4.0 USES OF MATERIALS OF CONCERN

As described in Section 1, the materials of concern for this project (listed in Table 1-1) were selected as a result of Task 2 and Task 6 activities based on known toxicologic properties of materials used by the plant, the environmental fate and transport characteristics of the materials, and preliminary knowledge of the ways in which the materials have historically been stored, used, and disposed of at the Rocky Flats Plant. A number of the materials of concern were retained for further study because no information on their storage, use, or disposal could be found.

Section 2 describes the extensive campaign of document reviews and personnel interviews that was conducted and focussed on the materials of concern to gather information on how these materials have been used throughout the history of the Rocky Flats Plant. The following pages will describe the key information sources utilized to document uses of the materials of concern at Rocky Flats, and present the material use profiles and air emission source maps that have been generated to summarize the significant points about historical uses of each material.

4.1 Key Information Sources

Information regarding the historical uses of each material of concern has been obtained primarily from plant document reviews and plant personnel interviews. The most important documents for material usage information have been the Air Pollution Emission Notices (APENs) and Waste Stream and Residue Identification and Characterization Reports (WSRIC). Other relevant documents have been obtained from searches performed on the legal/environmental index, the legal database, the integrated research file, the Building 706 Technical Library, and the Building 881 Archives. Although the APENs and WSRIC documents reflect material usage and emissions only during the late 1980s, they provided a starting point for our investigation prior to interviews. Consequently, interview time was optimized as a result of the project team's knowledge of current day operations. As stated in Section 3.0 of this report, many processes have remained fairly constant over the years. Interviews and historical correspondence were used to identify differences between current day and historical operations. Two examples of these differences are the enriched uranium operations of the 1950s and solvent substitutions occurring in the 1970s.

The personnel interview process was focussed on the materials of concern. ChemRisk verified with the interviewees the modern-day uses of the materials, if any, as described in the APENs and/or WSRIC reports. Information was then requested on any historical changes to processes, buildings, and effluent treatment or handling systems that would have affected associated air emissions. Knowledge of any major material additions, substitutions, or eliminations was also requested. Each interviewee was asked for suggestions on how to best reconstruct the changes in chemical use rates

and emissions over the years, since emissions of other materials have not historically been monitored to the extent that radionuclides and beryllium have. Information on historical waste generation, treatment, and disposal practices was elicited, along with information about any of the major accidents and incidents of interest to the project. Members of the ChemRisk team identified the list of materials of concern for each interviewee, and asked for information pertaining to any materials that came to mind that have been used in significant quantities but were not among the materials of concern. See Appendix C for a listing of the actual interview questions.

4.2 Emission Source Maps and Material Use Profiles

The following pages present emission source maps and material use profiles for each material of concern. The material use profiles present qualitative historical information on use of the materials of concern obtained in Task 3 and 4 activities. Source maps show qualitative historical information regarding building locations of potential emissions of the materials of concern. The maps also present quantitative current day air emissions as percentages of site emission totals. Quantitative data on historical emissions is being developed as part of Task 5 and will be presented in the Task 5 Source Terms Report. The following fields of information are provided to describe the uses of each material at Rocky Flats and the spatial distribution of emission sources on the site:

Emission Sources -	*Significant airborne emission sources for each material of concern are indicated on a plant map. The source information is, for the most part, based on modern-day APENs estimates, and EIS database radionuclide releases for 1988.*
Synonyms -	*Many materials of concern have multiple names in popular use, and in practice, trade names and slang terms are common.*
Chemical Forms and Properties -	*Several of the materials of concern are elements or isotopes of elements. As such, they can exist as various compounds and in different physical states. Indications are given in this field of the physical forms that have been used at Rocky Flats and their associated physical and chemical properties.*
Uses by Man and Presence in Nature-	*Some of the materials of concern are found in nature.*

Others may be detectable in the environment due to man's activities. Where applicable, this field indicates typical natural abundances, or ranges of typical background concentrations.

Toxicologic Highlights - *Known toxicologic properties of the materials are presented, for example known or suspected animal or human carcinogens, reproductive toxins, or irritants. Known patterns of distribution in the body are described.*

Uses at Rocky Flats - *Results of the historical investigation are presented for each material- the "who, what, when, where, and why" of use of the material at Rocky Flats. Inventory quantities from 1974 (Barrick, 1974) and 1988/89 (Setlock, 1990) are presented when available.*

Modern-Day Emission Estimates - *Expected emission rates of the material are presented based on Air Pollution Emission Notices submitted by EG&G Rocky Flats or, for radionuclides, DOE Effluent Information System data for 1988.*

Monitoring Data Availability - *The availability of emission monitoring data is described, be it routine or as special-studies of building or process emissions. Ambient monitoring, if any, is also listed.*

Period(s) of Use at Rocky Flats - *To the extent possible, the time period(s) of use of the material at Rocky Flats are indicated.*

The following convention is used for indicating periods of material presence or use:

filled circles		indicate points in time where use is documented, for example hazardous material inventories in 1974 and 1988/89, or dates of correspondence describing uses.
empty circles		indicate points in time where inventories or summaries were prepared, and use of the material was *not* indicated.
solid lines		indicate periods of documented use.
dashed lines		indicate periods of possible use.

4.3 Grouping of the Material Use Profiles

The material use profiles presented in this report are placed in two groups. The first group contains those twelve materials for which investigations have conclusively demonstrated that the material has been used at Rocky Flats in significant quantity, and in forms and processes that are associated with a reasonable potential for off-site release. The materials presented in this group are those which warrant further quantitative evaluation from the standpoint of potential off-site releases, and will be the focus of Task 5 source term estimation efforts.

The thirteen materials in the second group of material use profiles are those for which extensive investigation has indicated that uses of the material at Rocky Flats have been extremely limited in scope or duration, associated with insignificant quantities of the material, or have involved processes or forms of the material which were not expected to have any significant off-site releases. These materials therefore do not warrant further quantitative evaluation of potential off-site impacts.

A number of materials on the initial list of materials of concern generated as part of project Task 2 were included because no information was immediately available with regards to the nature of their use and potential for release. For four of the materials in the second group, even after the extensive searches and interviews performed as part of this Task 3 and 4 effort, no information could be found with regards to a use at the plant which supports the recorded inventory quantity or a potential for

off-site release. These materials are:

Benzidine
1,3-Butadiene
Ethylene Oxide
Propylene Oxide

In addition, information obtained on the other nine materials of concern in the second group has indicated that based on the nature of their use they do not warrant further quantitative evaluation of potential off-site impacts. These include:

Benzene
Cadmium Compounds
Chromium Compounds
Formaldehyde
Hydrazine
Lead Compounds
Mercury
Nickel Compounds
Nitric Acid

A comparison of the emission source maps with inventory quantities presented in the Building Summaries (Appendix B) indicates that in some cases, buildings or processes which use a given material are not identified as emission sources of that material. This is because the manner in which the material is stored, processed, or handled is not expected to lead to significant emissions. Lead is an example of such a case. On a number of the emission source maps, the waste treatment buildings are identified as air emission sources for chemicals which are not expected to be released in significant quantities in their primary areas of use as indicated by inventory quantities. Cadmium is an example of such a difference between the source maps and inventory quantities.

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MATERIALS OF CONCERN
EMISSION SOURCE DIAGRAMS
AND
MATERIAL USE PROFILES

GROUP NUMBER 1

The twelve materials presented in this group are those which warrant further quantitative evaluation from the standpoint of potential off-site health impacts, and will be the focus of Task 5 source term estimation efforts.

Insert Figure 4-1

SYNONYMS: None. Americium is named after the Americas.

CHEMICAL FORMS AND PROPERTIES:

- Americium is more white and silvery than plutonium. It is more malleable than uranium, and tarnishes slowly in dry room-temperature air.
- Am-241, a decay product of Pu-241, is associated with plutonium handling and processing.

USES BY MAN AND PRESENCE IN NATURE:

- Am-241 is used as a radiation source for static eliminators, smoke detectors, and as a medical diagnostic tracer.
- Am-241 has been used as a gamma radiography source and in thickness gages in the glass industry.

TOXICOLOGICAL HIGHLIGHTS:

- Americium most commonly enters the body by inhalation.
- It deposits primarily in the liver and skeleton with elimination half-times of 20 and 50 years, respectively.
- The main concern at low exposures is the probability of increased risk of cancer from irradiation of cells. Heavy metal poisoning from ingestion or inhalation occurs with exposure to large amounts.

USES AT ROCKY FLATS:

- Am-241 is associated with the plutonium used at Rocky Flats, at levels depending on the length of time that has passed since the Pu was produced. In general, the average age of the Pu at Rocky Flats is about 10 years, and Am ranges from 10 to 20% of the Pu activity (USDOE, 1980).

- Am-241 is separated from plutonium as a contaminant. At times in history, americium has also been purified at Rocky Flats for sale for commercial applications such as use as a medical diagnostic tracer and for smoke detector ionization sources. In the early 1980s, about a kilogram of >95% americium oxide was shipped to Oak Ridge National Laboratory each year (Knighton, 1981). Now americium is considered a waste product.

- Retired weapons components ("site returns") are disassembled, and some parts are processed via molten salt extraction to remove americium. A "salt scrub" process recovers Am and Pu from associated salts.

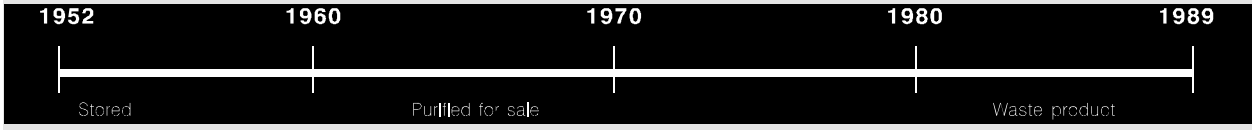
MODERN-DAY EMISSION ESTIMATE FROM EG&G REPORTS:

For 1988, reported americium-241 emissions were 2.02 microcuries airborne and 115 microcuries from waterborne surface runoff (Rockwell, 1989).

MONITORING DATA AVAILABILITY:

Americium has been monitored in Rocky Flats airborne effluents since 1985 and in waterborne effluents since at least 1971.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-2

SYNONYMS: Glucinium or Glucinum

CHEMICAL FORMS AND PROPERTIES:

- Beryllium is a hard, brittle, gray-white solid metallic element.
- Beryllium is useful in nuclear weapons because it is light-weight, strong, and reflects neutrons but is transparent to X rays.

USES BY MAN AND PRESENCE IN NATURE:

- Beryllium is found in some 30 mineral species, including beryl, chrysoberyl, and phenacite. Aquamarine and emerald are precious forms of beryl.
- Beryllium is used in ceramics, electron tubes, and high temperature reaction systems

TOXICOLOGICAL HIGHLIGHTS:

- Beryllium is a probable inhalation carcinogen (evidence in animals, inadequate evidence in humans).
- Chronic and acute Be inhalation exposure can result in pulmonary disease, termed berylliosis.
- Allergic contact dermatitis can result from dermal exposure.

USES AT ROCKY FLATS:

- Beryllium has been used to make weapons parts since 1958, based on R&D work that began at the plant in 1953 (Campbell, 1986). Early "wrought" process operations involved casting Be ingots, sawing the ingots into "billets", "canning" the billets with a stainless steel cladding to protect the Be from the atmosphere, heating and rolling into sheets, and removing the "cans". The Be sheets were then etched, rolled again, annealed, cut and pressed into shapes, and machined (USDOE, 1984).

- The wrought process ended in 1975, and since that time sintered blanks have been purchased from Brush Wellman, Inc. Machining is done on-site or by a subcontractor. Machining includes turning, milling, sawing, deburring, and polishing (Campbell, 1986).

- Be powder is mixed with other metals and pressed into shapes in Building 865 (EG&G, 1991c). Beryllium is vapor deposited to coat metal parts in Building 705 (EG&G, 1991d).

- Early Be machining operations were not enclosed (ChemRisk, 1991;RE-891[36]). There were "elephant trunks" for ventilation near Be machines and open hoods. Now, hoods are enclosed and machines have high & low vacuum systems to collect grit and fines (ChemRisk, 1991; RE-891[37]).

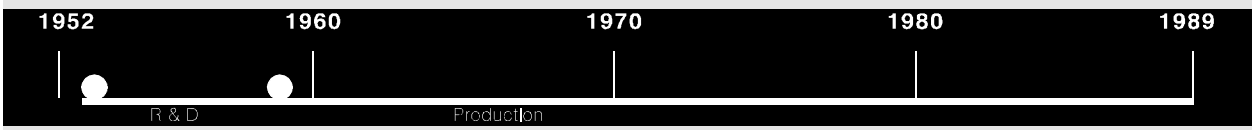
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

2.23×10^{-6} ton per year, which equals 0.07 ounces.

MONITORING DATA AVAILABILITY:

Be has been monitored in plant exhaust systems since at least 1963 (Hammond, 1963). It is currently monitored in 50 vents, although Be is actually processed in only six of the associated areas (EG&G, 1990a). Be is among 11 elements analyzed by atomic absorption in waterborne effluents since at least 1980 (USDOE, 1980).

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-3

ROCKY FLATS MATERIAL USE PROFILE; CARBON TETRACHLORIDE

SYNONYMS: carbon chloride, carbon tet, perchloromethane, tetrachloromethane, Freon 10, Halon 104

CHEMICAL FORMS AND PROPERTIES:

- Carbon tetrachloride is a clear, colorless, nonflammable liquid with a distinctive ether-like odor.
- Carbon tetrachloride is present in the environment due to human activities; the EPA national database of atmospheric concentrations indicates a median urban carbon tetrachloride concentration of about 110 parts per trillion by volume (Sturges and Taylor, 1990).
- Carbon tetrachloride works well with Pu because it contains no hydrogen atoms. Hydrogenated solvents are more likely to leave behind harmful solvent residue (ChemRisk, 1991; RE-891[46]).

USES BY MAN AND PRESENCE IN NATURE:

- Carbon tetrachloride has seen a wide range of industrial and chemical applications.

TOXICOLOGICAL HIGHLIGHTS:

- Carbon tetrachloride is a probable inhalation carcinogen (evidence in animals only).
- Inhalation of large quantities can damage liver, kidneys, lungs, or central nervous system.
- Chronic ingestion exposure may produce liver toxicity.
- Chronic dermal exposure may cause skin irritations.

USES AT ROCKY FLATS:

- Rocky Flats was formerly the largest volume U.S. user of carbon tetrachloride (EG&G, 1990b). Carbon tetrachloride has been used to clean glove-box walls, furnaces, product components, metal chips, machinery, and instruments. Prior to 5-6 years ago, it was used "like a bucket of soap and water." (ChemRisk, 1991; RE-891[16]).

- Briquetting and chip degreasing emissions have the highest carbon tetrachloride concentrations- up to approximately 13% by volume (ChemRisk, 1991; RE-891[5,7,32]).

- Carbon tetrachloride was present on the 1974 Harmful Materials Inventory in the amount of 12,500 kg. The quantity indicated on the 1988/89 Chemical Inventory was 7,060 kg.

- Carbon tetrachloride was used as a diluent in solvent extraction operations on a laboratory scale (ChemRisk, 1991; RE-891[43]).

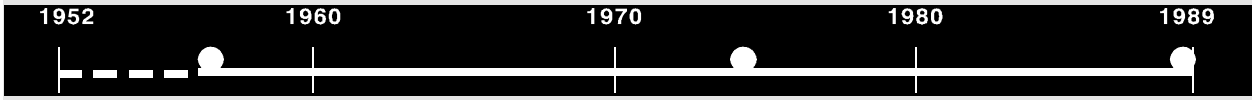
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

40.4 tons per year, which equals 80,800 pounds.

MONITORING DATA AVAILABILITY:

Carbon tetrachloride has not been routinely monitored in airborne or waterborne effluents. There have been several special studies involving short-term monitoring of carbon tetrachloride emissions in the work-place or in airborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-4

SYNONYMS: methane trichloride, trichloromethane

CHEMICAL FORMS AND PROPERTIES:

- Chloroform is a dense, colorless, volatile liquid with a pleasant odor.
- When heated to decomposition, forms phosgene gas.

USES BY MAN AND PRESENCE IN NATURE:

- Chloroform is used in manufacturing of floor polishes, resins, vitamins, penicillin, as a dry cleaning agent, and in production of chlorodifluoromethane.
- Chloroform is a by-product in chlorinated drinking water and municipal sewage
- It is ubiquitous in the environment; the EPA national database of atmospheric concentrations indicates a median urban chloroform concentration of about 58 parts per trillion by volume (Sturges and Taylor, 1990).

TOXICOLOGICAL HIGHLIGHTS:

- Chloroform is a probable carcinogen (evidence in animals, but inadequate evidence in humans).
- It is considered a potential developmental toxicant based on animal studies.
- Dermal exposure to chloroform may cause skin irritation.
- Acute inhalation exposure may cause liver and kidney toxicity.

USES AT ROCKY FLATS:

- Chloroform is used in analyses of plutonium samples for determination of gallium content. Chloroform extracts the gallium oxide complex (EG&G, 1990c).

- Chloroform is released from process liquid waste neutralization processes (EG&G, 1991b).

- Chloroform has reportedly been used by carpenters to join plastics, but is no longer used in that manner (ChemRisk, 1991; RE-891[35,56]).

- The 1974 Harmful Materials Inventory listed chloroform with a quantity of 5513 liters. The 1988/89 Chemical Inventory Quantity was 500 kg, with uses including as an adhesive/solvent in Building 334, a glue for plexiglass in Building 460, and dissolving of plastics and photo resists in Building 881.

MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

0.844 tons per year, which equals 1,688 pounds per year.

MONITORING DATA AVAILABILITY:

Chloroform has not been routinely monitored in airborne or waterborne effluents, but has been the subject of some special, short-term monitoring studies.

PERIOD(S) OF USE AT ROCKY FLATS:

Insert Figure 4-5

ROCKY FLATS MATERIAL USE PROFILE; METHYLENE CHLORIDE

SYNONYMS: dichloromethane, DCM, methylene dichloride

CHEMICAL FORMS AND PROPERTIES:

- Methylene chloride is a colorless liquid with a pleasant, chloroform-like odor.
- Methylene chloride is moderately soluble in water and highly volatile in air.

USES BY MAN AND PRESENCE IN NATURE:

- Because it is an excellent solvent with low flammability, methylene chloride is used in paint removers, aerosol products, production of urethane foams and pharmaceutical products, and as a cleaning agent for metal parts and electronic components.
- It is also produced at low levels by chlorination of drinking water.

TOXICOLOGICAL HIGHLIGHTS:

- Methylene chloride is one of the least toxic chlorinated hydrocarbons.
- The primary route of exposure is by inhalation.
- Methylene chloride is a probable carcinogen (evidence in animals only).
- Inhalation of high levels of methylene chloride causes irritation to the eyes, nose, and throat.

USES AT ROCKY FLATS:

- Methylene chloride is present in paints and paint strippers used at Rocky Flats. Use was significant in Building 889, particularly in the 1960s and 1970s (e.g. clean-up of oralloy line equipment from Building 881).

- Methylene chloride is an ingredient of the "Cee Bee" solution used in aqueous component cleaning (EG&G, 1991f).

- It is used in several laboratories and process areas for sample preparation and analysis.

- Methylene chloride has been detected in samples of the sludge contained in the sanitary sewage treatment plant drying beds (EG&G, 1991e).

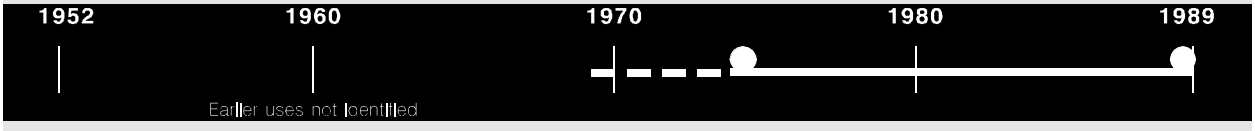
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

3.33 tons per year, which equals 6,660 pounds per year.

MONITORING DATA AVAILABILITY:

Methylene chloride has not been routinely monitored in airborne or waterborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-6

ROCKY FLATS MATERIAL USE PROFILE; PLUTONIUM

SYNONYMS: None. Plutonium is named after the planet Pluto.

CHEMICAL FORMS AND PROPERTIES:

- Plutonium is a silvery, white metal that takes on a yellow tarnish when slightly oxidized.
- Pu-239 is produced when U-238 absorbs a neutron; Pu-239 can absorb more neutrons to form heavier isotopes, such as Pu-240, Pu-241, and Pu-242. Pu-239 is fissionable.
- A relatively large piece of plutonium will be warm to the touch because of the energy given off by alpha decay. Larger pieces will produce enough heat to boil water.
- Plutonium metal is attacked by all common gases at elevated temperatures; for example, nitrogen forms nitrides and hydrogen forms hydrides.

USES BY MAN AND PRESENCE IN NATURE:

- Plutonium is primarily produced and used by man in reactors and nuclear weapons.
- Plutonium is also found in trace quantities in naturally-occurring uranium ores.
- Pu-238 has been used as a power source in space, for example for equipment on the lunar surface.

TOXICOLOGICAL HIGHLIGHTS:

- Inhalation is the primary health concern because particles embedded in lungs emit alpha and some gamma rays with a half-life of 24,000 years.
- About 0.1% of ingested amount enters the bloodstream. About 80% of the resulting blood burden deposits in the liver and skeleton, with elimination half-lives of 20 and 50 years, respectively.
- The main concern at low exposures is the probability of increased risk of cancer from irradiation of cells. Heavy metal poisoning from ingestion or inhalation occurs with exposures to large amounts.

USES AT ROCKY FLATS:

- Pu fabrication involves casting, rolling and forming, machining, and final product assembly.

- Recovery involves dissolution of Pu metal and Pu bearing residues, purification, and conversion to metal. An incinerator was used for Pu recovery from 1959 (Gaskins and Martin, 1970) until 1988. Effluents were HEPA filtered.

- Production Support uses Pu in physical chemistry research and product testing, metallurgical support, nuclear joining, pyrochemical technology, hydride operations, chemical technology, coatings & metal film deposition, and machining and gaging support (Kneale, 1989).

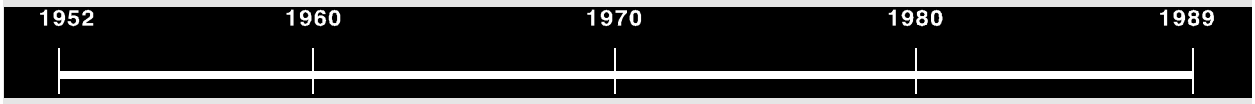
MODERN-DAY EMISSION ESTIMATE FROM EG&G REPORTS:

1988 Pu air emissions were 15.33 µCi. Surface water runoff totalled 118 µCi (Rockwell, 1989).

MONITORING DATA AVAILABILITY:

Air monitoring 1953-1973 was for total long-lived alpha. After 1973, analyses were specific for Pu (USDOE, 1980). Prior to 1961, ambient water and vegetation sample analyses were gross alpha or Pu + Th, later separations were specific for Pu and U (ChemRisk, 1991; RE-891[5,7,32]).

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-7

ROCKY FLATS MATERIAL USE PROFILE; TETRACHLOROETHYLENE

SYNONYMS: PCE, perchlorethylene, perchloroethylene, "perc", tetrachlorethylene

CHEMICAL FORMS AND PROPERTIES:

- PCE is a colorless liquid with a mild, chloroform-like odor.
- It is a noncombustible liquid.

USES BY MAN AND PRESENCE IN NATURE:

- PCE is used in dry cleaning and degreasing fabricated metal parts.
- It rapidly volatilizes from water to air, and rapidly migrates from soil to groundwater.

TOXICOLOGICAL HIGHLIGHTS:

- The most likely route of human exposure to PCE is inhalation.
- PCE is a probable carcinogen (evidence in animals, but limited evidence in humans).
- Chronic exposure to low levels of PCE is not likely to present a health concern.
- Acute exposure to high concentrations causes central nervous system depression and cardiovascular effects.
- PCE has been observed to cause dermal irritation.

USES AT ROCKY FLATS:

- PCE was widely used for part cleaning and degreasing in Buildings 881, 444, 883, 771, and 776 (ChemRisk, 1991; RE-891[39,48,53]).

- PCE was apparently most heavily used during the period of enriched uranium processing in Building 881 (prior to 1963); about 50 drums per month were used (ChemRisk, 1991; RE-891[39]).

- The period of PCE use in Building 886 was from about 1965 to 1975 (ChemRisk, 1991; RE-891[53]).

- Based on the 1974 Harmful Materials Inventory quantity of 4462 kg, the 1988/89 Chemical Inventory quantity of 1.5 kg, and personnel interviews, it appears that PCE was replaced by 1,1,1-trichloroethane for plutonium component cleaning and vapor degreasing in the 1970s.

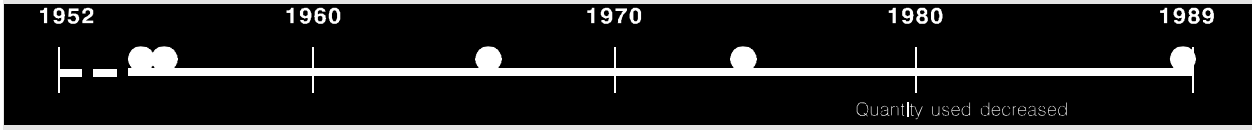
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

0.0000714 ton per year, which equals 2.28 ounces per year. Modern-day emissions are not representative of periods of much higher use in earlier years.

MONITORING DATA AVAILABILITY:

PCE has not been routinely monitored in airborne or waterborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-8

ROCKY FLATS MATERIAL USE PROFILE; THORIUM

SYNONYMS: None. Thorium was named after Thor, the Norse god of thunder, weather, and crops.

CHEMICAL FORMS AND PROPERTIES:

- **!** Thorium is a soft, ductile metal that can be easily scratched.
- **!** Th-232 is a very long-lived alpha particle emitting isotope with a half-life exceeding 10 billion years.

USES BY MAN AND PRESENCE IN NATURE:

- **!** Th is found in nature in ores such as thorite and monazite.
- **!** Th is used in ceramic glazes, optical glass, welding electrodes, gas lantern mantles, and alloys.

TOXICOLOGICAL HIGHLIGHTS:

- **!** 0.02% is absorbed into the blood, then 70% deposits in bone and is eliminated with a 22 y half-life.
- **!** The main concern at low exposures is the probability of increased risk of cancer from irradiation of cells. Heavy metal poisoning from ingestion or inhalation occurs with exposures to large amounts.

USES AT ROCKY FLATS:

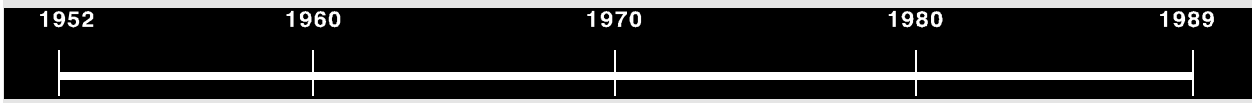
- **!** Thorium has been used in several ways at Rocky Flats since 1952. The quantities of Th used have varied from none to about 238 kilograms in any month (Anonymous, 1976).
  - The major use has been fabrication of metal parts from natural thorium and thorium alloys.
  - Th oxide ("thoria") may have been used as a mold coating compound in limited experiments, but never on a production scale.
  - Th compounds have been used in analytical procedures and "development programs". Amounts were small, but applications "numerous".
  - Twice during 1964 to 1969, "thorium strikes" removed gamma-emitting Th-228 from U-233 metal. The strikes used natural thorium (Putzier, 1982).
  - Th has also been used as a stand-in for the more expensive U or Pu components in various phases of development programs.
- **!** A project in B-881 involved Th production over several years in the late 1950s to early 1960s (ChemRisk, 1991; RE-891[48]). There were very tight controls, and Th went through the same processes as enriched uranium, but most was sent to Savannah River or Oak Ridge for recovery.

MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs: Not addressed in the APEN program.

MONITORING DATA AVAILABILITY:

Th contributes to total alpha, but has not been specifically analyzed routinely in effluents. Before 1961, ether extraction separated Pu + Th from environmental samples. After 1961, specific separations for Pu and U were performed (ChemRisk, 1991; RE-891[5,7,32]).

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-9

ROCKY FLATS MATERIAL USE PROFILE; 1,1,1-TRICHLOROETHANE

SYNONYMS: chlorothene, methyl chloroform, "1,1,1-TCA"

CHEMICAL FORMS AND PROPERTIES:

- 1,1,1-TCA is a colorless liquid with a faint, benzene-like odor.

USES BY MAN AND PRESENCE IN NATURE:

- 1,1,1-TCA is one of the most frequently used cleaning solvents in industry.
- It is removed from water by volatilization; can migrate to groundwater.
- 1,1,1-TCA is ubiquitous in the environment; the EPA national database of atmospheric concentrations indicates a median urban 1,1,1-TCA concentration of about 365 parts per trillion (Sturges and Taylor, 1990).

TOXICOLOGICAL HIGHLIGHTS:

- There is no animal or human evidence of 1,1,1-TCA carcinogenicity.
- Toxic effects of 1,1,1-TCA exposure include central nervous system depression and lack of coordination and equilibrium at low concentrations, and at very high concentrations, anesthesia.

USES AT ROCKY FLATS:

- 1,1,1-TCA has been used to clean and degrease metal parts. It has been used in uranium cleaning operations and in plutonium component cleaning and vapor degreasing (EG&G, 1990b).

- 1,1,1-TCA replaced trichloroethylene in the 1970s in the search for a cleaning solvent with acceptable material compatibility and toxicologic qualities.

- 1,1,1-TCA was present on the 1974 Harmful Materials Inventory with a quantity of 22,763 kg. It was present on the 1988/89 Chemical Inventory with a quantity of 1,750 kg.

- As of May 1990, 1,1,1-TCA was still in use for cleaning in assembly operations, but implementation of isopropyl alcohol as a substitute for non-plutonium areas had begun. Water has been proposed as a substitute for 1,1,1-TCA for non-plutonium cleaning in plutonium areas, and non-regulated solvents such as water-based detergents, liquid carbon dioxide, and petroleum distillates have been recommended for in-process plutonium cleaning (EG&G, 1990b).

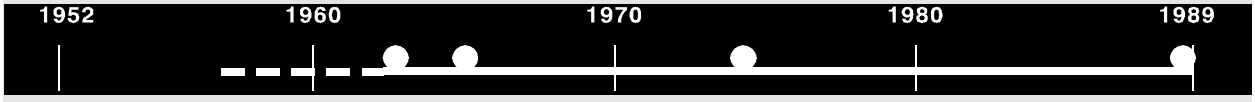
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

31.4 tons per year, which equals 62,800 pounds per year.

MONITORING DATA AVAILABILITY:

1,1,1-TCA has not been routinely monitored in airborne or waterborne effluents. It has been included in some special studies of organic solvent emissions.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-10

ROCKY FLATS MATERIAL USE PROFILE; TRICHLOROETHYLENE

SYNONYMS: TCE, trichloroethene, ethylene trichloride, triclene, "trike"

CHEMICAL FORMS AND PROPERTIES:

- TCE is a colorless liquid (sometimes dyed blue) with a pleasant, chloroform-like odor.

USES BY MAN AND PRESENCE IN NATURE:

- TCE is a common solvent in organic chemical and pharmaceutical manufacturing.
- TCE rapidly volatilizes from water and soil; can leach into groundwater from soil.
- TCE is ubiquitous in the environment; the EPA national database of atmospheric concentrations indicates a median urban TCE concentration of 200 parts per trillion (Sturges and Taylor, 1990).

TOXICOLOGICAL HIGHLIGHTS:

- TCE is a probable inhalation and ingestion carcinogen (evidence in animals only).
- Chronic toxic effects of TCE exposure involve the kidneys, liver, nervous system, and skin.
- Acute TCE inhalation and ingestion studies indicate no toxicity.
- TCE reacts with sunlight and air to contribute to photochemical smog.

USES AT ROCKY FLATS:

- TCE was used in large quantities to clean and degrease Be, Pu, and U parts. TCE in ultrasonic vapor degreasers replaced acetone, isopropyl alcohol, and other solvents for parts cleaning in 1963. Nearly 10,000 gallons of TCE were used during 1973 (Musgrave, 1974). TCE was replaced by 1,1,1-TCA later in the 1970s in the search for a nonphotochemically reactive solvent with acceptable material compatibility. In some areas, the progression of cleaning solvents went from isopropyl alcohol to CCl_4 to TCE to 1,1,1-TCA (ChemRisk, 1991; RE-891[67]).

- TCE was present on the 1974 Harmful Materials Inventory with a quantity of 22,763 kg. The quantity present on the 1988/89 Chemical Inventory decreased to 140 kg.

- TCE was used for decontamination (e.g. of B-771 glove-boxes) before KW soap solution came into use in the 1960s (ChemRisk, 1991; RE-891[25]). It was used in significant quantities during the period of enriched uranium processing in Building 881 (prior to 1963); about 50 drums per month were used (ChemRisk, 1991; RE-891[39]).

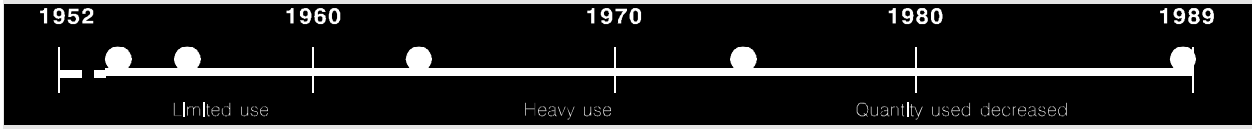
- Small quantities of TCE are used in Building 460 inspection operations to remove a putty-like substance used to make molds (ChemRisk, 1991; RE-891[35]).

MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs: 0.152 ton per year (304 pounds)

MONITORING DATA AVAILABILITY:

TCE has not been routinely monitored in airborne or waterborne effluents, but has been included in several special studies of organic solvent emissions.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-11

ROCKY FLATS MATERIAL USE PROFILE; TRITIUM

SYNONYMS: Hydrogen-3

CHEMICAL FORMS AND PROPERTIES:

- Tritium is the sole radioactive isotope of the element hydrogen; the stable isotopes are protium (H-1, ordinary hydrogen) and deuterium (H-2 or D), which is present in "heavy water."

USES BY MAN AND PRESENCE IN NATURE:

- Tritium is found in nature at low levels as a result of cosmic ray reactions with nitrogen and spontaneous fissioning of elements in the earth's crust.
- Tritium has been used in luminous paints and as a biological tracer.
- Upon release to the environment, tritium mixes with the global pool of hydrogen atoms.

TOXICOLOGICAL HIGHLIGHTS:

- Tritiated water vapor or tritium gas can penetrate the skin, lungs, or GI tract.
- Tritiated water is completely absorbed and excreted with a half-life of 10 days; some becomes bound to organic molecules and half-life may vary.
- Tritiated water vapor is, relatively speaking, much more hazardous radiologically than is tritium gas (as HT or T_2).

USES AT ROCKY FLATS:

- Tritium has been present at Rocky Flats since 1964 as trans-shipments, Special Order work, standards, and nondestructive testing sources (Hoffman, 1992).

- Tritium is also sometimes released during disassembly of contaminated weapon components. The H-3 environmental control system is designed to capture H-3 from process atmospheres (EG&G, 1990d).

- Hydriding operations designed to recover plutonium resulted in tritium releases when contaminated materials were fed to the process (See Section 6, 1973 tritium release). Plutonium Analytical Laboratory operations in Building 559 are a possible source of tritium emissions from processing of product and waste streams containing tritium (EG&G, 1990c).

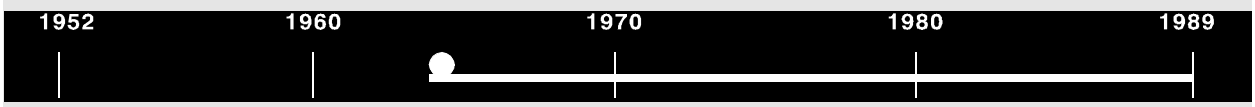
MODERN-DAY EMISSION ESTIMATE FROM EG&G REPORTS:

Releases of airborne tritium totalling 0.015 Ci were reported for 1988 (Rockwell, 1989). A 1988 waterborne H-3 release total of 0.23 Ci was reported in the USDOE Effluent Information System.

MONITORING DATA AVAILABILITY:

H-3 monitoring results have been published since 1973 for waterborne effluents and since 1974 for airborne effluents. Airborne tritium was monitored prior to 1973 in preparation for production work that didn't materialize at Rocky Flats (Hoffman, 1992). Results have not been located.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-12

SYNONYMS: Named after the planet Uranus. Forms are called oralloy, EU, tuballoy, staballoy, and D-38.

CHEMICAL FORMS AND PROPERTIES:

- A heavy, slightly radioactive, silvery white metal; readily oxidizes to black on contact with air.
- Natural uranium consists primarily of U-234 (0.005%), U-235 (0.7%), and U-238 (99%).
- Enriched uranium, often called oralloy (from Oak Ridge alloy) or EU, has more U-235 than natural uranium (about 93% U-235 at Rocky Flats). U-235 is fissionable.
- Depleted uranium (often called tuballoy or D-38) has less U-235 than natural uranium, therefore a higher content of U-238. U-238 can absorb neutrons and become fissionable Pu-239.
- Over 95% of enriched U's alpha activity comes from the trace U-234 present. Enriched U yields about 150 dpm per microgram, compared to 0.7 for depleted U and 1.5 for natural U (Putzier, 1982).

USES BY MAN AND PRESENCE IN NATURE:

- Uranium is ubiquitous in soils and rocks, with concentrations ranging from 1 to 4 ppm.
- Enriched U is the main fissionable fuel for power reactors and is a component of nuclear weapons.
- Depleted uranium is used in armor-piercing shells due to its high density.

TOXICOLOGICAL HIGHLIGHTS:

- Exposure to soluble uranium compounds produces kidney damage. While radioactive isotopes of uranium are considered carcinogens, chemical toxicity often dominates.
- The main concern at low exposures is the probability of increased risk of cancer from irradiation of cells. Heavy metal poisoning from ingestion or inhalation occurs with exposures to large amounts.
- Insoluble U compounds are a hazard to the lungs when inhaled, and to the bone when ingested.

USES AT ROCKY FLATS:

- Uranium has been used from initial plant operation to make weapons parts. Enriched and depleted U metal have been the main forms used. Uranium has been alloyed with niobium and other metals.

- Fissile U-233 was processed over 15 years from the late 1950s to the early 1970s. U-233 was aqueously processed, cast, and machined in Buildings 771, 776/777, and 779. U-233 was machined in B-881. U-236 was processed in B-881 on special runs. U-233 and U-236 were separated on a lab scale in B-771 for Oak Ridge (ChemRisk, 1991; RE-891[9,31,48]).

- In the mid-1980s, hundreds of tons of depleted U were processed in B-883 to manufacture armor plates for the Army's M1A1 tanks (ChemRisk, 1991; RE-891[13,31,36,69]).

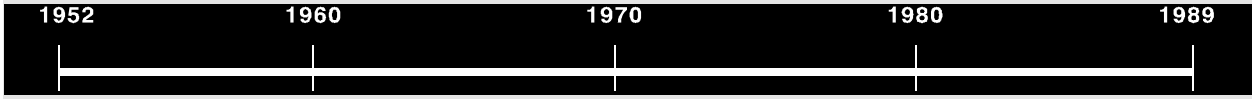
MODERN-DAY EMISSION ESTIMATE FROM EG&G REPORTS:

For 1988, an airborne release total of 11.93 microcuries of uranium was reported along with a waterborne emission total (from surface water runoff) of 24,300 microcuries (Rockwell, 1989).

MONITORING DATA AVAILABILITY:

Air effluent measurements 1953-1973 were total alpha activity, assumed to be U or Pu. From 1973 on, samples from Pu areas were analyzed specifically for Pu. From 1978 on, analyses were specific for U and Be (USDOE, 1980). Before 1961, water and vegetation analyses were gross alpha or Pu+Th. After 1961, separations were specific for Pu and U (ChemRisk, 1991; RE-891[5,7,32]).

PERIOD(S) OF USE AT ROCKY FLATS:



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MATERIALS OF CONCERN
EMISSION SOURCE DIAGRAMS
AND
MATERIAL USE PROFILES

GROUP NUMBER 2

The thirteen materials in this group are those for which extensive investigation has indicated that uses of the material at Rocky Flats have been extremely limited in scope or duration, associated with insignificant quantities of the material, or have involved processes or forms of the material which were not expected to have significant off-site releases. These materials do not warrant further quantitative evaluation of potential off-site impacts.

insert Figure 4-13

ROCKY FLATS MATERIAL USE PROFILE; BENZENE

SYNONYMS: benzol, benzole, coal naptha, cyclohexatriene, phene, phenyl hydride, pyrobenzol

CHEMICAL FORMS AND PROPERTIES:

- Benzene is a clear, colorless, noncorrosive, highly flammable liquid
- Benzene has a strong, rather pleasant odor.

USES BY MAN AND PRESENCE IN NATURE:

- Benzene saw widespread industrial use in the 1930s to 1960s, mostly as an intermediate in producing other organic chemicals. Other uses include manufacture of detergents and pesticides and as a solvent or paint remover.

TOXICOLOGICAL HIGHLIGHTS:

- Benzene is considered an inhalation carcinogen (evidence in both humans and animals).
- Chronic inhalation exposure is associated with blood and bone marrow disorders, such as leukemia.
- Acute toxicity effects are central nervous system depression, respiratory or cardiac arrest.

USES AT ROCKY FLATS:

- Many interviewees indicated that benzene was used in small quantities, mainly in laboratories. Its use at the plant was not widespread, and it was never used in production processes.

- Benzene is listed in the Building 881 APEN report as a process chemical. No specific use is listed. The building currently houses laboratories, maintenance shops, and plant support activities.

- Benzene was reportedly used in a tank in Building 777 for ultrasonic testing of components. The tank held a couple hundred gallons, and would periodically leak and cause evacuation of the area until a team in protective clothing could enter and make repairs. The tank was used from around 1966 to about 1975 (ChemRisk, 1991; RE-891[40])

- Benzene was present on the 1974 Harmful Materials Inventory with a quantity of 42.5 kg, and was present on the 1988/89 Chemical Inventory with a quantity of 5 kg.

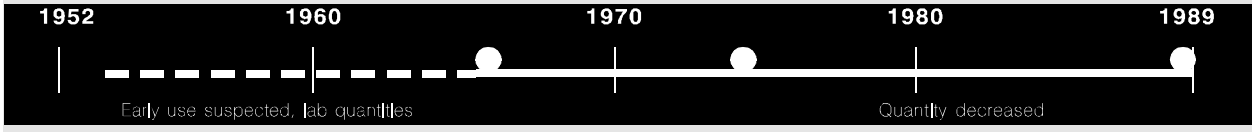
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

7.74 pounds per year

MONITORING DATA AVAILABILITY:

Benzene has not been routinely monitored in airborne or waterborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-14

SYNONYMS: 4,4'-Bianiline, 4,4'-Biphenyldiamine, 1,1'-Biphenyl-4,4'-diamine, 4,4'-Diaminobiphenyl, p'-Diaminodiphenyl

CHEMICAL FORMS AND PROPERTIES:

- Benzidine is a grayish-yellow, reddish-gray, or white crystalline powder.

USES BY MAN AND PRESENCE IN NATURE:

- Benzidine is used in the manufacture of dyes.

TOXICOLOGICAL HIGHLIGHTS:

- Exposure to benzidine can occur through inhalation, ingestion, or dermal contact.
- There is evidence of carcinogenicity in humans.
- No information is available on effects of chronic exposure.
- Liver and kidney damage can result from acute exposure.

USES AT ROCKY FLATS:

- Benzidine was on the 1974 Harmful Materials Inventory, with a quantity of under an ounce and no location listed. Benzidine was not on the 1988/89 Chemical Inventory.

- May have been used as a molecular weight standard for osmosis applications (ChemRisk, 1991; RE-891[11]).

MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

Benzidine is not addressed in the APEN reports.

MONITORING DATA AVAILABILITY:

Benzidine has not been routinely monitored in airborne or waterborne effluents or the environment.

PERIOD(S) OF USE AT ROCKY FLATS:

Insert Figure 4-15

ROCKY FLATS MATERIAL USE PROFILE; 1,3-BUTADIENE

SYNONYMS: biethylene, bivinyl, butadiene, divinyl, erythrene, vinylethylene

CHEMICAL FORMS AND PROPERTIES:

- At room temperature, 1,3-butadiene is a colorless gas with a mild aromatic or gasoline-like odor.
- 1,3-butadiene can be liquified below 24 degrees F.

USES BY MAN AND PRESENCE IN NATURE:

- 1,3-butadiene is released from motor vehicles, burning of fossil fuels, and plastic and rubber manufacturing.

TOXICOLOGICAL HIGHLIGHTS:

- 1,3- butadiene is a probable inhalation carcinogen (evidence in animals, but not in humans).
- Chronic exposure to animals resulted in adverse effects to the liver, testes, and ovaries.
- The acute toxic effect is irritation of the respiratory tract, mucous membranes, and eyes.

USES AT ROCKY FLATS:

- 1,3-butadiene was on the 1974 Harmful Materials Inventory, with a quantity of about 250 pounds and no location listed. Butadiene was not on the 1988/89 Chemical Inventory.

- No interviewees or records reviewed have indicated any uses for 1,3-butadiene at Rocky Flats.

- The only mentions of butadiene located in records repositories deal with ABS (Acrylonitrile Butadiene Styrene) thermoplastic and studies to characterize its thermal stability and compatibility with organic solvents. A document has also been located which deals with identification of drums with styrene butadiene gaskets. The significance of the material is not otherwise evident.

MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

Butadiene is not addressed in the APEN reports.

MONITORING DATA AVAILABILITY:

Butadiene has apparently not been monitored in airborne or waterborne effluents or the environment.

PERIOD(S) OF USE AT ROCKY FLATS:

Insert Figure 4-16

SYNONYMS: Metal: None. Named from kadmeia, the ancient name for calamine, zinc carbonate.

CHEMICAL FORMS AND PROPERTIES:

- Cadmium compounds used include elemental or metallic cadmium oxide, cadmium chloride, and cadmium sulfate.
- Elemental cadmium is a soft, silver-white, blue-tinged, lustrous, odorless solid. It is easily cut with a knife. It is noncombustible in bulk form, but will burn in powder form.

USES BY MAN AND PRESENCE IN NATURE:

- Cadmium is used in plating, solders, pigments, batteries, plastics, and television tube phosphors.
- Cd enters the environment from discarded metal products, phosphate fertilizer, and fuel combustion.

TOXICOLOGICAL HIGHLIGHTS:

- Probable inhalation carcinogen (evidence in animals; limited evidence in humans).
- Toxic effects of chronic inhalation exposure include emphysema and painful joints and bones.
- Acute ingestion exposure produces stomach irritation and vomiting; acute inhalation exposure may result in breathing distress and pulmonary edema.

USES AT ROCKY FLATS:

- Cd has been used in plating. Some solutions are made by mixing cadmium salts with cyanide solutions, others are purchased in aqueous form. Cd plating is done at room temperature in 20-gallon tanks. Some liquid evaporates, but measurements show that the metals remain in solution (Simmons, 1992).

- Since RCRA went into effect, plating wastes were drummed and shipped off-site as hazardous waste. Before RCRA, they were treated in B-774 (Simmons, 1992) by addition of sodium hydroxide and mixing with Portland cement and an absorbent material (Anderson, et al., 1984). Dilute rinsing solutions are sent to B-374. Prior to B-374, the solar ponds were used to treat wastewater, and as a result "pondcrete" made from solar pond wastes contains Cd (Paynter, 1989).

- Cd salts have been used as neutron absorbers for criticality safety in recovery operations that take place in equipment that was not dimensionally safe; e.g. in B-771 and B-881 (Schuske, 1958). Cd has been used for thermal neutron shielding because of its high neutron capture cross-section.

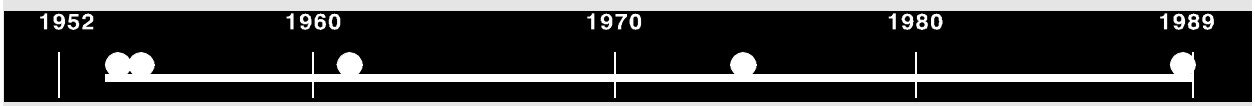
- Cd has been rolled and formed in Buildings 444, 883, and 865. Cd was used as commonly as lead for shielding from the late 1950s through the 1970s, but in smaller quantities. During welding, Cd was afforded the same protective measures as for beryllium (ChemRisk, 1991; RE-891[40]). Cd was alloyed with other metals in B-444 (Dow, 1965).

- Of the 100 kg of Cd on the 1974 Harmful Material Inventory, 57% was elemental and 34% was cadmium oxide. Of the 46 kg of Cd on the 1988/89 Chemical Inventory, 31% was elemental and 56% was oxide.

MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs: Cd is not addressed in the APEN reports.

MONITORING DATA AVAILABILITY: Cadmium has not been routinely monitored.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-17

ROCKY FLATS MATERIAL USE PROFILE; CHROMIUM

SYNONYMS: None. Chromium is named from chroma, Greek for color.

CHEMICAL FORMS AND PROPERTIES:

- Elemental chromium is a blue-white to steel-gray, lustrous, brittle, hard solid.
- Different forms of chromium include trivalent and hexavalent chromium.

USES BY MAN AND PRESENCE IN NATURE:

- Chromium is commonly used for plating of metals and other substrates. It is used to harden steel and make stainless steel and many useful alloys. Cr is used to give glass an emerald green color.
- Chromium occurs naturally, primarily in chromite ore.
- Trivalent chromium is the stable form found in nature. Hexavalent chromium is almost exclusively produced as the result of manufacturing activities. In nature, hexavalent chromium is more often converted to trivalent than the reverse process.

TOXICOLOGICAL HIGHLIGHTS:

- Hexavalent chromium is thought to be an inhalation carcinogen (evidence in both humans and animals). Effects of chronic chromium exposure include changes in the skin and mucous membranes. Acute exposure to high doses of chromium can result in damage to the liver, kidneys, gastrointestinal tract, and circulatory system.
- Chronic trivalent Cr inhalation and ingestion exposure appears to have minimal health effects.

USES AT ROCKY FLATS:

- Cr compounds have been used for plating in the B-444 R&D plating lab (ChemRisk, 1991; RE-891[9,56]). Some solutions are made by mixing chromium salts with acids, others are purchased in aqueous form. Cr plating solutions are heated, and are used in 75-gallon tanks. Some liquid evaporates, but measurements show that the metals remain in solution (Simmons, 1992).

- Since RCRA went into effect, plating wastes have been drummed and shipped off-site as hazardous waste. Before RCRA, they were treated in B-774 (Simmons, 1992) by addition of sodium hydroxide and mixing with Portland cement and an absorbent material. Dilute rinsing are sent to B-374. Prior to B-374, the solar ponds were used to treat wastewater (Anderson, et al., 1984).

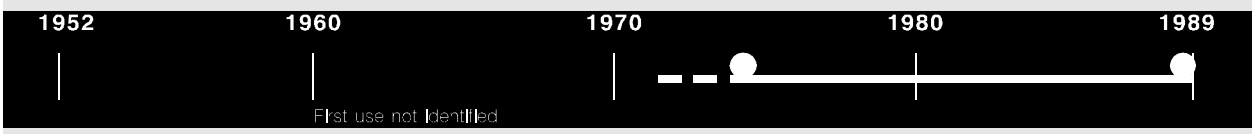
- Cr trioxide was used in B-444 (with sulfuric acid and phosphoric acid) to chemically mill Be (ChemRisk, 1991; RE-891[56]). Cr compounds were on the 1974 Harmful Materials Inventory with a quantity of 211 kg. The 1988/89 Chemical Inventory lists a quantity of 793 kg, 692 kg of which is Cr trioxide.

MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs: Cr is not addressed in the APEN reports.

MONITORING DATA AVAILABILITY:

Total chromium (mg/l) is currently monitored in surface waterborne effluents from Rocky Flats.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-18

ROCKY FLATS MATERIAL USE PROFILE; ETHYLENE OXIDE

SYNONYMS: dimethylene oxide, 1,2-epoxy ethane, oxirane, ETO

CHEMICAL FORMS AND PROPERTIES:

- Ethylene oxide is a colorless gas or liquid (below 51° F), with an ether-like odor.
- Ethylene oxide is not persistent in the environment due to high reactivity (degradation)

USES BY MAN AND PRESENCE IN NATURE:

- Ethylene oxide is used as chemical intermediate, fumigant, and sterilizing agent

TOXICOLOGICAL HIGHLIGHTS:

- Ethylene oxide is a probable inhalation carcinogen (evidence in animals; insufficient for humans).
- Acute inhalation exposure can result in headache, nausea, and respiratory irritation.
- Acute exposure to high concentrations causes central nervous system depression.
- Aqueous solutions can be extremely irritating to the skin.

USES AT ROCKY FLATS:

- Ethylene oxide was on the 1974 Harmful Materials Inventory, with a quantity of 192,400 kg and no location listed. It was not on the 1988/89 Chemical Inventory.

- Chemical utilization checklists completed by plant managers in 1978 provided no positive responses indicating ethylene oxide use (Barrick, 1978).

- Dow may have experimented with ethylene oxide as a possible substitute for carbon tetrachloride as a solvent that could be used with plutonium without the hydrogen generation problems associated with some solvents contacting plutonium (ChemRisk, 1991; RE-891[46]).

- Reports of a possible classified use for ethylene oxide have not been supported in classified document reviews or interviews.

- Ethylene oxide was used to sterilize respirator cartridges in the Building 776 laundry for several years beginning in 1960 or 1961 (ChemRisk, 1991; RE-891 [71]).

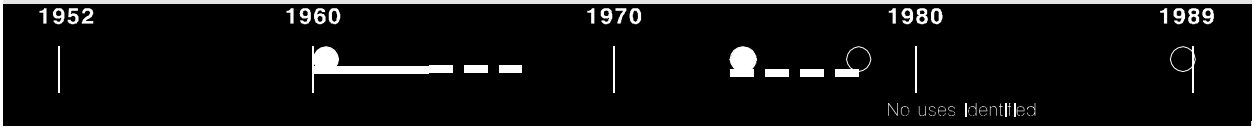
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

Ethylene oxide is not addressed in the APEN program.

MONITORING DATA AVAILABILITY:

Ethylene oxide has not been routinely monitored in airborne or waterborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-19

ROCKY FLATS MATERIAL USE PROFILE; FORMALDEHYDE

SYNONYMS: gaseous forms: methanal, methyl aldehyde, methylene oxide
aqueous solutions: formalin

CHEMICAL FORMS AND PROPERTIES:

- A nearly colorless gas at room temperature, with a pungent, suffocating odor.
- Degradation occurs rapidly in air and water.

USES BY MAN AND PRESENCE IN NATURE:

- Formaldehyde is a powerful antiseptic, germicide, fungicide, and preservative used in the tanning and preservation of hides and furs and in embalming.
- Formaldehyde is also used to improve fastness of dyes, waterproofing of fabrics, processing and preserving rubber, and preserving foodstuffs.
- It is also used as a seed and soil disinfectant, in hardening paper products, in developing photographic film, and in refining gold and silver.

TOXICOLOGICAL HIGHLIGHTS:

- Formaldehyde is a probable carcinogen (evidence in animals; insufficient evidence in humans).
- Dermal contact can result in skin irritation or allergic contact dermatitis.
- Formaldehyde is a respiratory irritant.

USES AT ROCKY FLATS:

- Formaldehyde was on the 1974 chemical inventory, with a quantity of 27 kg and no location listed. A quantity of 146 kg was reflected on the 1988/89 inventory.

- Formaldehyde may have been tested for de-nitration in Building 771, but it is very violent, and was never used in large quantities (ChemRisk, 1991; RE-891[11]).

- According to the 1988/89 Chemical Inventory, a large portion of the formaldehyde used at Rocky Flats at that time was used by the Utilities Department to sterilize reverse osmosis membranes used for waste water treatment in Building 910.

MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

Formaldehyde is not addressed in the APEN reports.

MONITORING DATA AVAILABILITY:

Formaldehyde has not been routinely monitored in airborne or waterborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:

Insert Figure 4-20

SYNONYMS: diamine, diamide, hydrazine (anhydrous), hydrazine base

CHEMICAL FORMS AND PROPERTIES:

- Hydrazine is a colorless liquid with an ammonia-like odor.
- Hydrazine is a solid below 36° F.

USES BY MAN AND PRESENCE IN NATURE:

- Hydrazine is used as a reducing agent and as a rocket fuel.
- Hydrazine is used for synthesis and analysis of a wide variety of organic compounds.

TOXICOLOGICAL HIGHLIGHTS:

- Hydrazine is a probable carcinogen (evidence in animals, but not in humans).
- Chronic exposure to hydrazine may cause damage to the liver and red blood cells.
- Acute hydrazine exposure may cause corrosive damage to the eyes, skin, and mucous membranes.

USES AT ROCKY FLATS:

- Hydrazine was on the 1974 Harmful Materials Inventory with a quantity of 30 kg. The 1988/89 Chemical Inventory reflected a total of about 2 kg of hydrazine in use in laboratories.

- Hydrazine was used in very small quantities in neptunium recovery operations as a holding reductant for neptunium valency. Hydrazine was added to destroy any nitrous acid that could destroy the value of Fe(II) as a reducing agent (Conner and Baaso, 1981). Hydrazine was also used to assist in reducing plutonium valency (ChemRisk, 1991; RE-891[9,43]).

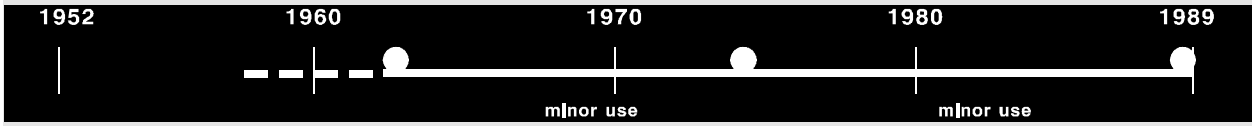
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

Hydrazine is not addressed in the APEN reports.

MONITORING DATA AVAILABILITY:

Hydrazine was not routinely monitored in airborne or waterborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-21

ROCKY FLATS MATERIAL USE PROFILE; LEAD

SYNONYMS: lead metal, plumbum

CHEMICAL FORMS AND PROPERTIES:

- Lead is a heavy, ductile, soft gray solid.
- Lead compounds include lead chloride, lead dioxide, lead tetroxide, and lead chromate.

USES BY MAN AND PRESENCE IN NATURE:

- Native lead occurs in nature, but is rare. Lead is obtained chiefly from galena ore, PbS.
- Lead is ubiquitous in the environment due to past use of leaded gasoline.
- Lead is extremely persistent in water and soil, but not easily taken up by plants.

TOXICOLOGICAL HIGHLIGHTS:

- Lead is a probable carcinogen (some evidence in animals, but no evidence in humans).
- Toxic effects from chronic exposure include learning disabilities, brain and kidney damage.
- Acute lead exposure affects the nervous system, kidneys, and blood-forming organs.

USES AT ROCKY FLATS:

- Lead has been used mainly in metal form for radiation shielding throughout the plant site. The 1974 inventory quantity was over a million pounds. The 1988/89 Chemical Inventory apparently excluded much of the lead metal, and indicated the presence of 1350 kg.

- Lead tetroxide (red lead) was also used by maintenance machinists in rebuilding machines and leak testing fittings (ChemRisk, 1991; RE-891[56]).

- Lead fluoroborate and lead oxide have been used in small quantities in plating operations based on the 1988/89 Chemical Inventory.

- Lead fluoride and lead metal were used in Building 771. There were laboratory-scale attempts at lead/americium alloying (ChemRisk, 1991; RE-891[9]).

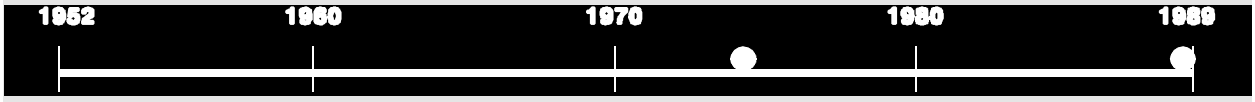
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

Lead is not addressed in the APEN reports.

MONITORING DATA AVAILABILITY:

Lead has not been routinely monitored in airborne or waterborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-22

SYNONYMS: colloidal mercury, metallic mercury, quicksilver. Named after the planet Mercury.

CHEMICAL FORMS AND PROPERTIES:

- Mercury is silvery-white, heavy, odorless, and is the only common metal liquid at ordinary temperatures.
- Mercury compounds include methyl mercury, mercuric oxide, and mercurous chloride.
- Methyl (organic) mercury is more toxic than other mercury compounds.

USES BY MAN AND PRESENCE IN NATURE:

- Mercury is used in many industries, including textile printing, photography, and the manufacture of scientific equipment and batteries.
- Mercury rarely occurs free in nature; the chief ore is cinnabar, HgS.
- Mercury compounds are fairly mobile in the environment.
- Elemental mercury volatilizes at room temperature.

TOXICOLOGICAL HIGHLIGHTS:

- Uptake in food is usually the largest source of human exposure.
- Inhalation of mercury may cause pneumonia, bronchitis, gum inflammation, or nausea.
- Inadequate evidence of carcinogenicity in animals or humans.
- Chronic exposure is associated with behavioral and neurological disturbances.
- Methyl mercury may pass into the fetus and concentrate in brain tissue.

USES AT ROCKY FLATS:

- Hg used at Rocky Flats is for the most part limited to the metallic mercury contained in instruments such as barometers and thermometers, plant machinery, mercury switches, and experimental apparatus (EG&G, 1986). Hg has been collected from plant sources and purified by distillation at the B-881 General Laboratory. It was recycled back to the originating area in 5 lb. containers (EG&G, 1986). There are no large sources of mercury like those found at Oak Ridge or Savannah River Laboratories (ChemRisk, 1991; RE-891[11]).

- Materials present in 1971 included mercuric chloride, mercuric oxide, mercury/thallium, batteries, electrodes, fluorescent lamps, and rectifiers (Willging, 1972).

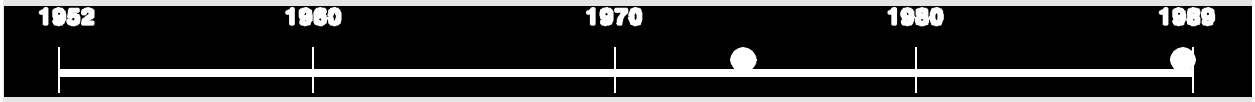
- A reference to mercury emissions from an unspecified joining operation in the Building 777 "modulab" has been located and reviewed (Putzier, 1975). A welding operation used mercury to make contact with spinning parts during the welding (ChemRisk, 1991; RE-891 [71]).

MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs: Hg is not addressed in the APEN reports.

MONITORING DATA AVAILABILITY:

Mercury has not been routinely monitored in airborne or waterborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-23

SYNONYMS: Metal: elemental nickel. Compound synonyms vary by compound.

CHEMICAL FORMS AND PROPERTIES:

- ! Nickel metal is a lustrous, silvery solid.
- ! Nickel compounds include nickel carbonyl, nickel nitrate, and nickel monoxide.

USES BY MAN AND PRESENCE IN NATURE:

- ! Nickel is used for plating, metal alloying, and in welding.

TOXICOLOGICAL HIGHLIGHTS:

- ! Nickel carbonyl, Ni subsulfide, and Ni refinery dust are carcinogens (evidence in humans and animals).
- ! Chronic Ni exposure is associated with emphysema, loss of sense of smell, and severe nasal injuries.
- ! Dermal exposure can produce a contact dermatitis which is called "nickel itch" and is common among nickel platers.
- ! Nickel carbonyl poisoning is insidious since there is no particular discomfort during the exposure and serious effects are delayed for hours to days.

USES AT ROCKY FLATS:

- ! Nickel plating of weapon components was conducted in B-444 up until shutdown of the plating lab in 1990 (ChemRisk, 1991; RE-891[56]). Some plating solutions are made by mixing metal salts with acids, others are purchased in aqueous form. Ni plating solutions are heated and used in 75-gal. tanks. Some liquid evaporates, but measurements show that the metals do not (Simmons, 1992).

- ! Since RCRA went into effect, plating wastes have been drummed and shipped off-site as hazardous waste. Before RCRA, they were treated in B-774 (Simmons, 1992) by addition of sodium hydroxide and mixing with Portland cement and an absorbent material. Dilute rinsing solutions are sent to B-374. Prior to B-374, the solar ponds were used to treat wastewater (Anderson, et al., 1984).

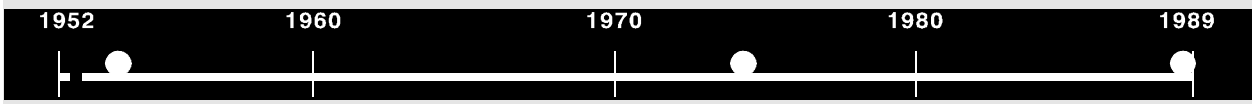
- ! Nickel carbonyl plating was conducted in B-771, 777, and 779 from the early 1950s until the early 1960s or 1970s (ChemRisk, 1991; RE-891[3,40,49,67]). Nickel plating by nickel carbonyl decomposition was used for U and delta phase (alloyed) Pu. It was carried out by heating the cleaned metal in a vacuum to 80-85° C, charging in a partial atmosphere of Ni carbonyl to flash coat the part, and increasing the temperature to 100-110° C to accelerate the plating (Pitts, 1962).

MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs: Nickel is not addressed in the APEN reports.

MONITORING DATA AVAILABILITY:

Nickel compounds have not been routinely monitored in airborne or waterborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-24

ROCKY FLATS MATERIAL USE PROFILE; NITRIC ACID

SYNONYMS: aqua fortis, engravers acid, hydrogen nitrate, red or white fuming nitric acid

CHEMICAL FORMS AND PROPERTIES:

- Nitric acid is colorless, yellow or red fuming liquid with an acrid, suffocating odor.
- Often in aqueous solutions. Fuming nitric acid is concentrated acid containing dissolved nitrogen.

USES BY MAN AND PRESENCE IN NATURE:

- Nitric acid is used to dissolve metals, for etching and cleaning metals, and to make fertilizers and explosives.

TOXICOLOGICAL HIGHLIGHTS:

- Nitric acid is not listed as a carcinogen by the EPA.
- Chronic nitric acid exposure may result in chronic bronchitis or pneumonia.
- Acute exposure may cause pulmonary congestion and edema.

USES AT ROCKY FLATS:

- Nitric acid is used in large quantities to dissolve plutonium metal and plutonium bearing residues to facilitate purification and recovery of plutonium (EG&G, 1990e). In times of high production, about two railroad tank cars of nitric acid were used per month (ChemRisk, 1991; RE-891[39]).

- Nitric acid is used in metal etching and plating operations. Uranium parts are treated in an ultrasonic etching bath prior to assembly coating (EG&G, 1991h).

- Titanium buildup on fixtures is stripped by immersion in acid solutions (EG&G, 1991h).

- Nitric acid is used in the first stage of radioactive decontamination treatment to decrease plutonium and americium concentrations (EG&G, 1991a).

- In other operations, nitric acid is used for parts cleaning (EG&G, 1991f) and various laboratory analyses (EG&G, 1990c, 1991c, 1991g).

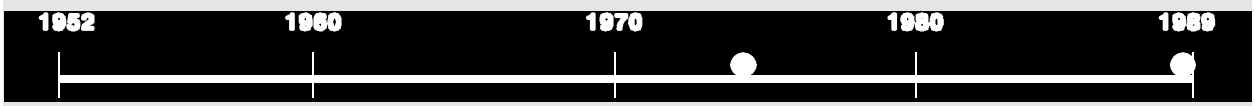
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

0.37 ton per year, which equals 740 pounds per year. This emission estimate is for nitrogen oxides (NOx) resulting from nitric acid use.

MONITORING DATA AVAILABILITY:

Nitric acid has not been routinely monitored in airborne or waterborne effluents. Some special studies of nitric acid and nitrogen dioxide emissions have been done (Hobbs, 1974).

PERIOD(S) OF USE AT ROCKY FLATS:



Insert Figure 4-25

ROCKY FLATS MATERIAL USE PROFILE; PROPYLENE OXIDE

SYNONYMS: 1,2-epoxy propane, methyl ethylene oxide, methyloxirane, propene oxide, 1,2-propylene oxide

CHEMICAL FORMS AND PROPERTIES:

- Propylene oxide is a colorless liquid with a benzene-like odor.
- Propylene oxide is a gas above 94° F.

USES BY MAN AND PRESENCE IN NATURE:

- Propylene oxide is used as a chemical intermediate, for example in polyurethane manufacturing, and in the preparation of lubricants and demulsifiers.
- It is sometimes used directly as a solvent and sterilizing agent.

TOXICOLOGICAL HIGHLIGHTS:

- Propylene oxide is a probable carcinogen (evidence in animals only).
- Chronic exposure to propylene oxide has caused eye and throat irritation and congestion.
- Acute exposure has produced temporary corneal injury and contact dermatitis.

USES AT ROCKY FLATS:

- Propylene oxide was on the 1974 chemical inventory, with a quantity of 1.5 kg and no location listed. It was not on the 1988/89 inventory.

- Dow may have experimented with propylene oxide as a possible substitute for carbon tetrachloride as a solvent that could be used with plutonium without the hydrogen generation problems associated with some solvents contacting plutonium (ChemRisk, 1991; RE-891[46]).

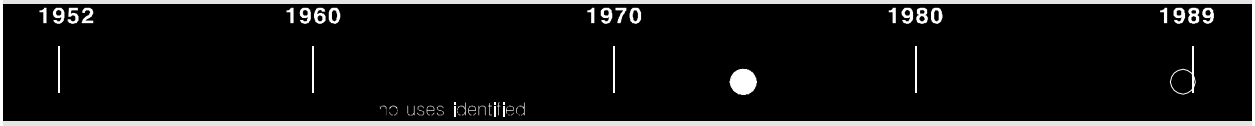
MODERN-DAY EMISSION ESTIMATE FROM EG&G APENs:

Propylene oxide is not addressed in the APEN reports.

MONITORING DATA AVAILABILITY:

Propylene oxide has not been routinely monitored in airborne or waterborne effluents.

PERIOD(S) OF USE AT ROCKY FLATS:



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5.0 HISTORICAL RELEASE POINTS

The general modes of release of materials from the Rocky Flats Plant to the off-site environment have included airborne effluents, waterborne emissions, and those resulting from solid waste disposal or accidents. Historical airborne emissions include those from routine facility operations as well as those associated with the accidents and incidents described in Section 6 of this report. Airborne effluents exit the various Rocky Flats buildings by way of numerous release points of varying geometry and significance.

Waterborne emissions from the Plant have included process wastes, laundry wastes, sanitary waste, and surface runoff from the site. Waterborne emissions from the plant have left the site via the North and South Walnut Creek and Woman Creek drainage, and spray application of certain waste waters to various area of plant property has been practiced. While there is no evidence of intentional disposal of liquids to the ground water aquifers underlying the site, various contaminants have appeared in ground water collected within the site boundary as a result of past disposal practices and/or other releases of chemicals and radionuclides to the environment.

Solid wastes have been generated at the plant since its early operation. In addition, liquid wastes which cannot be recovered are often solidified in preparation for disposal. While landfills have been operated on the plant site for disposal of certain solid wastes, and there are numerous accounts of on-site burial of radioactive and chemical wastes, a great majority of radioactive and hazardous solids have historically been shipped off the site for disposal.

This section describes the emission points which have been associated with airborne and waterborne releases of the materials of concern from the Rocky Flats Plant. Solid waste disposal practices are discussed, along with documentation of past activities surrounding Rocky Flats' handling and treatment of wastes received from off-site sources.

5.1 Airborne Emissions

Table 5-1 contains information that characterizes the emission points for airborne emissions of materials of concern from the Rocky Flats Plant. For each release point, the following types of information are provided:

Location	*The building or buildings which are associated with or provide contaminants to the release point are identified.*
Identifiers	*Codes, names, or other identifiers for the release point are provided, based on information from the DOE Effluent Information System (EIS), EG&G Air Pollution Emission Notices (APENs), and other applicable documents.*
Stack or Vent Type	*The type of release point (e.g. elevated stack, roof-top vent, wall vent) is indicated based on plant documents.*
Typical Exhaust Qualities	*Properties of the exhaust stream which are relevant to prediction of off-site concentrations and doses are summarized where available. Examples include typical velocities and temperatures.*
Expected Constituents	*The materials of concern which are expected to be contained in the emissions from the release point are identified based on APENs or the EIS.*
Contribution to Site Totals	*For each material of concern expected to be present, the percentage of the site total release expected from this release point is presented as an indicator of the significance of the release point for that material. The sources of this emission data are the modern-day APEN reports and DOE Effluent Information System totals for 1988.*

For each material of concern, knowledge of the relative significance of each release point, the spatial distribution of significant emission sources, the geometries of the release points, and the characteristics of the effluent streams are all factors which will be evaluated for potential significance in planning of the Task 6 approaches for modeling of off-site impacts of the emissions to be estimated as part of Task 5.

TABLE 5-1 ROCKY FLATS AIRBORNE EMISSION POINTS

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
371C-001 Vent #1; System 1	Dicesium Hexachloro-plutonate Ops, Chemical Standard Lab, and Maintenance Ops.	Louvered Penthouse Roof - 37 ft Stack - 4.0 ft	(1)	Nitric acid (Nox): 0.0030% Beryllium: 11.2% Plutonium: 0.80% Americium: 0.8% Uranium: 2.8%
371C-002 Vent #2; System 2	Plutonium Analytical Support Lab and Maintenance Ops.	Louvered Penthouse Roof - 37 ft Stack - 4.0 ft	(1)	Nitric acid (Nox): 0.06% Beryllium: 8.1% Plutonium: 0.83% Americium: 1.8% Uranium: 4.2%
374D-002 Vent #3	Waste Receiving and Neutralization	Circular Dia - 16.25" Roof - 37 ft Stack - 8.4 ft above roof	17.537 cfm 3.769 fpm 70 deg F	Beryllium: 0.67% Plutonium: 0.44% Americium: 1.3% Uranium: 0.58%
374J-001 Vent #'s 7,8,9	Waste Receiving and Neutralization	Louvered Penthouse Dim. 72" x 54" (3 sides) Roof - 37 ft Stack - 3.6 ft above roof	115.430 cfm 13.22 fpm 70 deg F	Nitric Acid (Nox): 5.4% Beryllium: 0.66% Methylene Chloride: 0.74% 1,1,1-TCA: 0.0081% Chloroform: 0.16% PCE: 100% TCE: 0.1% Plutonium: 0.93% Americium: 1.9% Uranium: 3.9%
444 Vent #122	Beryllium Machining Areas	(1)	(1)	Beryllium: 25%

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
444N-003 Vent #82	Production Plating Laboratory	Rectangular Dim. 30.5"x24.0" Stack 10.7 ft above ground level	(1)	Uranium: 0.1% Nitric Acid(Nox): 20%
444N-004 Vent #200 Filter Plenum Building 450	Foundry, Uranium Machining, Titanium Stripping, Assembly, Welding, Brazing, Etching, and Coating	Rectangular Roof Height 14.8 ft Stack 2.0 ft above roof Dimensions 108"x96"	(1)	Nitric Acid (NO_x): 47% Uranium: 4.1%
447D-001 Filter Plenum 201 Building 451	Electron Beam Welding Maintenance Operations Vacuum Arc Melt Furnace Chip Roaster	Rectangular Roof Height 10.3 ft Stack 2.5 ft above the roof Dimensions 60" x ?	Flow Rate: 64,000 ACFM Velocity: 2133 ft/min Temp: 70°F	Beryllium: 6.9% Methylene Chloride: 0.045% Uranium: 2.4%
Building 460 High-bay Exhaust Vents 2, 4, 5, 6, 35, 36, 38, 39, 40, and 43	Product Inspection, Maintenance Activities	63"x63"vents, 40" above roof	Flow Rate: 34,820 ACFM Velocity: 1,263 FPM Temp: 70°F	TCE: 99.9% 1,1,1-TCA: 0.015% Chloroform: 0.74%
460-14 Rooms 117 and 118 Exhausts	Material Development Part Cleaning	12" dia stack 10 feet above roof	(1)	Carbon tet: 0.0066%
460-23 Hood Exhausts	Aqueous Assembly Cleaning	36"x36" vent 2' above roof	(1)	1,1,1-TCA: 0.011% Methylene Chloride: 0.045%
460-30 Hood Exhausts	Assembly Cleaning-Automated and Internal Cleaning Lines	24" dia stack, 10 ft above roof	(1)	Nitric acid (NOx): 3.4%

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
460-54 Room exhaust fan	Nondestructive testing; radiographic testing	24" dia wall vent 13' above grade	(1)	1,1,1-TCA: 0.0009%
559A-001 Exhaust Vent #36 Building 561 plenum	Gallium Determination, Emissions Spectroscopy, Uranium Analysis, and Plutonium Oxidation	Double inverted J 57"x48" Roof Height 21 ft Stack 2.0 ft above roof	Flow Rate: 73,600 ACFM Velocity: 3067 ft/min Temp: 70°F	Beryllium: 6.5% Chloroform: 87.7% Nitric Acid (NOx): 0.26% Plutonium: 3.0% Uranium: 2% Americium: 3.7% Tritium: 2.6%
707 Vent 1/2	(1)	Mushroom Diameter 28" Roof Height 37.5 ft Stack Height 8.6 ft above roof	(1)	Beryllium: 0.33% Plutonium: 0.2% Americium: 1.4% Uranium: 0.6%
707 Vent 3/4	(1)	Mushroom Diameter 14" Roof Height 37.5 ft Stack Height 7.8 ft above roof	(1)	Beryllium: 0.33% Plutonium: Same as 707 Vent 1/2 (2) Americium: Same as 707 Vent 1/2 Uranium: Same as 707 Vent 1/2
707B-006 Vent 9/10	Pu casting, oxidation, storage, and shearing	2 Inverted J's Dim. 18"x18" Roof Height 37.5 ft Stack Height 3.0 ft above the roof	(1)	Beryllium: 0.31% Carbon Tet.: 8.32% Plutonium: 0.06% Americium: 0.08% Uranium: 0.08%

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
707B-003 Vent 28	Part assembly, weighing, testing, and inspection	Inverted J Dim. 36"x36" Roof Height 37.5 ft Stack Height 3.0 ft above the roof	(1)	Beryllium: 1.1% 1,1,1-TCA: 5.5% Carbon Tet.: 0.27% Plutonium: 0.80% Americium: 1.1% Uranium: 0.4% Tritium: 2.2%
707B-005 Vent 36	Pu casting ops, rolling and forming, briquetting, machining, and inspection	Inverted J Diameter 14" Roof Height 37.5 ft Stack Height 3.0 ft above the roof	(1)	Beryllium: 0.09% Carbon Tet.: 71.4% 1,1,1-TCA: 0.031% Plutonium: 0.01% Americium: 0.08% Uranium: 0.08%
707 Vent 38/39	(1)	Mushroom Diameter 43.5" Roof Height 37.5 ft Stack Height 10.2 ft above the roof	(1)	Beryllium: 0.33% Plutonium: Same as 707 Vent 1/2 (2) Americium: Same as 707 Vent 1/2 Uranium: Same as 707 Vent 1/2
707 Vent 40/41	(1)	Mushroom Diameter 43.5" Roof Height 37.5 ft Stack Height 10.2 ft above the roof	(1)	Beryllium: 0.33% Plutonium: Same as 707 Vent 1/2 (2) Americium: Same as 707 Vent 1/2 Uranium: Same as 707 Vent 1/2
707 Vent 42/43	(1)	Mushroom Diameter 43.5" Roof Height 37.5 ft Stack Height 10.2 ft above the roof	(1)	Beryllium: 0.33% Plutonium: Same as 707 Vent 1/2 (2) Americium: Same as 707 Vent 1/2 Uranium: Same as 707 Vent 1/2

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
707 Vent 44/45	radiography	Mushroom Diameter 43.5" Roof Height 37.5 ft Stack Height 10.2 ft above the roof	(1)	Beryllium: 0.32% 1,1,1-TCA: 0.028% Plutonium: Same as 707 Vent 1/2 (2) Americium: Same as 707 Vent 1/2 Uranium: Same as 707 Vent 1/2
707B-001 Vent 55	Assembly-superdry	Inverted J Dim. 22"x22" Roof Height 37.5 ft Stack Height 3.0 ft above the roof	(1)	Beryllium: 0.76% 1,1,1-TCA: 0.25% Plutonium: 0.03% Americium: 0.05% Uranium: 0.5% Tritium: 0.5%
707B-004 Vent 65	Pu machining, part degreasing, assembly testing	Inverted J Dim. 36"x36" Roof Height 37.5 ft Stack Height 3.5 ft above the roof	(1)	Beryllium: 1.2% 1,1,1-TCA: 7.92% Plutonium: 0.10% Americium: 0.3% Uranium: 0.7% Tritium: 0.9%
707B-002 Vent 75	(1)	Inverted J Dim: 30"x30" Roof Height 37.5 ft Stack Height 3.0 ft above the roof	(1)	Beryllium: 0.33% Plutonium: 0.21% Americium: 0.4% Uranium: 1.3% Tritium: 0.9%
707 Vent 76/77	(1)	Mushroom Diameter 43.5" Roof Height 37.5 ft Stack Height 10.2 ft above the roof	(1)	Beryllium: 0.33% Plutonium: Same as 707 Vent 1/2 (2) Americium: Same as 707 Vent 1/2 Uranium: Same as 707 Vent 1/2

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
707 Vent 78/79	Calibration lab, instrument cleaning	Mushroom Diameter 43.5" Roof Height 37.5 ft Stack Height 10.2 ft above the roof	(1)	Beryllium: 0.39% 1,1,1-TCA: <0.0001% Plutonium: Same as 707 Vent 1/2 (2) Americium: Same as 707 Vent 1/2 Uranium: Same as 707 Vent 1/2
707 Vent 80/81	Assembly brazing scanning, testing	Mushroom Diameter 43.5" Roof Height 37.5 ft Stack Height 10.2 ft above the roof	(1)	Beryllium: 0.40% 1,1,1-TCA: 0.49% Plutonium: Same as 707 Vent 1/2 (2) Americium: Same as 707 Vent 1/2 Uranium: Same as 707 Vent 1/2
771C-001 Vent #86 Building 771 Main exhaust	Plutonium Recovery Facility	Stack Height: 145 ft Diameter: 120 inches	Flow Rate: 184,000 ACFM Velocity: 2313 ft/min Temp: 70° F	Beryllium: 0.11% Methylene Chloride: 21% Nitric Acid (NOx): 11.1% Plutonium: 70% Uranium: 7.1% Tritium: 20.2% Americium: 64%
771C-002 Vent #9 Building 771C Main Plenum	Shipping and Counting Areas	Stack Height 21 ft Diameter 2.0 ft	Flow Rate: 8279 ACFM Velocity: 2635 ft/min Temp: 70° F	Beryllium: 0.13% Plutonium: 4% Uranium: 0.33% Americium: 5.8%
771C-005 Building 771C Room Plenum Vent #'s 2 & 8	Shipping and Counting Areas	Stack Height 21 ft Diameter 2.4 ft	Flow Rate: 10695 ACFM Velocity: 1168 ft/min Temp: 70° F	Beryllium: 0.12% Plutonium: 8% Americium: 9.1% Uranium: 0.32%

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
771G-001 Building 771A Main Exhaust Vent #67 Paint Hood Exhaust	Paint Stripping and Paint Applications	Stack Height 16 ft Diameter 1.1 ft	Flow Rate: 1700 ACFM Velocity: 1848 ft/min Temp: 70° F	No chemicals of concern listed
774D-001 Filter Plenum 202 Vent #4	Organic and sludge immobilization system (OASIS)	Inverted J Dimensions - 60"x16.3" Roof Height 26 ft Stack 1.5 ft above roof	(1)	1,1,1-TCA: 30.9% Plutonium: 2% Americium: 1.8% Uranium: 0.12%
776E-001 Plenum 250 Vent #24	Baler, Briquetting, Machining, Disassembly and Assembly Operations, and Radiography	Louvered Penthouse Roof Height 38 ft Stack 3.3 ft above roof Four sides (N,S,E,W), all rectangular Dimensions: 244"x28"	Flow Rate: 72,800 ACFM Velocity: 150 ft/min Temp: 70° F	Beryllium: 9.0% Carbon Tet: 20% Methylene Chloride: 70% 1,1,1-TCA: 49.7% Plutonium: 1.3% Americium: 1.2% Uranium: 1.4% Tritium: 1.6%
776E-002 Plenum 206 Vent #32	Special Weapons Projects, Plutonium Metallography Lab, Ultrasonic Cleaning System, Foundry Operations, TCA Collection and Filtration System	Louvered Penthouse Roof Height 38 ft Stack 3.3 ft above roof Four sides (N,S,E,W), all rectangular Dimensions 244"x28"	Flow Rate: 19,000 ACFM Velocity: 39 ft/min Temp: 70° F	Beryllium: 7.2% 1,1,1-TCA: 4.8% Plutonium: 0.30% Americium: 0.24% Uranium: 0.36% Tritium: 52%

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
776E-003 Plenum 201/203 Vent #24	Baler, Briquetting, Machining, Disassembly and Assembly Operations, and Radiography	Louvered Penthouse Roof Height 38 ft Stack 3.3 ft above roof Four sides (N,S,E,W), all rectangular Dimensions: 244"x28"	Flow Rate: 72,800 ACFM Velocity: 150 ft/min Temp: 70° F	Beryllium: Same as 776E-001 Carbon Tet: Same as 776E-001 Methylene Chloride: Same as 776E-001 1,1,1-TCA: (Same as 776E-001) Plutonium: 0.03% Americium: 0.05% Uranium: 0.15%
776E-004 Plenum 205 Vent #32	Special Weapons Projects, Plutonium Metallography Lab, Ultrasonic Cleaning System, Foundry Operations, TCA Collection and Filtration System	Louvered Penthouse Roof Height 38 ft Stack 3.3 ft above roof Four sides (N,S,E,W), all rectangular Dimensions 244"x28"	Flow Rate: 19,000 ACFM Velocity: 39 ft/min Temp: 70° F	Beryllium: Same as 776E-002 1,1,1-TCA: Same as 776E-002 Plutonium: 0.16% Americium: 0.25% Uranium: 0.44% Tritium: 7.2%
776E-005 Plenum 204 Vent #24	Baler, Briquetting, Machining, Disassembly and Assembly Operations, and Radiography	Louvered Penthouse Roof Height 38 ft Stack 3.3 ft above roof Four sides (N,S,E,W), all rectangular Dimensions: 244"x28"	Flow Rate: 72,800 ACFM Velocity: 150 ft/min Temp: 70° F	Beryllium: Same as 776E-001 Carbon Tet: Same as 776E-001 Methylene Chloride: Same as 776E-001 1,1,1-TCA: Same as 776E-001 Plutonium: 0.36% Americium: 0.41% Uranium: 1.3% Tritium: 6.6%
776E-006 Plenum 251 Vent #45	(1)	Inverted J Roof Height 35.8 ft Stack 6.5 ft above roof Dimensions 60"x32"	Flow Rate: 4754 ACFM Velocity: 257 ft/min Temp: 70° F	Beryllium: 0.67% Plutonium: 0.08% Americium: 0.2% Uranium: 0.20%

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
776E-007 Plenum 252 Vent #44	(1)	Inverted J Roof Height 35.8 ft Stack 7.5 ft above roof Dimensions 36"x27"	Flow Rate: 5850 ACFM Velocity: 975 ft/min Temp 70° F	Beryllium: 0.49% Plutonium: 0.13% Americium: 0.25% Uranium: 0.10%
776E-008 Plenum 202 Vent #17	(1)	Stack to Conical Hat Roof Height 38 ft Stack Height 14.8 ft Diameter 20.25"	Flow Rate: 6000 ACFM Velocity: 25,000 ft/min Temp: 70° F	Beryllium: 0.85% Plutonium: 0.11% Americium: 0.12% Uranium: 0.10%
776E-009 Plenum 207 Vent #32	Special Weapons Projects, Plutonium Metallography Lab, Ultrasonic Cleaning System, Foundry Operations, TCA Collection and Filtration System	Louvered Penthouse Roof Height 38 ft Stack 3.3 ft above roof Four sides (N,S,E,W), all rectangular Dimensions 244"x28"	Flow Rate: 19,000 ACFM Velocity: 39 ft/min Temp: 70° F	Beryllium: Same as 776E-002 1,1,1-TCA: Same as 776E-002 Plutonium: 0.26% Americium: 0.6% Uranium: 0.55%
778H-001 Laundry	Laundry Facilities	Cylindrical Diameter 48" Roof Height 25.9 ft Stack 5.3 ft above roof	(1)	Plutonium: 0.77% Americium: 0.83% Uranium: 3.6%
779F-001 Vent #71 Building 729 plenum	(1)	Circular Stack Diameter 37.75 inches Stack Height 93.5 ft	Flow Rate: 17707 ACFM Velocity: 2361 ft/min Temp: 70° F	Plutonium: 0.21% Americium: 0.21% Uranium: 0.29% Tritium: 0.92%

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
779F-002 Vent #70 Building 782 plenum	(1)	Double inverted J Dimensions 57"x48" Roof Height 20.1 ft Stack 1.8 ft above roof	Flow Rate: 61506 ACFM Velocity: 4316 ft/min Temp: 70° F	Plutonium: 4.1% Americium: 0.68% Uranium: 2.2% Tritium: 1.3%
865P-001 Vent Pair 58/59 Building 867	Beryllium Powder work, Research and Development of Metalworking Processes, Metallography Lab, and Grit Blasters	Rectangular Dimensions 56"x56.5" Roof Height 11.0 ft Stack 4.0 feet above roof	(1)	Beryllium: 0.03% Nitric Acid(NOx): 0.64% Uranium: 2.2%
865P-002 Vent Pair 63/64 Building 866	Beryllium Powder work, Research and Development of Metalworking Processes, Metallography Lab, and Grit Blasters	Rectangular Dimensions 60"x56.25" Roof Height 14.0 ft Stack 1.5 ft above roof	(1)	Beryllium: 0.03% Nitric Acid(NOx): 0.64% Uranium: 1.6%
881Q-001 Ducts 1,2,3 and 4. These ducts exit through the same stack as 881Q-002.	Research and Development Activities	Circular (4 outlets) Diameter 96.0 inches Roof height 32.6 ft Stack 8.0 ft above roof	Flow Rate: 14,258 ACFM Velocity: 2,159 ft/min Temp: 70° F	Benzene: 100% Beryllium: 3.3% Carbon Tet: 0.002% Chloroform: 11.4% Methylene Chloride: 8% Nitric Acid(NOx): 11.8% 1,1,1-TCA: 0.23% Plutonium: 0.45% Americium: 2.1% Uranium: 6.2% Tritium: 2.7%

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
881Q-002 Ducts 5 and 6. These ducts exit through the same stack as 881Q-001	Research and Development Activities	Circular (4 outlets) Diameter 96.0 inches Roof height 32.6 ft Stack 8.0 ft above roof	Flow Rate: 14,258 ACFM Velocity: 2,159 ft/min Temp: 70° F	Plutonium: 0.24% Americium: 0.19% Uranium: 3.8%
883R-001 Vent #44 Duct A Building 879 plenum	Rolling, Shearing, Blanking/Trepanning, and Forming of Depleted Uranium	Rectangular Dimensions 98.25"x52.75" Roof Height 15.2 ft Stack 7.0 ft above roof	Flow Rate: 102 CFM Velocity and Temperature were not available	Beryllium: 4.5% Uranium: 11%
883R-002 Vent #45 Duct B Building 879 plenum	Rolling, Shearing, Blanking/Trepanning, and Forming of Depleted Uranium	Rectangular Dimensions 98.5"x52" Roof Height 15.2 ft Stack 6.7 ft above roof	Flow Rate: 102 CFM Velocity and Temperature were not available	Beryllium: 4.5% Uranium: 17%
883R-003 Vent #34 Room 139 Plenum exhaust	Rolling, Shearing, Blanking/Trepanning, and Forming of Depleted Uranium	Circular Stack Diameter 48" Stack height 69 feet	(1)	Uranium: 12%
886S-001 Vent #15 Plenum Building 875	Nitrate Storage Tanks in Rooms 101 and 103	Rectangular Dimensions 48"x24" Roof Height 17.3 feet Stack Height 1.5 feet	Flow Rate: 17.490 CFM Velocity and Temperature not available	Plutonium: 0.03% Americium: 0.04% Uranium: 1.1%
889T-001 Main exhaust plenum	No APEN available Equipment Decontamination	Cylindrical Stack Diameter 28" Stack Height 31.3 ft	(1)	Plutonium: 0.02% Uranium: 0.77%

BUILDING AND IDENTIFIERS	MAIN INPUTS	STACK OR VENT TYPE	TYPICAL EXHAUST QUALITIES	EXPECTED CONSTITUENTS AND CONTRIBUTIONS TO SITE TOTAL
991U-001 Building 985 plenum	Air handling system for the underground storage vaults 996, 997, and 999.	Rectangle Dimensions 48"x24" Roof Height 18.4 feet Stack 2.0 feet above roof	(1)	Beryllium: 1.4% Plutonium: 0.04% Americium: 0.29% Uranium: 0.80%
991U-002 Main exhaust	Production warehouse and non-destructive testing.	Rectangle Dimensions 60"x54" Roof Height: North 2 ft; West 4 ft; South 20 ft Stack 3.7 ft above the roof	(1)	Plutonium: 0.06% Americium: 0.37% Uranium: 0.44%

Notes: (1)Not characterized in information sources identified to-date. Will be investigated further if required for emission modeling.

(2)The percentages for plutonium, americium, and uranium are included in the percentage provided for vent numbers 1/2 in building 707.

Nitric Acid emission percentages do not include emissions from the tank farm (APEN Building 218).
Methylene Chloride emission percentages do not include data from the sludge drying beds.
Chemical emission percentages are based on data from the Air Pollution Emission Notices.
Radionuclide emission percentages are based ON Department of Energy Effluent Information System totals for 1988.

Sources:EG&G Rocky Flats, 1991
Los Alamos, 1991
USDOE, 1991a

5.2 Waterborne Emissions

The environs of the Rocky Flats Plant include a variety of surface water bodies. Various creeks drain the site, and retention ponds placed along several of them have received surface runoff and waterborne wastes from plant operations. These streams feed into a number of reservoirs which have served as sources of recreation, irrigation, and drinking water for a growing population of Front Range residents.

Surface Water Flow Patterns

Several streams occur near the Rocky Flats site. Three of them, North Walnut Creek, South Walnut Creek, and Woman Creek, drain the Rocky Flats site. North Walnut Creek flows eastward from the plant and into Great Western Reservoir, which supplies drinking water to the city of Broomfield. Woman Creek drains the south portion of the site and flows into Standley Lake, which is a source of irrigation water for the area and supplies water for the cities of Westminster, Thornton and Northglenn. Woman Creek also feeds Mower Reservoir by way of Mower Ditch. Sanitary wastes and laundry wastes have, for periods of Rocky Flats history, been released from the plant to on-site retention ponds on South Walnut Creek which flow to Great Western Reservoir. The primary creeks and retention ponds on the Rocky Flats site are shown in Figure 5-1. Because of the surface water drainage patterns of the area and prevalent airflow patterns, Great Western Reservoir, Standley Lake, and Mower Reservoir are the three water bodies most likely to have been impacted by surface water runoff, discharge of treated and untreated waste water, and airborne effluents from Rocky Flats.

Holding Pond History

Several series of retention ponds have been constructed along the creeks which drain the Rocky Flats site for use in management of plant wastes and surface water runoff. The ponds of primary importance have been known as the A-series and B-series ponds, which are located on North and South Walnut Creeks. Of lesser importance are the C-series ponds on Woman Creek. The A, B, and C-series ponds are shown on Figure 5-1.

From plant start-up in 1952 to 1953, low level contaminated waste containing nitrates and radioactive substances (laundry wastewater including plutonium and uranium) was discharged directly into North Walnut Creek. From 1953, when Pond A-1 was constructed, to 1957, when low-level contaminated waste was rerouted to the process waste treatment facility, low-level waste was discharged into Pond A-1 for eventual discharge into North Walnut Creek. In pre-1970s documents, Pond A-1 is often referred to as Pond 1.

INSERT FIGURE 5-1; RFP CREEKS AND PONDS

The early discharges of low-level contaminated waste to North Walnut Creek and Pond A-1 resulted in accumulation of significant levels of plutonium in the sediments of Pond A-1 and North Walnut Creek. From 1971 to 1973, Pond A-1 underwent major reconstruction. Reconstruction activities resulted in increased plutonium concentrations in the surface water samples, but not in pond sediments (USDOE, 1991b). It is likely that resuspension of the plutonium allowed it to migrate downstream to Great Western Reservoir.

After 1957, the A-series ponds were used primarily to control surface water runoff from the northern part of the site, however, the ponds also received process liquid waste, cooling tower blowdown, and steam condensate discharges which contained chromates and algicides. After Pond A-2 was completed in the mid-1970s, water from Pond A-1 was allowed to flow into Pond A-2, from which water was disposed of by natural and spray assisted evaporation
(USDOE, 1991b). Currently, Ponds A-1 and A-2 are used for spill control and receive only local surface runoff and seepage. Any water that collects in the ponds is spray evaporated.

Pond A-3 was constructed in 1971, and has been used to collect surface water runoff from northern portions of the plant for hold-up prior to being discharged downstream. Runoff from these areas is diverted around Ponds A-1 and A-2 into Pond A-3, where it is temporarily detained before being released to Pond A-4. Pond A-4 was constructed in 1980, and historically received water from Pond A-3 and B-5. Pond A-4 water is discharged into Walnut Creek.

Between 1952 and 1973 decontaminated process wastewater, sewage treatment plant effluent, and laundry wastewater after 1957, were released into South Walnut Creek and subsequently into the B-series ponds. In pre-1970 documents, Ponds B-1 through B-3 are referred to as Ponds 3, 4, and 5 (USDOE, 1991c). The only known radioactive effluent entering the sewage treatment plant and the B-series ponds occurred between 1969 and 1972 when low-level laundry effluent was channelled through the treatment plant. In the latter half of 1972, plumbing changes were made to channel all sanitary plant wastes through the sewage treatment plant and then into the sludge drying beds.

Like in the A-series ponds, the discharge of low-level contaminated wastes to the B-series ponds resulted in the accumulation of plutonium in the pond sediments. From 1971 to 1973, major reconstruction activities on B-series ponds resulted in the disturbance of bottom sediments containing plutonium. Much of the upstream sediment migrated into Pond B-1 and subsequently increased the plutonium inventory of all the B-series ponds as a result of the disturbance.

INSERT FIGURE 5-2; RETENTION POND PHOTO

Currently, Ponds B-1 and B-2 are used for spill control and receive only local surface runoff. Pond B-4 receives discharges from Pond B-3, and Pond B-4 water is continuously released to Pond B-5. Pond B-5 was constructed after 1979, and was used as an overflow pond for Pond B-4. In 1991, a pipeline was built to allow periodic pumping of Pond C-2 water into Pond B-5. Currently, Pond B-5 receives water from Pond B-4 and surface runoff from the Central Avenue Ditch. Water in Pond B-5 is detained, then pumped to Pond A-4 prior to being discharged into Walnut Creek and diverted around Great Western Reservoir via the Broomfield Diversion Ditch (BDD).

Currently, the C-series holding ponds are used primarily to capture and control surface water runoff from the plant site. Between 1952 and 1973, filter backwash water from the water treatment facility, which treats water from Clear Creek prior to its use at the plant, was discharged to Pond C-1, detained for a period of time, then released to Woman Creek. Woman Creek empties into Standley Lake. In addition, cooling tower blowdown water was discharged to Pond C-1 until the latter part of 1974. In the early 1970s, plant practices were changed, and Pond C-1 was used principally to manage surface water runoff in the Woman Creek drainage (USDOE, 1991e).

Pond C-2 was constructed in 1980 to detain runoff water from the South Interceptor Ditch. Water in Pond C-2 is monitored monthly and discharged periodically. Discharged water is pumped through the BDD around Great Western Reservoir into Big Dry Creek (USDOE, 1991e).

Great Western Reservoir History

Great Western Reservoir is located approximately 1.5 miles east of the Rocky Flats Plant's eastern boundary. Great Western was constructed in 1904 by the Great Western Reservoir and Canal Company. The reservoir receives surface water runoff from Clear Creek through Church Ditch, Coal Creek through McKay Ditch, Upper Church Ditch, and Walnut Creek. Originally, the reservoir was 42 feet deep and had a storage capacity of 1420 acre-feet. In 1955, the Turnpike Land Company bought the reservoir and established the Broomfield Heights Mutual Service Association to own and operate water and sewer utilities for the Broomfield Heights development. In 1958, the reservoir was enlarged to its present storage capacity of 3250 acre-feet (1.06 billion gallons) and is 62 feet deep (Schnoor, 1991). In 1962, the City of Broomfield bought the water and sewer services from the Turnpike Land Company.

INSERT FIGURE 5-3; RESERVOIRS NEAR RFP

Great Western Reservoir water was used for irrigation until 1955. Since 1955, the sole water use has been as the City of Broomfield's municipal water supply. Public access to the Great Western Reservoir and the surrounding area has been limited since at least 1971. Recreation activities such as fishing and boating have not been permitted. Presently, the area is fenced and posted to exclude the public.

Until 1955, Great Western Reservoir water was used for irrigation only, and no treatment was required prior to use. After the Turnpike Land Company purchased the reservoir, the Company built a water treatment plant. This early "filter plant" had a single treatment unit called a perifilter. The raw water was coagulated with alum, then gravity filtered and disinfected with chlorine. From 1968 to 1972, the water treatment plant was expanded. This expansion included the addition of treatment steps for clarification, additional filtration, and fluoridation. In 1978, the treatment plant was again expanded. This expansion increased the filtering capacity, changed the perifilter unit to a flocculator, added tubes in the clarifier, added another clearwell, and upgraded fluoride feeders (Schnoor, 1991).

The radionuclides contained in plant discharges accumulated in the sediments of the holding ponds, Walnut Creek, and Great Western Reservoir. The U.S. Environmental Protection Agency concluded in 1975 that historical releases of contaminants from Rocky Flats to Great Western Reservoir resulted primarily from the following activities (USDOE, 1991c):

- Early operational practices at the plant in the 1950s and 1960s.
- Holding Pond Reconstruction between 1970-1973, which resuspended pond sediments and released bound radionuclides to Great Western Reservoir.
- A 1973 tritium release from the Rocky Flats Plant.
- Airborne transfer of radionuclides, primarily plutonium.

Standley Lake History

Standley Lake is a large reservoir located approximately two miles southeast of the Rocky Flats Plant's eastern boundary. It is owned by the Farmers Reservoir and Irrigation Company (FRICO). FRICO had the Standley Lake reservoir constructed on Big Dry Creek from 1907 to 1912. The original capacity of the dam was 49,060 acre-feet, however structural problems developed with the dam and limited the reservoirs usable capacity to 17,541 acre-feet. In 1963, the City of Westminster and FRICO entered into an agreement concerning the rehabilitation of the reservoir. Westminster agreed to rehabilitate the reservoir to a total capacity of 42,000 acre-feet. In so doing, the City would receive the use of the reservoir capacity exceeding 30,000 acre-feet. The rehabilitation was

completed in 1966. Once again, structural problems developed with the dam and limited the reservoir's usable capacity. The full capacity of the reservoir did not become usable until 1981 (Tipton and Kalmbach, Inc., 1989).

From 1914 to 1966, water from Standley Lake was only used for irrigation. The water was first used for drinking in 1966, when the City of Westminster completed rehabilitation of the dam. Presently, the City of Westminster owns 37.3 percent of the shares in the Standley Lake Division, and the cities of Thornton and Northglenn own 13.3 and 17.7 percent of the shares, respectively. The remaining shares (31.7 percent) are still owned by FRICO and the corresponding water is transported through irrigation ditches to agricultural areas northeast of the lake, primarily between Broomfield and Fort Lupton (Tipton and Kalmbach, Inc., 1989).

Standley Lake water used for domestic purposes receives conventional treatment, involving coagulation, sedimentation, filtration, and disinfection (ChemRisk, 1991). Water used for irrigation has never been treated.

Mower Reservoir History

Mower Reservoir is a small privately-owned impoundment located just southeast of the Rocky Flats Plant (USDOE, 1991c). The reservoir is fed by Woman Creek via Mower Ditch, an irrigation ditch that originates within the Rocky Flats boundary (USDOE, 1991c). The associated water rights decree states that water from the reservoir was first diverted for irrigation in 1872. The reservoir covers an area of approximately 9 acres and is roughly 50 feet deep at its deepest point and fluctuates in capacity depending upon water supply and demand (USDOE, 1991c). Outflow flows southeast from the reservoir, eventually discharging to Standley Lake (USDOE, 1991c). Mower Reservoir is used for agricultural purposes, stock watering, domestic lawn watering, and irrigation of approximately 80 acres (State of Colorado, 1973). The water in Mower Reservoir is not treated and has never been treated prior to use.

5.3 On-Site Waste Disposal Practices

While most hazardous and radioactive wastes from Rocky Flats operations have been shipped off the site for disposal, there are about 178 inactive waste sites within the plant boundaries. Some of the involved areas have been the sites of storage, burial, incineration, detoxification, and land application of various forms of Rocky Flats waste. Some of the sites have been cleaned up, while others have not been disturbed since their period of activity ended.

It should be noted that the sites depicted in Figure 5-4 and Table 5-2 are those associated with incidents of purposeful disposal of waste. There are numerous documents describing cases of

accidental spills, for example Own and Steward, 1974. For the purposes of this project, accidental spills have been evaluated as part of the accidents and incidents investigation described in Section 6.

Table 5-2 describes approximately 50 locations of on-site waste disposal at the Rocky Flats Plant. The locations of these areas are depicted in Figure 5-4. Some of the areas became operational in the early days of plant operation. Most disposal practices have ended, but several of the noted areas remain active as part of modern-day operations of the facility.

The following information is provided for each waste disposal area listed in Table 5-2:

A Description — *The popular name or names of the waste disposal area are identified.*

Map Area — *The spotting codes corresponding to the location of the area on Figure 5-4 are listed to facilitate location by the reader. The letter and number codes (for example B-2) identify the applicable area of the map based on axis labels similar to those used on road maps.*

Nature of Disposal Activity — *The nature of the disposal activity that took place in the area is described to the extent possible based on available documentation. The identity and quantities of the disposed materials are identified, as well as the estimated time period of area use and the methods of disposal. Some values indicating the extent of contamination are included when available. Any retrieval, clean-up, containment, or other remediation measures applied to each area are described.*

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INSERT FIGURE 5-4; ON-SITE WASTE DISPOSAL SITES

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TABLE 5-2: ROCKY FLATS FACILITY WASTE DISPOSAL AREAS

DESCRIPTION	MAP AREA	NATURE OF DISPOSAL ACTIVITY
Spray Fields North of the Plant	H,I-3,4	These spray fields were used shortly after the present landfill became operational in 1986, to spray water from two ponds over ground surfaces to enhance evaporation. The East Landfill Pond, also known as the existing landfill pond, and the West Landfill Pond were used to intercept groundwater that may have been contaminated by landfill leachate. The South Area Spray field was used first, until runoff was found to be draining into North Walnut Creek. Use of that field was discontinued, and use of the North Area Spray Field was also found to flow into North Walnut Creek. Spraying was then moved to the Pond Area Spray Field, and drainage flowed back into the existing landfill pond. In September of 1973, tritium and strontium were detected in landfill pond water. Several metals and radionuclides have been detected in a downgradient bedrock groundwater monitoring well installed in 1989, but may represent natural background conditions (USDOE, 1991b). In May of 1981, the West Pond was covered over as part of an expansion project for the existing landfill (USDOE, 1991b).
Trenches A, B, C	H,I-4	Trench A appeared to be active from 1964 to about 1974. Trench B was active in 1959, with date of closure unknown. Trenches A and B received uranium- and/or plutonium-contaminated sludge from the sewage treatment plant. Trench C is actually two separate trenches, that apparently were active from 1964 until 1974. Materials placed in Trenches C have not been identified, but sewage sludge is most probable. Several metals and radionuclides and TCE have been detected in a groundwater monitoring well in Trench A. Metals and radionuclides may represent background (USDOE, 1991b). The trenches are no longer active. A road was built across Trenches A and C in 1978 (USDOE, 1991b).
Contaminated Concrete Slab Burial Area	I-5	A concrete slab with direct count (non-removable) americium contamination was buried here (Owen and Steward, 1974). The concrete slab was later excavated, and the contaminated portion of the slab was cut off for off-site disposal (Owen and Steward, 1974).

DESCRIPTION	MAP AREA	NATURE OF DISPOSAL ACTIVITY
Nickel Carbonyl Bottle Disposal Area	J-6	Between March and August of 1972, approximately 185 pounds of nickel carbonyl ("X-gas", $Ni(CO)_4$) contained in seven 25-pound cylinders, two 5-pound cylinders, and one lecture bottle were disposed of. A "dry well" hole about fifteen feet deep and three feet in diameter was drilled in a remote area of the plant site, and the cylinders were opened by individuals wearing supplied air packs and suspended in the hole until they were drained. In some cases, the chemical ignited immediately after release to the well. In other cases, the well remained silent for long periods before a muffled ignition occurred. Samples at the lip of the hole indicated concentrations around 10 parts per million during the disposal (Hobbs, 1972). The map location is the approximate location where empty nickel carbonyl bottles were buried after the chemical was destroyed by burning during the 1957 fire in Building 771 or when ready for discard. Explosive charges were used to destructively vent the cylinders and ignite any residual gas (Owen and Steward, 1974). There are reports that an additional 12 cylinders were vented and buried one-half mile north and west of the current sanitary landfill (Smith, 1975).
East Area Spray Field	L,M-5	The East Spray Field became operational in 1989 to provide additional area for spray evaporation of water from Pond B-3, which is sewage treatment plant effluent and local surface runoff (USDOE, 1991b). Use of this area was discontinued shortly after it became operational in late 1989 due to problems with excessive runoff (USDOE, 1991b).
Radioactive Soil Dump Area	K,L-5,6	The Soil Dump Area received 50 to 75 dump truck loads of soil containing low levels of plutonium. The soil was excavated during construction of Parking Area No. 334 in the middle of the western half of the plant production area, and had been put there after excavation near Building 774, the waste treatment plant (USDOE, 1991b).
Trench T-1	K-7	Approximately 25,000 kg of depleted uranium chips in 125 drums were deposited in the trench during 1952-1962. The drums were covered with about 2 feet of fill dirt (Owen and Steward, 1974). Depleted uranium was put in the trench primarily due to the hazards of transporting the metal. All drums buried were from Building 444 (Putzier, 1970).

DESCRIPTION	MAP AREA	NATURE OF DISPOSAL ACTIVITY
Trenches T-2 through T-8	J-8 K,L,M-7	Approximately 100,000 kg of sanitary sewage sludge and about 275 flattened empty drums contaminated with uranium were disposed of in these trenches. Activities ranged from 800 to 8,000 dpm/g. T-4 also contains some uranium-plutonium contaminated asphalt planking from the 207 solar ponds. Estimated total alpha activity is between 100 and 150 mCi (Owen and Steward, 1974). The first sludge buried on the plant site dates back to July, 1954. Trenches T-2 through T-8 were used for sludge burial up to August 14, 1968, when the sanitary landfill became operational. Concentrations of radioactivity in the dried sludge have not varied much over the years; the maximum reported was 7,900,000 dpm/kg in June 1960, and the minimum was 840,000 dpm/kg in August, 1964. Earlier activity was primarily uranium, with probable increasing plutonium fraction leading up to primarily plutonium composition in later years (Putzier, 1970). Some contaminated asphalt planking discarded from Pond 2A repair work was buried in Trench T-4. Contamination was principally uranium, with minor Pu contamination possible. No quantitative data are available (Putzier, 1970).
Trenches T-9, T-10, and T-11	L,M,N-7	Trenches T-4 through T-11 are all located just east of the East Access Gate outside the security fence. The trenches, approximately 50 by 300 feet in size, were used from 1954 to 1968 for the disposal of flattened drums contaminated with uranium and plutonium. Activity ranges were from 800 to 8,000 dpm per gram. Trenches T-4 and T-11 also contain some uranium and plutonium-contaminated asphalt planking from the solar evaporation ponds and quantities of sanitary sewage sludge (USDOE, 1986).

DESCRIPTION	MAP AREA	NATURE OF DISPOSAL ACTIVITY
Mound Area	K-7	A total of 1,045 drums of oil and solid waste were buried. Most contamination was depleted uranium, with some enriched uranium and possibly low-level plutonium (Owen and Steward, 1974). The first mound burial was in April, 1954. Drums were buried here steadily up to March, 1957, at which time uranium contaminated oil from 90 drums was burned. In April, 1957, another 79 were burned. The final burial was in September, 1958, involving 89 plutonium contaminated oil drums from Building 776. The distribution of waste drum sources was as follows: From B-444; 1298 drums of oils, stillbottoms, sand, perclene From B-776; 89 drums of oils with carbon tetrachloride From B-881; 85 drums of oils From B-991; 79 drums of concentrated dry waste From B-771; 46 drums of oils with carbon tetrachloride From B-441; 9 drums of dry waste, paper, glass Assuming similar concentrations of plutonium as from 903 area drums, the mound contained about 285 grams of plutonium. After September, 1958, oil and coolant drums were moved to the mound area but were not buried. In July of 1959, they were moved across the road to begin accumulation in the Building 903 drum storage area (Putzier, 1970). Complete Retrieval and off-site disposal were achieved in May, 1970. No plutonium was detected. Soil samples ranging from 0.8 to 112.5 dpm/g were attributed to 903 Area infiltration (Owen and Steward, 1974).
Pallet Burn Site	J-7	An area southwest of oil burn pit number 2 was used to destroy wooden pallets in 1965. The materials that may have been spilled on the pallets is unknown (USDOE, 1986). A 1974 summation of incidents affecting soils near Rocky Flats indicated on two maps the presence of a "pallet destruction area" south of Building 991. Other than indicating the site was active in 1968, no discussion was provided (Owen and Steward, 1974). There are also indications of pallet disposal activities in a burning pit south of Building 881 in 1965. In May of 1965, a pallet containing 3 sheets (60 kg) of depleted uranium was inadvertently burned in that pit. After discovery of the event, two barrels of contaminated soil were removed for shipment to Arco, Idaho for disposal (Young, 1965).

DESCRIPTION	MAP AREA	NATURE OF DISPOSAL ACTIVITY
Oil Burn Pit #2	J-7	A total of 1,082 drums of oil containing uranium were burned during 1957 and 1961-1965. The resulting approximately 10,000 cubic feet of residues and some flattened drums were covered with backfill (Owen and Steward, 1974). A burning pit was cut near the mound, and burning of the contents of 169 drums took place in March and April of 1957. Oil burning area #2 is actually two parallel trenches essentially side by side near the mound. No further burning occurred until June 1961, after which time oils were burned frequently. May 1965 was the last month any burning took place. The total number of drums burned on-site was 1093, but it is not clear how many were 30-gallon or 55-gallon drums. About 250-300 emptied drums were flattened and probably buried in trenches 3, 4, 5, 6, 7, and 8 or mounded over in the burning pit areas (Putzier, 1970). The pit was cleaned up and removed in the 1970s (USDOE, 1986).
Reactive Metal Destruction Site (the 952 area)	K-8	Approximately 400 to 500 pounds of metallic lithium were destroyed over 1956 to 1970. Residues, primarily non-toxic lithium carbonate, were buried. Smaller quantities of other reactive metals (sodium, calcium, and magnesium) and some solvents were also destroyed in this location (Owen and Steward, 1974).
Gas Detoxification Area	K-8	Building 952, utilized for Toxic Gas Storage, was located in this general area. The gas detoxification area referred to (USDOE, 1987 and Helmstadt, 1988) was most likely associated with the nickel carbonyl cylinders that were stored in Building 952 and later destroyed as described under Nickel Carbonyl Bottle Disposal Area in this table (Hobbs, 1972).
903 Drum Storage Area	J-7,8	From 1958 through 1967, approximately 5,240 drums of oil containing radioactivity were stored at this location. Of these drums, 3,570 contained plutonium. Corroded drums lead to deposition of plutonium over an area of 98,000 square feet, which was covered with asphalt and fill material in November, 1969 (Owen and Steward, 1974). Over 1959 to 1966, the distribution of drum sources was as follows: B-776 (69%), B-881 (17%), B-444 (8.6%), B-883 (3.5%), B-771 (2.5%). Drums were moved to the area after 1966. Some of the uranium contaminated oils at the 903 area were burned. The contents of 191 drums were processed for Pu recovery at the 903 filter plant. With the transfer of contents into new drums, the equivalent of 4826 55-gallon drums were transported to Building 774 for solidification. Of these, 3572 contained Pu contaminated coolant (Putzier, 1970).

DESCRIPTION	MAP AREA	NATURE OF DISPOSAL ACTIVITY
800 Area Radioactive Site Liquid Dumping Area Chemical Burial Area	I,J-8,9 I-8 I-8	From 1951 until 1972, portions of the "Hillside Area" near Building 881 were used as oil sludge pits, chemical burial sites, liquid disposal sites, solvent drum storage sites, and fire damage refuse disposal sites. As a result, soil and groundwater have been contaminated with volatile organic compounds including carbon tetrachloride, TCE, and PCE. Alluvial groundwater contains 1,1,1-TCA, and chloroform. Uranium was the only radionuclide occurring above estimated background concentrations (USDOE, 1990). One of the Solid Waste Management Units (SWMUs) in the 881 Hillside area, SWMU 130, is sometimes called the 800 Area Radioactive Site #1 (Helmstadt, 1988).
Contaminated Soil Burial	I-8	Plutonium contaminated soil from the periphery of Building 774 waste storage tanks was buried here. The soil averaged 250 dpm per gram. The 240 drums of soil were buried under 3 feet of fill dirt (Steward, 1973).
Asphalt and Soil Burial	I-8	Approximately 320 tons of plutonium-infiltrated asphalt and soil from the 1969 Building 776 fire were buried in 1969 under 1 to 2 feet of fill dirt. Less than 1 mCi of plutonium is estimated to be dispersed in about 250 cubic yards of material, with an estimated alpha activity of about 7 dpm/g. About 60 cubic yards of plutonium contaminated soil from the Building 774 waste storage tank area was placed on top of the asphalt disposal area in 1972, and covered with 3 feet of fill dirt. Estimated activity of the soil was less than 250 dpm/g total long-lived alpha (Owen and Steward, 1974). Total contained plutonium is estimated at 0.97 mCi or about 14 milligrams (Putzier, 1970).
Oil Sludge Pit	I-9	Approximately 30 to 50 drums of oil sludge from a storage tank cleanout were emptied into a pit, which was then backfilled. No radioactivity was involved (Owen and Steward, 1974).
Concrete Slab Disposal Area	H-8	An area of several hundred square feet northwest of Building 881 was involved in storage of a contaminated concrete slab in 1958. The slab had been removed from the east side of Building 776 (Owen and Steward, 1974). The slab was later broken up, removed, and the area cleaned (Owen and Steward, 1974).
Original Landfill	F,G-9	The original plant landfill was used from 1952 to 1968 to dispose of general plant wastes. An estimated 20 kg of depleted uranium ash is buried along with normal plant waste, including small quantities of various chemicals. The 20 kg of depleted uranium resulted when 60 kg was inadvertently burned and only 40 kg were recovered. (Owen and Steward, 1974). The landfill may have received nonradioactive hazardous chemical wastes generated at the plant, including solvents. A reported old graphite dump located south of Building 440 that might have received beryllium and uranium was actually the original plant landfill (USDOE, 1986).

DESCRIPTION	MAP AREA	NATURE OF DISPOSAL ACTIVITY
Former Incinerator	D-9	From 1952 to August, 1968, all combustible noncontaminated waste from the Rocky Flats Plant was incinerated in Facility 219 along the west access road. All noncombustible noncontaminated trash and ashes from the incinerator were dumped adjacent to the incinerator and covered with dirt (Seastone, 1973) Small quantities of depleted uranium contaminated combustibles were burned along with the general combustible plant refuse over the years 1952 to 1968. It is estimated that less than 100 grams of depleted uranium would be involved (Piltingsrud, 1973). The incinerator burned office-type wastes and some depleted uranium chips. Ashes were put into pits located adjacent to the incinerator or were pushed over the side of the hill into the Woman Creek drainage. Incineration was discontinued and the incinerator demolished in the early 1960s (USDOE, 1986).
Incinerator Ash Pits I-1 through I-4	D,E-9	An estimated 100 grams of depleted uranium was burned with general combustible waste in the nearby incinerator from 1952 through 1968. Ashes from the incinerator were buried in these trenches (Owen and Steward, 1974). Some unknown quantity of depleted uranium contaminated incinerator ashes were dumped in an area south of West Road and within a few hundred feet southeast and southwest of the incinerator (Putzier, 1970). Ashes from operation of the incinerator were put into pits located adjacent to the incinerator or were pushed over the side of the hill into the Woman Creek drainage. Incineration was discontinued and the incinerator demolished in the early 1960s. The ash pits were covered with fill (USDOE, 1986).
Concrete Wash Pad	D-9	There have been reports that material from Buildings 444 and 881 was placed between the original sanitary landfill and the incinerator ash pits. More recently, cement trucks were washed in that area (Smith, 1975). It appears that the area was used to dispose of waste concrete from plant construction activities. It is also likely that concrete trucks were washed down in this area after delivering concrete (USDOE, 1991e).
West Spray Field	A,B,C,D-7,8,9	From 1982 to 1985, the West Spray Field was spray irrigated with water from solar evaporation ponds that contained elevated levels of nitrates and other wastes. The practice may have contaminated the ground water and the water in the soil lying just above the ground water (USDOE, 1991d).
Lithium Metal Destruction Areas	F-7	Approximately 400 to 500 pounds of metallic lithium were destroyed over 1956 to 1970. Residues, primarily non-toxic lithium carbonate, were buried. Smaller quantities of other reactive metals (sodium, calcium, and magnesium) and some solvents were also destroyed in this location (Owen and Steward, 1974). Building 335 is located over an old lithium metal destruction site. Lithium metal was disposed of at this location by placing it in trenches and reacting it with water. Residues were covered with soil (USDOE, 1986).

DESCRIPTION	MAP AREA	NATURE OF DISPOSAL ACTIVITY
Soil Burial Area, Building 334 Parking Lot Area	G-7	Soil containing low levels of plutonium was placed near Building 334 after excavation near Building 774, the waste treatment plant. The volume of the soil containing plutonium and the associated concentrations are not known (USDOE, 1991b). Between 50 to 75 dump truck loads of soil were removed during construction of Parking Area No. 334 and placed in the Soil Dump Area on the northeast side of the plant (USDOE, 1991b).
Oil Burn Pit #1	F-7	Ten drums of oil containing depleted uranium were burned in August 1956. The residue was covered with backfill. The area is now located under Building 335 and involves approximately 70 cubic feet of depleted uranium residue (Owen and Steward, 1974). The first oil was burned in August 1956 in what was referred to as the garage oil burning pit (Putzier, 1970). Building 335 was constructed over burn pit number 1 and a lithium metal destruction site (USDOE, 1986).
Solvent Burning Ground	G-7	A "solvent burning ground", designated at solid waste management unit number 171, is listed in various documents (Helmstadt, 1988; EN-589 and USDOE, 1987). Building 335 has been used in the past, and still is to some degree, for training of fire department personnel. The original, preconstructed building was placed in an area north of Building 331 after the 1969 fire (PAC 700-157.7). Experiments took place to test heat and water effects on different types of materials, for example, filter plenums. When this area was first used for training purposes, magnesium chips coated with a water soluble material were burned. Diesel fuel was the main material that was used. Gasoline was utilized to ignite the diesel fuel. The fire fighters may have also used waste solvents.
Scrap Metal Disposal Area	H-6	Scrap metal components, mostly from original construction, were buried in this area. Although no detectable radioactive or chemical contamination was observed, some pieces came from process areas and low level contamination of a small percentage is possible (Owen and Steward, 1974).
Former Cooling Tower Blowdown Retention Ponds	F,G-8	These small ponds were used to contain water from cooling towers. Hexavalent chromium is present. Some quantity of lithium was also destroyed in the two eastern-most ponds. These ponds were covered with fill (Owen and Steward, 1974) and may have been used to bury small amounts of depleted uranium (USDOE, 1986).

DESCRIPTION	MAP AREA	NATURE OF DISPOSAL ACTIVITY
Present Landfill	G,H-3,4	Started operation in 1968, and currently in use. Materials with less than Minimum Detectable Activity radioactivity (500 dpm/60 square cm direct or 50 dpm/square ft smear) are accepted for burial. From August 1968 to February 1970, approximately 1,000 kg of sanitary sewage sludge, with 800 to 8,000 dpm/g of alpha activity, were buried. Estimated total activity was 1 to 1.5 mCi. Recent surveys have detected other radionuclides, including tritium, in small quantities (Owen and Steward, 1974).

Most of the waste disposal activities described in Table 5-2 involved shallow-land burial of materials or localized contamination of soil. The potential off-site impacts of these waste disposal activities are associated primarily with surface water or ground water contamination. In this study, burial and soil contamination incidents will be addressed in terms of potential off-site impacts via surface water and ground water pathways.

A smaller number of disposal practices resulted in airborne emissions. The activities potentially impacting off-site air quality that were of sufficient duration or extent to be considered quantifiable for source term development are the burning at the Pallet Burn Site, oil burning at Pit 1 and Pit 2, and the oil storage at the Building 903 Drum Storage Area which lead to soil contamination and dispersal that is being studied in detail as part of the accident and incident portion of the project.

5.4 Waste Received from Off-Site Sources

Because of the unique capabilities of the Rocky Flats Plant to handle hazardous materials, process wastes, and arrange for shipment of wastes to federally-approved disposal facilities, a number of private companies, educational institutions, and federal facilities have historically called upon Rocky Flats for assistance with waste treatment, storage, and shipment. Instances in which Rocky Flats received wastes from off-site entities are described in this section.

In June of 1957, the Rocky Flats AEC Office granted permission for the Dow Chemical Company to accept at Rocky Flats wastes generated by local off-site institutions and government agencies. Wastes initially received originated from Lowry Air Force Base, Martin Aircraft Company, The Bureau of Reclamation, and the U.S. Geological Survey. Over the period from 1957 to 1971, in which Rocky Flats policy allowed handling of off-site waste, wastes were received from the following industries and agencies (Ryan, 1957 to 1971):

The U.S. Bureau of Reclamation
The Colorado School of Mines
Colorado University School of Medicine
The Coors Porcelain Company
The Denver Research Institute
"Dow Construction"
General Electric Sandia Laboratories
Lawrence Radiation Lab
Martin Aircraft Company

The Rocky Mountain Arsenal
Sunstrand
TOSCO
U.S. Department of the Interior
"USF and WL" (US Fish and Wildlife Commission?)
Veterans Administration Hospital

With the exception of some of the wastes received from the Coors Porcelain Company, which are discussed in detail below, information about the types of wastes received at Rocky Flats from off-site sources is limited. Most of the information was obtained from monthly reports generated by the Rocky Flats Waste Disposal Coordination Group. These reports document the types and numbers of containers received, the date received, the date of disposal, and place of disposal. Sometimes totals given are combined waste shipments from several sources, with the percent contribution from each individual source not indicated. Further information describing the composition of wastes received has not been located.

With the exception of the liquid wastes received from Coors, which were dumped into the solar evaporation ponds and treated in the same manner as Rocky Flats liquid wastes, all wastes received at Rocky Flats documented in the monthly reports were shipped off-site for disposal, most commonly in Idaho, without treatment at Rocky Flats. Wastes introduced to the solar ponds were treated as described in Section 3, with residues shipped off-site for disposal. While there is evidence that other off-site originating wastes were introduced into the solar ponds, for example wastes from the Colorado State University beagle dog studies (USDOE, 1986), they were not documented in the waste disposal group monthly reports. Our investigation has indicated no cases of waste being received at Rocky Flats from off-site sources and being disposed of on the Rocky Flats site.

From 1957 to 1971, Rocky Flats trans-shipped to off-site, government operated disposal facilities in Arco, Idaho, the following quantities of waste: 318 fifty-five-gallon drums, 48 twenty-gallon drums, 4 thirty-gallon drums, 126 cartons, 3 boxes, and 3 Chemical Warfare Service (CWS) filters for off-site generators. Table 5-3 presents a chronology of the wastes received at Rocky Flats from the various industries, institutions, and agencies. More detailed available information about some of the cases of Rocky Flats involvement in handling of off-site generated wastes is summarized in this section.

TABLE 5-3
ANNUAL SUMMARY OF OFF-SITE WASTES RECEIVED AT ROCKY FLATS

CALENDAR YEAR AND SOURCE	WASTE RECEIVED AT ROCKY FLATS
1957	
Martin Aircraft	Nine 55-gallon drums
Lowry AFB	51 cartons
US Bureau of Reclamation	Two 55-gallon drums One box One carton
1958	
Lowry AFB	64 cartons
Sunstrand	Twenty-nine 55-gallon drums
1959	
Sunstrand	Ten 55-gallon drums
Lowry AFB	Two 55-gallon drums
1960	
Denver Research Inst.	3 Chemical Warfare Service Filters
1961	
GE Sandia	Twenty-eight 20-gallon drums Thirteen 15-gallon drums
Denver Research Inst.	Four 55-gallon drums Two 30-gallon drums One carton
Lowry AFB	Four 55-gallon drums
Sunstrand	Two 30-gallon drums
Coors Porcelain	99,700 gallons of beryllium contaminated waste "First shipment of beryllium contaminated waste was received from Coors on June 23, 1961."

CALENDAR YEAR AND SOURCE	WASTE RECEIVED AT ROCKY FLATS
1962	
GE Sandia	Nine 20-gallon drums
Denver Research Institute	Seven Cartons
Coors Porcelain	137,000 gallons of beryllium contaminated waste A total of 502 drums of waste for temporary storage was received from Coors during 1962. "The first shipment of high level wastes from Coors was received July 30, 1962 and consisted of 13 drums. These drums were stored in the "Bull Pen". "The first uranium contaminated wastes were received from Coors on August 20, 1962."
CU Medical School	"The first of contaminated wastes from the Colorado Medical School were received on July 5, 1962."
1963	
Lawrence Radiation Lab	Forty-two 55-gallon drums
Coors Porcelain	22,000 gallons of beryllium contaminated waste. 246 drums of wastes for temporary storage (bringing the total drum storage to 748). In March of 1963 "a crew from Coors worked the drums of solid wastes in preparation for a shipment. Coors also returned six drums to Golden, Colorado." In May of 1963 "Coors Porcelain Company made a rail shipment of solid wastes during the month."
1964	
CU Medical School	Three 55-gallon drums
Colorado School of Mines	Two 55-gallon drums
Coors Porcelain	Twenty-six 55-gallon drums

CALENDAR YEAR AND SOURCE	WASTE RECEIVED AT ROCKY FLATS
1965	
January through June	No information
USGS and Denver Research Inst.	One 55-gallon drum
1966	
USGS and Denver Research Inst.	Three 55-gallon drums One 30-gallon drum One carton
1967	
USGS and Denver Research Inst.	Two 55-gallon drums
USGS	One 55-gallon drum
U.S. Dept. of the Interior	Two 55-gallon drums
1968	
Dow Construction, USGS, U.S. Dept. of Interior, VA Hospital	Eight 55-gallon drums One 30-gallon drum Two wooden boxes
1969	
Dow Construction, USGS, U.S. Dept. of Interior, VA Hospital, TOSCO, Rocky Mountain Arsenal, and Coors Porcelain	Thirty-two 55-gallon drums One carton
1970	
TOSCO	Twenty-five 55-gallon drums
VA Hospital	One 55-gallon drum
USGS	Sixteen 55-gallon drums
Coors Porcelain	Forty-four 55-gallon drums

CALENDAR YEAR AND SOURCE	WASTE RECEIVED AT ROCKY FLATS
1971	
USGS	Twenty-one 55-gallon drums
Denver Research Inst.	Five 55-gallon drums
USF & WL	Thirteen 55 gallon drums including 1 drum containing 20 Ci of tritium tracer material

Sources: Ryan, E.S. 1957-1971; History Reports - (Issued Monthly) - Waste Disposal Coordination Group, Rocky Flats Plant.

The Coors Porcelain Company

The Coors Porcelain Company (CPC) of Golden, Colorado entered into a contract in September of 1960 to manufacture 756,000 beryllium and beryllium-uranium fuel elements as part of a project to develop a nuclear propelled "ramjet" (air breathing) low-altitude supersonic missile system. In what was called the Pluto Program, CPC processed about 225 kilograms of uranium-235 in making the unfueled beryllium and fueled beryllium-uranium elements for the Tory II-C reactor designed by the Lawrence Livermore Laboratory. The following discussion is based on a package of information concerning project Pluto that was assembled by Rocky Flats staff in 1986 (Vejvoda, 1986). Details have been verified by ChemRisk review of waste management group records.

Agreements were reached with the AEC to allow CPC to dispose of Pluto program wastes at Rocky Flats, and to use Rocky Flats as an intermediate stopping point for solid wastes destined for federally-approved radioactive waste burial grounds. The first shipment of liquid waste received at Rocky Flats from CPC was reportedly on June 23, 1961. There is no indication of the amount. In 1962, 73 shipments of liquid waste were received from CPC, for a total of 179,700 gallons. Liquid wastes containing beryllium oxide and enriched uranium from the CPC fuel element fabrication process were transported to the Rocky Flats solar evaporation ponds in a 2,500 gallon tanker truck. For waste water to be eligible for transfer to the Rocky Flats solar ponds, the uranium concentration was required to be less than 20 parts per million. There was no similar limit on beryllium concentration. During fiscal year 1963, 33 shipments of liquid waste were received from CPC, for a reported total of 81,500 gallons.

The CPC, in their final operations report for the project, estimated that the total amount of uranium deposited in the solar ponds was 962 grams, accompanied by a minimum of 631.4 kilograms of beryllium, 1.0 kilogram of yttrium, and 0.6 kilogram of zirconium. Of the uranium processed by CPC, 5,276 grams were ultimately "not located", 3016 grams of which were unaccounted for, and 962 grams were "suspected" to have been sent to the Rocky Flats solar evaporation ponds. Rocky Flats did not validate or monitor the composition of the CPC liquid waste that was discharged to the solar ponds. The major portion of the CPC material deposited in the solar evaporation ponds was reportedly removed during 1970 and 1971, after a "Pond Alligator" system was installed in 1970 to pump sludge from Pond 207B to Building 774 for dewatering and packaging. The dewatered sludge was reportedly shipped to Idaho for disposal, and the filtrate returned to the solar evaporation ponds.

Rocky Flats also received some solid wastes with low-level uranium contamination from CPC and arranged shipment to the federally-operated National Reactor Testing Station (NRTS) in Idaho and temporarily stored some high-level uranium-235 scrap from the CPC. Records indicate that twenty-six 55-gallon drums of low-level uranium contaminated waste from the CPC, with a gross weight of 5,373 pounds, were trans-shipped to NRTS from Rocky Flats between June 30, 1964 and June 30, 1965.

Some enriched uranium contaminated government-furnished "excessed" (GFE) equipment associated with the Pluto Program was reportedly part of the contaminated waste stored at Rocky Flats, possibly in the area that was to become known as the 903 pad, prior to being shipped to Idaho in 1964 or 1965 for ultimate disposal.

CPC grinding and inspection activities reportedly generated significant quantities of enriched uranium scrap. When faced with a shortage of suitable storage space, CPC arranged for high-level uranium-235 scrap to be temporarily stored in a locked, fenced area on the Rocky Flats site called the "Bull Pen". This practice started with the receipt of 13 drums by Rocky Flats on July 30, 1962. By February 1963, a total of 748 drums of the scrap were in storage at Rocky Flats. Rocky Flats was not involved in any processing of this waste. The drums were shipped back to CPC by rail during May of 1963 for shipment to NUMEC for uranium recovery reprocessing.

Lawrence Livermore Laboratory terminated its contract with CPC in 1964. The fuel element fabrication project was abandoned. However, Rocky Flats waste records indicate that CPC's radioactive waste was still being accommodated in fiscal year 1970 (Vejvoda, 1986). Since 1971, Rocky Flats has had a policy prohibiting the receipt, storage, or trans-shipping of waste generated off-site.

PCB Waste Handling

Some limited details regarding handling of PCB wastes at Rocky Flats have been identified by the project (Buffer, 1991). They include:

- In 1980, "Rocky Flats Plant responded to a request by Congressman Tim Wirth and temporarily accepted for storage 17 barrels of PCB oil located on a Lafayette farm."

- In 1981, "the fluidized bed incinerator was used to successfully burn a gallon of PCBs."

- In 1982, "PCBs were shipped from Rocky Flats June 24 for disposal in Deer Park (near Houston) Texas; this included shipment of 17 drums of PCBs taken from a farm at Lafayette and stored on plant site." (Buffer, 1991).

None of these events are associated with releases of PCBs to the environment. Incidents involving PCBs are discussed in Section 6.0.

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