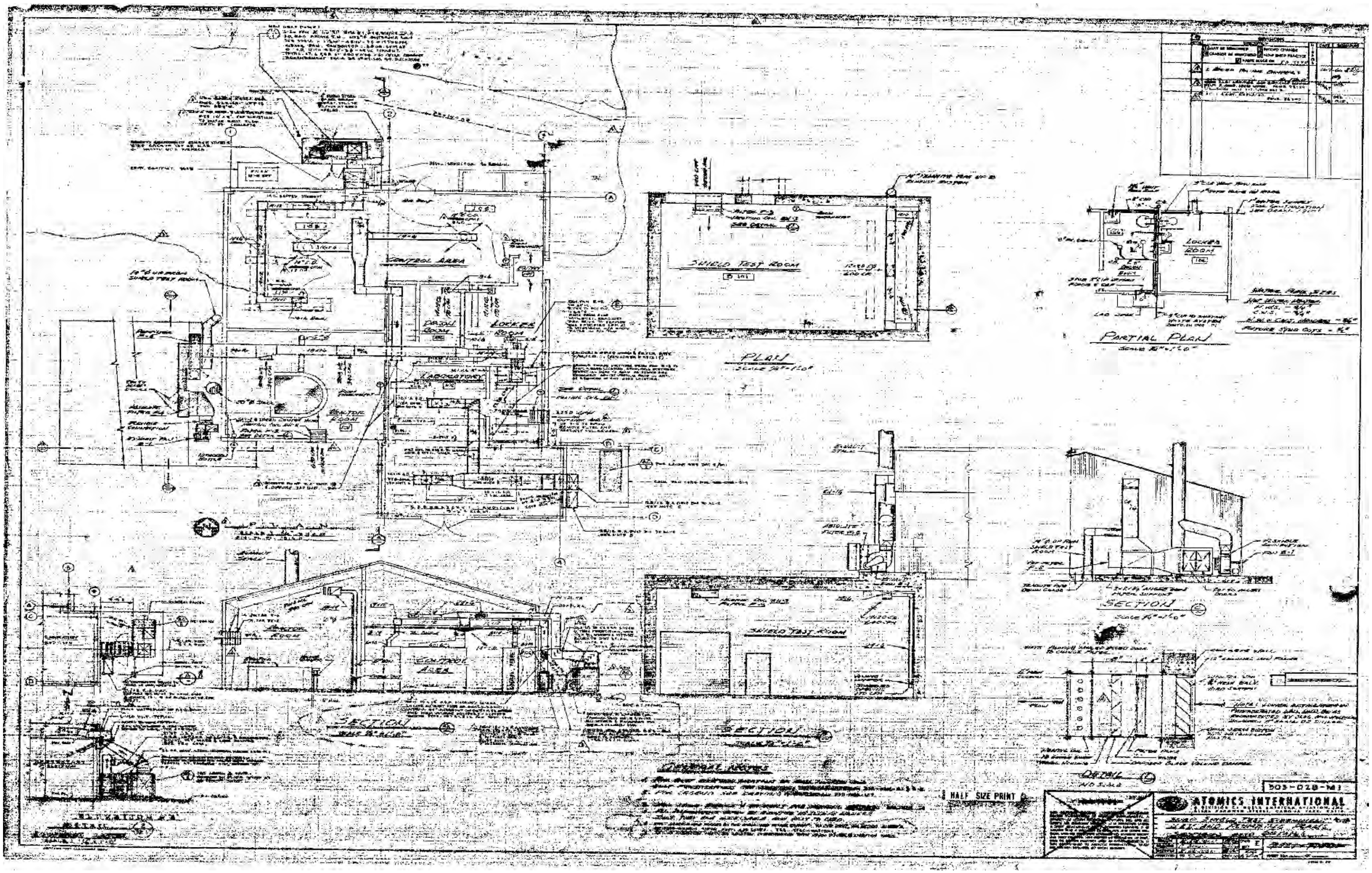
Figure 2.17m
Building 4028
Laboratory Addition and Elevation Plan



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Revised: 07/15/11 TB
Source: Boeing Company, 2008

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Figure 2.17n
Building 4028
Ventilation Plan

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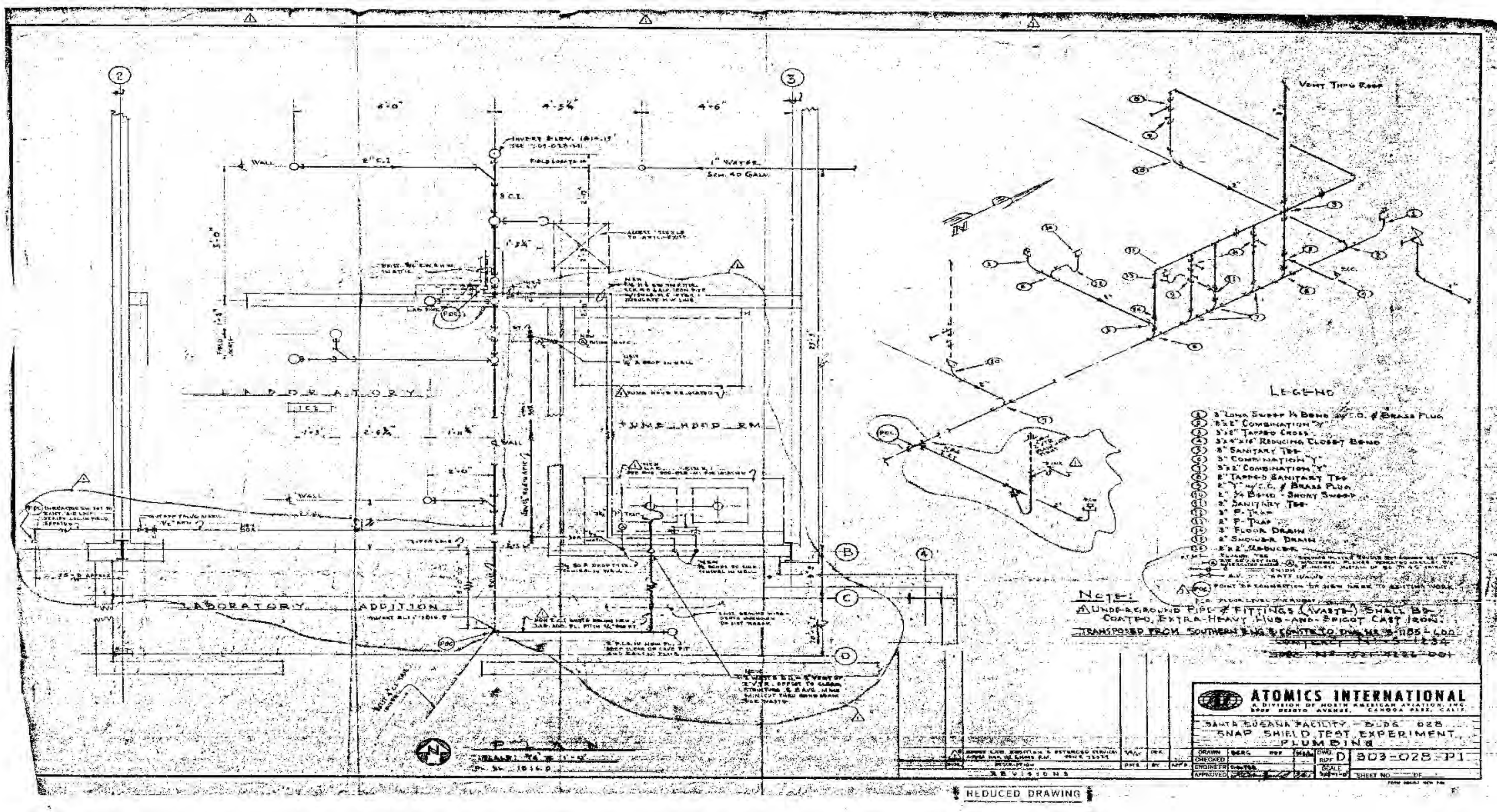

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Project:EP9038
Revised: 07/15/11 TB
Source: Boeing Company, 2008

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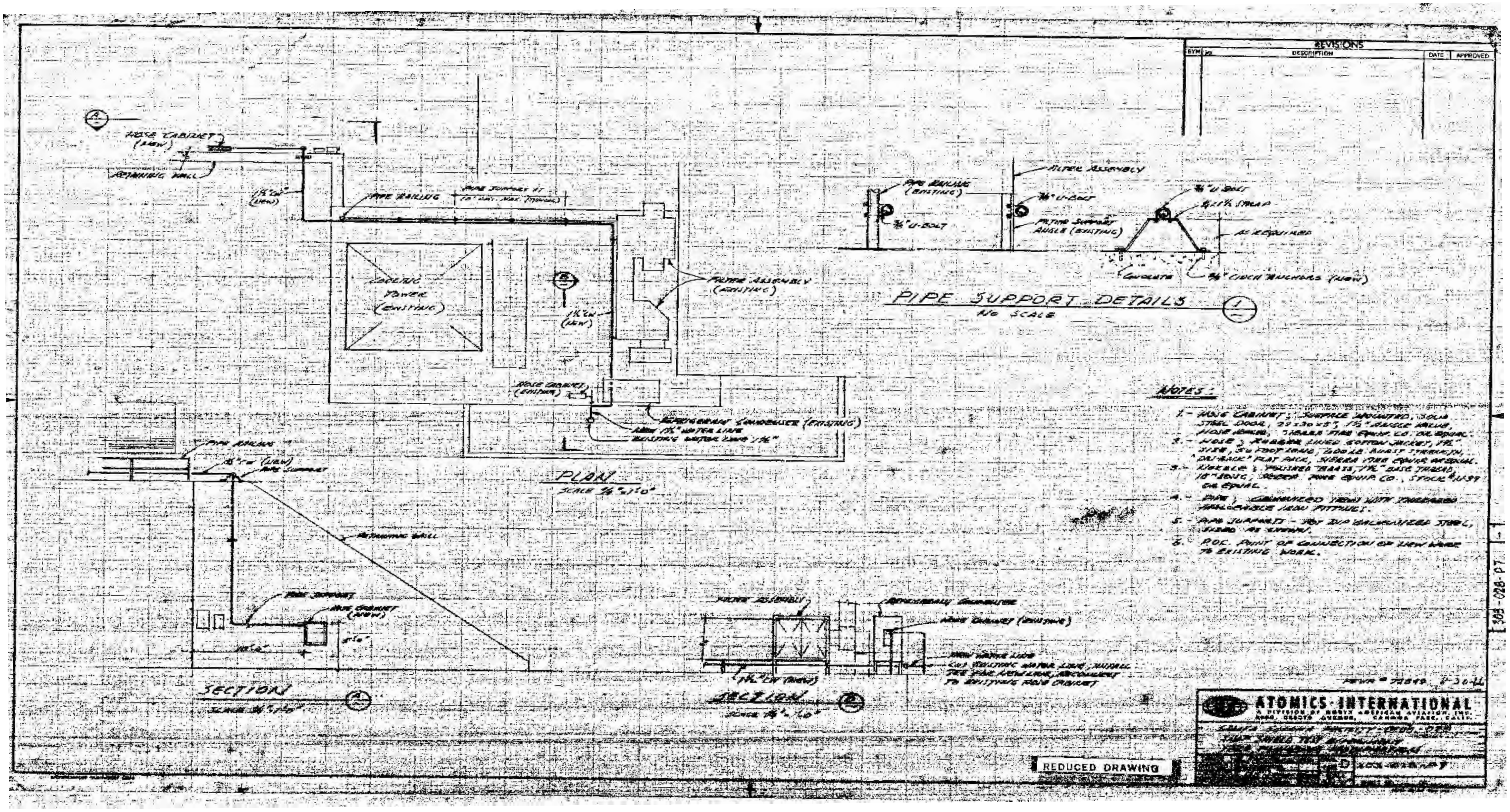
Figure 2.17o
Building 4028
Laboratory
Piping Plan



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Revised: 07/15/11 TB
Source: Boeing Company, 2008

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Figure 2.17p
Building 4028
Yard Plumbing
Modification

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Revised: 07/15/11 TB
Source: Boeing Company, 2008

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Figure 2.17q
Building 4028
Demolition
Photograph

\\az-srv-02\SharedGraphics\Phoenix\Graphics\SantaSusana\HSA-7\Figures\(2-17r)Bldg4028SPD.cdr
Project:EP9038
Revised: 07/15/11 TB
Source: Boeing Company, 2008

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Figure 2.17r
Building 4028
Site Photograph
Following Demolition

\\az-srv-02\SharedGraphics\Phoenix\Graphics\SantaSusana\HSA-7\Figures\(2-18a)RMHF4614SP.cdr
Project:EP9038
Revised: 07/05/11 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Note:
Building 4075 is in the Background

Figure 2.18a
RMHF 4614
Holdup Pond
Site Photograph

Redacted

\\az-srv-02\SharedGraphics\Phoenix\Graphics\SantaSusana\HSA-7\Figures\(2-18b)RMHF4614AP.cdr
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Revised: 07/14/11 TB
Source: Boeing Company, 2008

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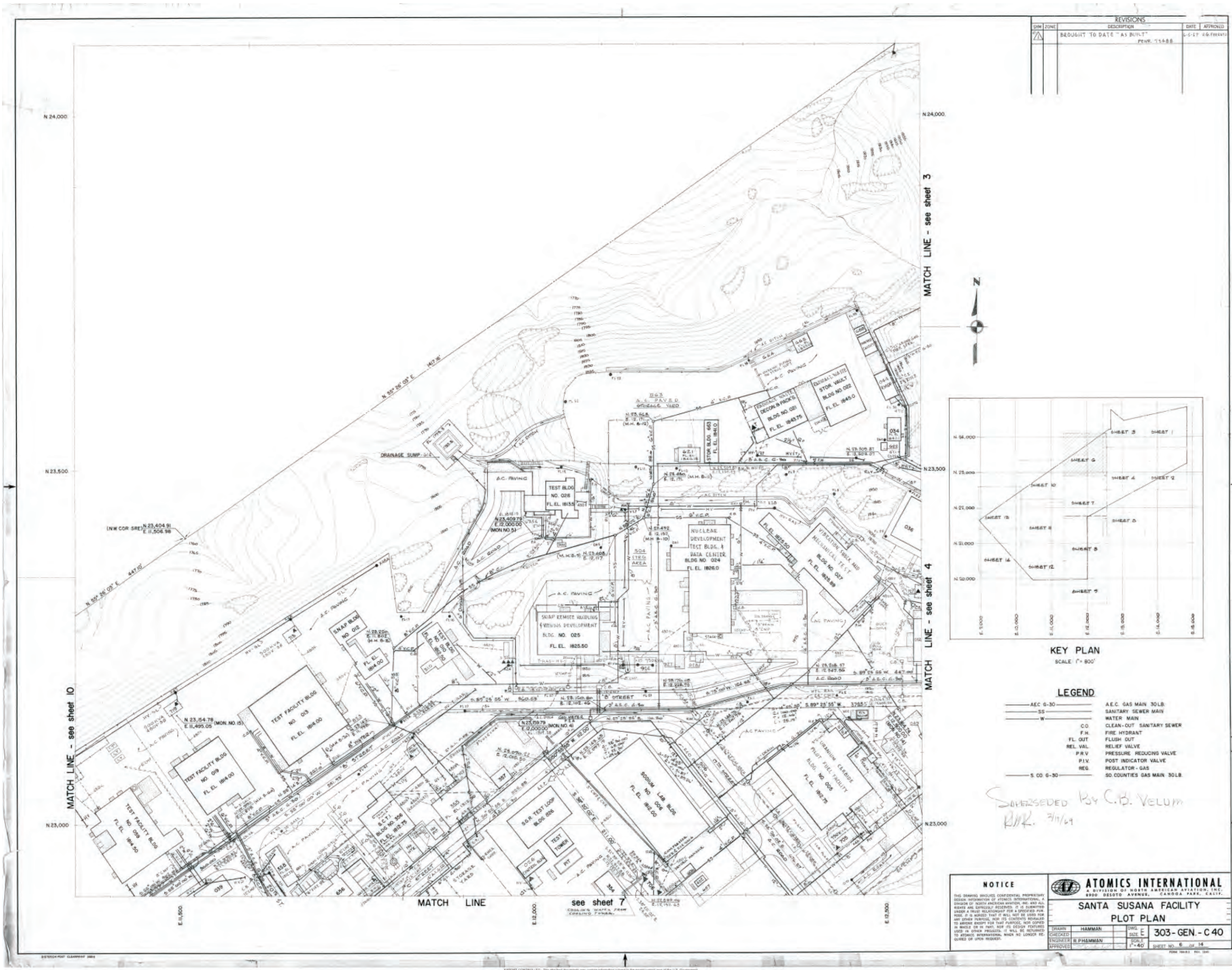
Figure 2.18b
RMHF 4614
Holdup Pond
Aerial Photograph



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Revised: 07/15/11 TB
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.18c
RMHF 4614
Holdup Pond
Plot Plan

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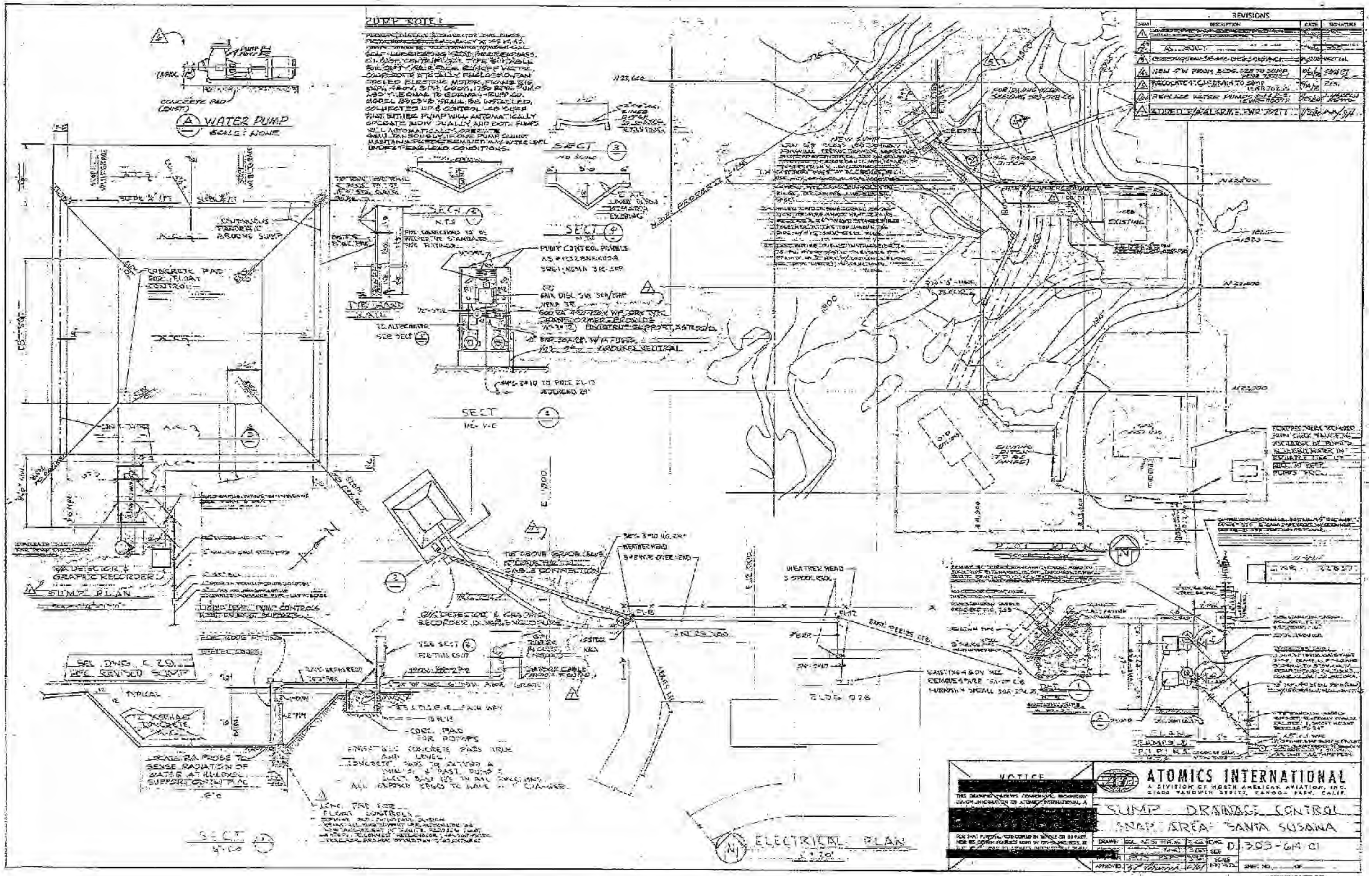

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Source: Boeing Company, 2008

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Figure 2.18d
RMHF 4614
Holdup Pond
Sump Drainage
Control Plan

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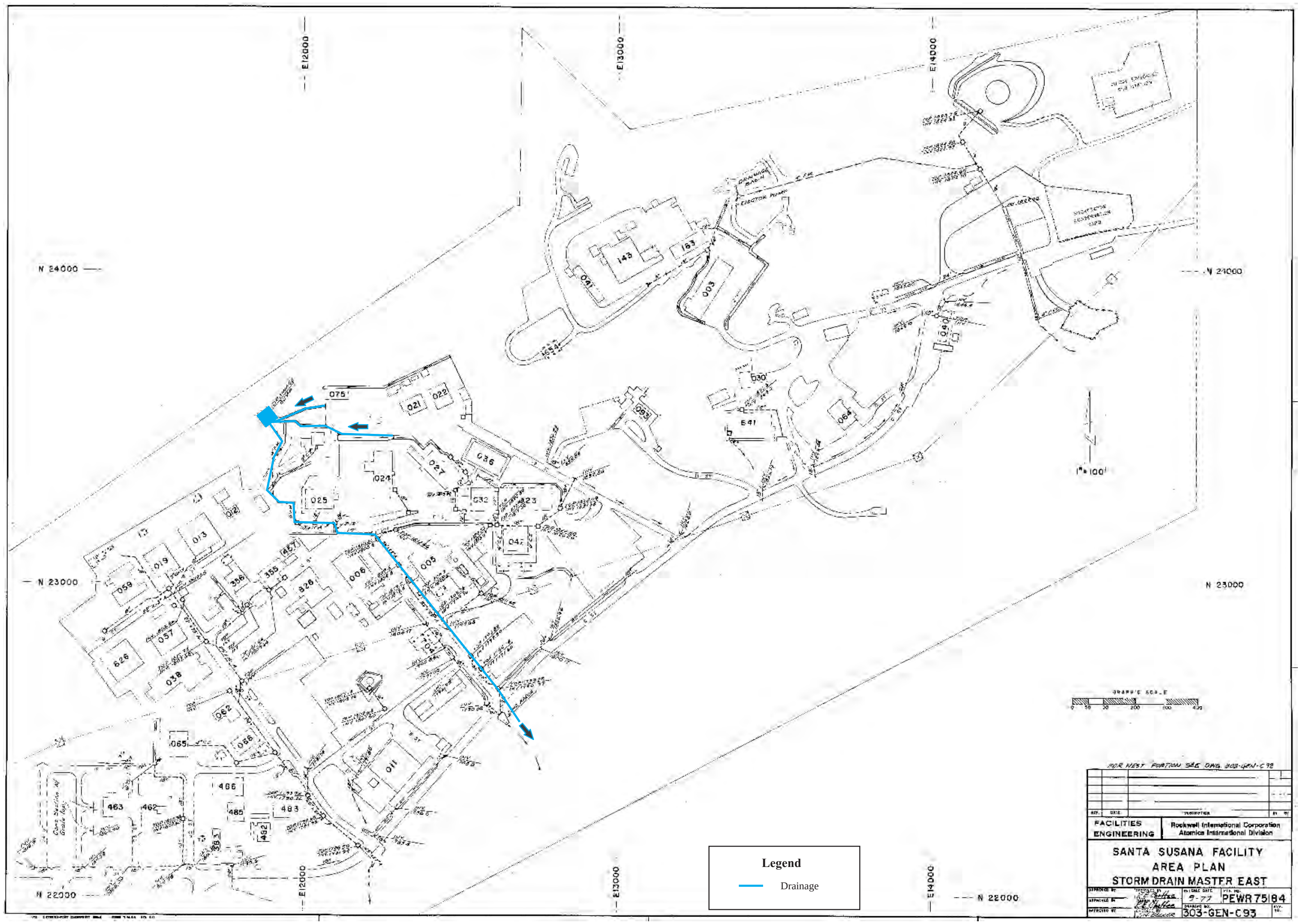

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Revised: 07/15/11 TB
Source: Boeing Company, 2008

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Figure 2.18e
RMHF 4614
Holdup Pond
Storm Drainage

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Source: Boeing Company, 2008

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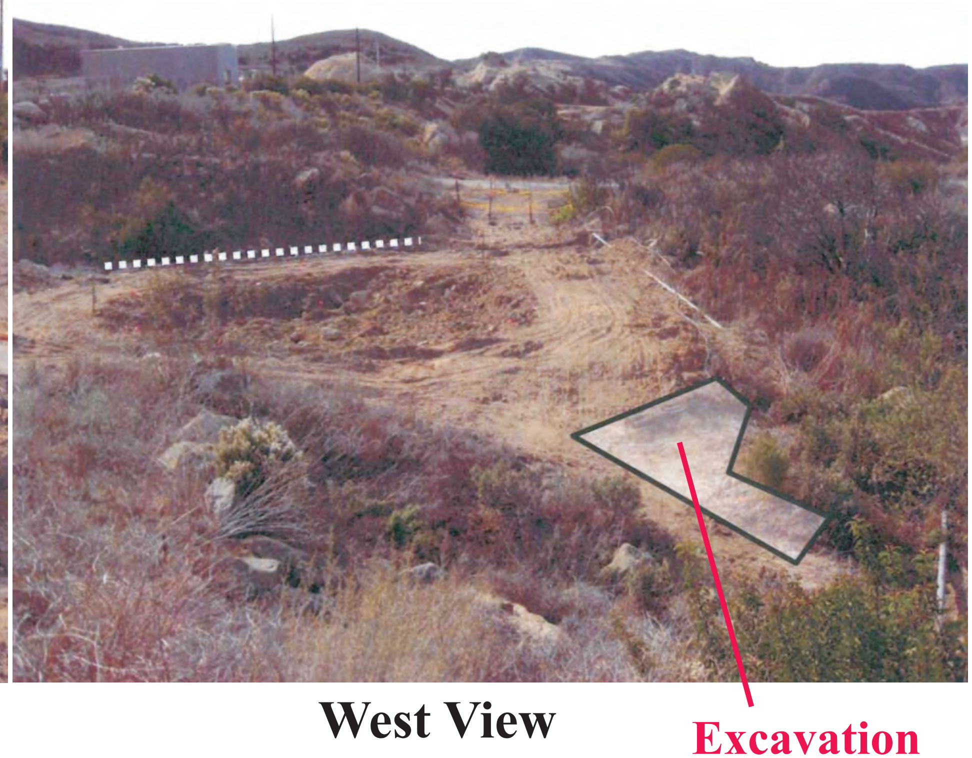
Figure 2.18f
RMHF 4614
Holdup Pond
Collection Tank

Drainage Channel View



West View

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Source: Boeing Company, 2008

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Figure 2.18g
RMHF 4614 Holdup Pond December 2006 Removal Action

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Revised: 07/15/11 TB
Source: Boeing Company, 2008

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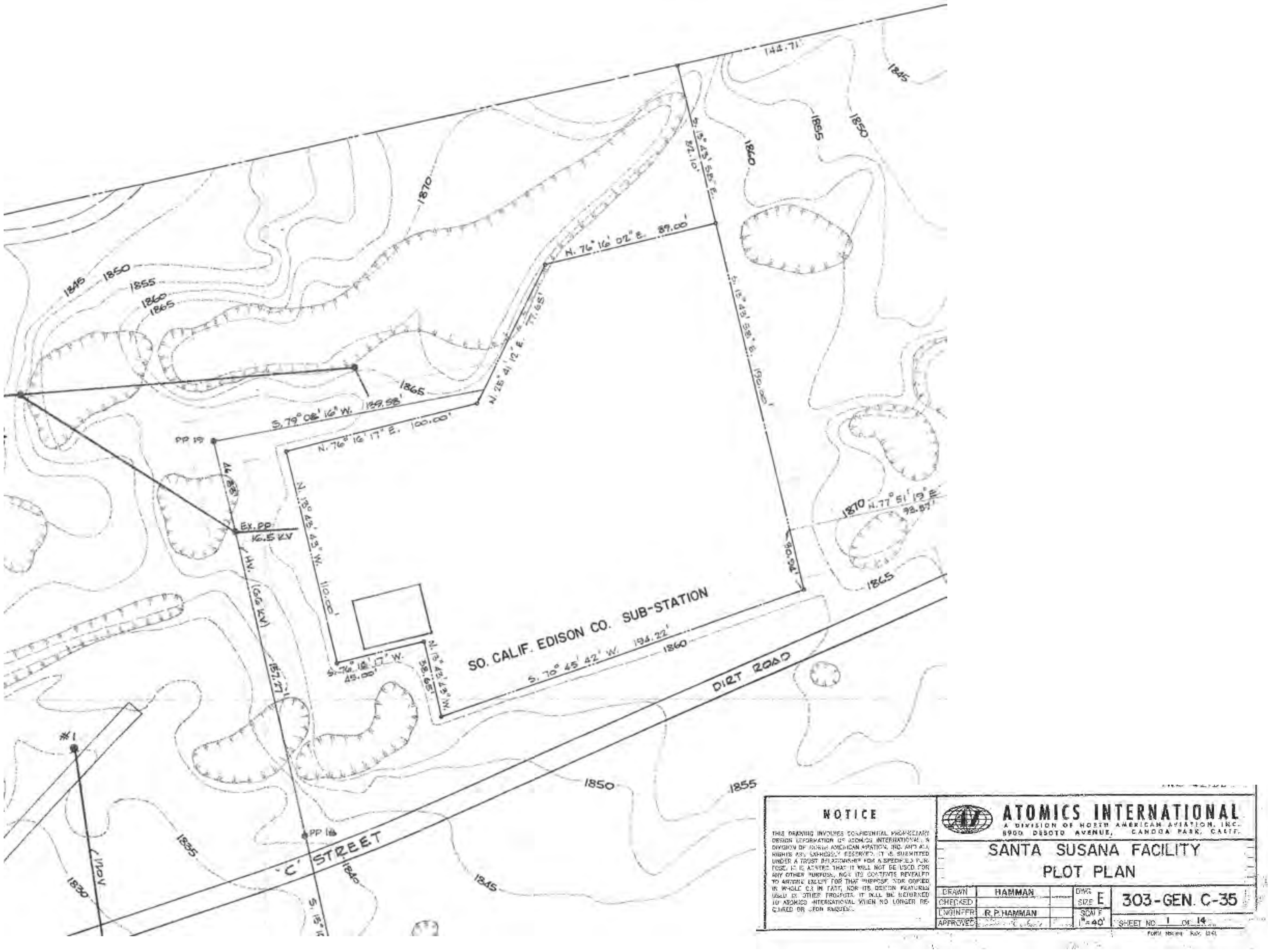
Figure 2.18h
Stormwater Culvert Leading to RMHF 4614 Holdup Pond Photograph 2009

Redacted



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Revised: 07/19/11 TJ
Source: Boeing Company, 2008

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Figure 2.19a
Southern California Edison Substation Plot Plan

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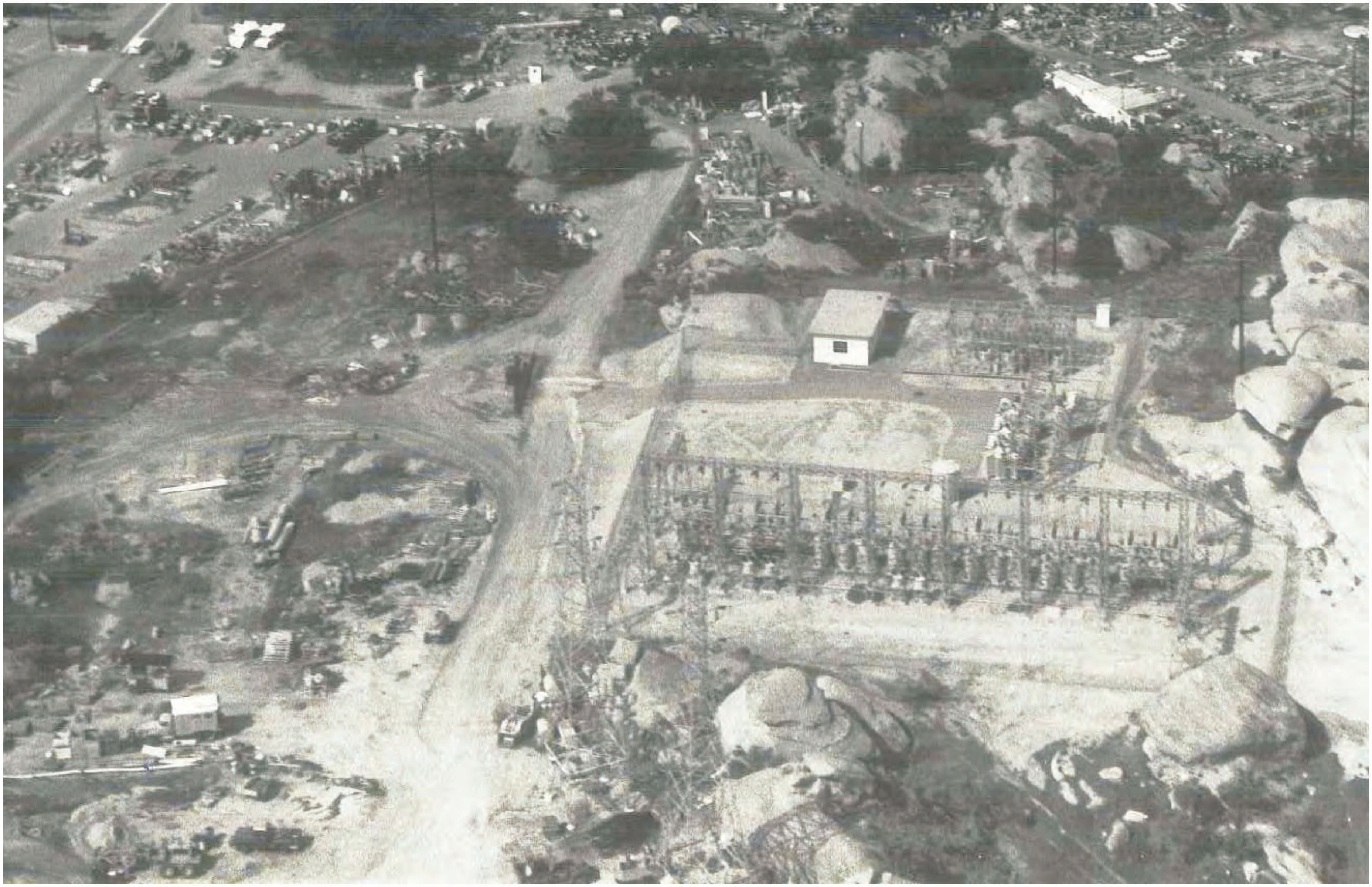

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Revised: 07/19/11 TJ
Source: Boeing Company, 2008

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Figure 2.19b
Southern California Edison Substation Historical Photograph 1963

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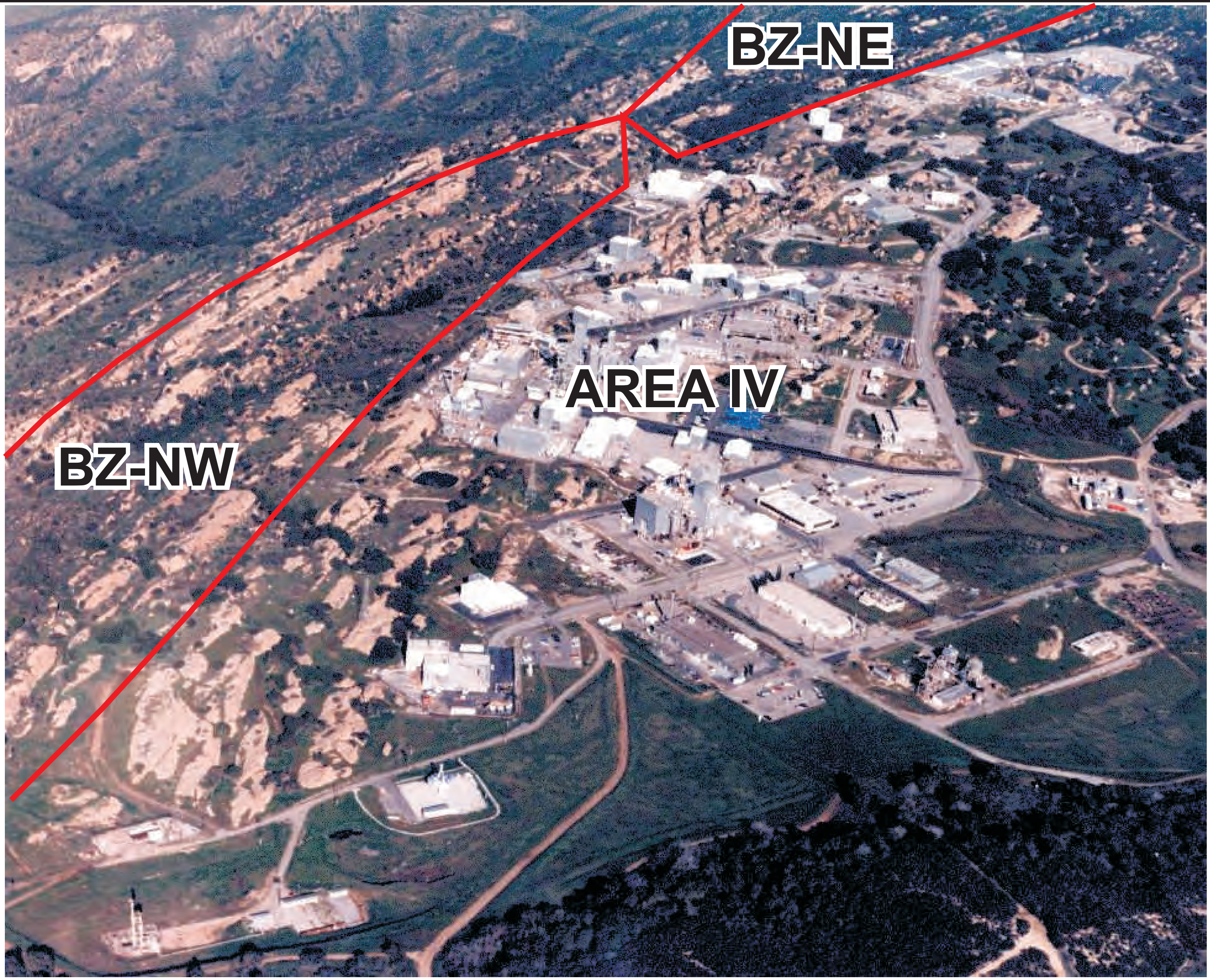

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Revised: 08/02/11 TJ
Source: Boeing Company, 2008

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Northern Buffer Zone (Boundaries are Approximate)

Figure 2.20
Northern Buffer Zone

Redacted