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Protective measures and radioactive levels in the vicinity of the Rocky Flats Plant Golden Colorado

JANUARY – DECEMBER 1971

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Rocky Flats Division

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ANNUAL REPORT ENVIRONMENTAL SAFEGUARD 1971

Radioactive Monitoring and Environmental Surveillance
January Through December 1971

Annual report on radioactive monitoring procedures and
radioactive levels in the vicinity of the Rocky Flats Plant
Golden Colorado

L M Steward
M R Boss

Prepared by Product and Health Physics Research and Ecology Group
Rocky Flats Division Dow Chemical U S A

J H Hanes Rocky Flats Division General Manager
H E Bowman Assistant General Manager for Operations
J F Willging Director Research and Ecology
J R Seed Director Product and Health Physics Research
S E Hammond Industrial Hygiene and Bioassay

• DOW CHEMICAL U S A
ROCKY FLATS DIVISION
P O BOX 888
GOLDEN COLORADO 80401

Prepared under Contract AT(29 1) 1106
for the
Albuquerque Operations Office
U S Atomic Energy Commission

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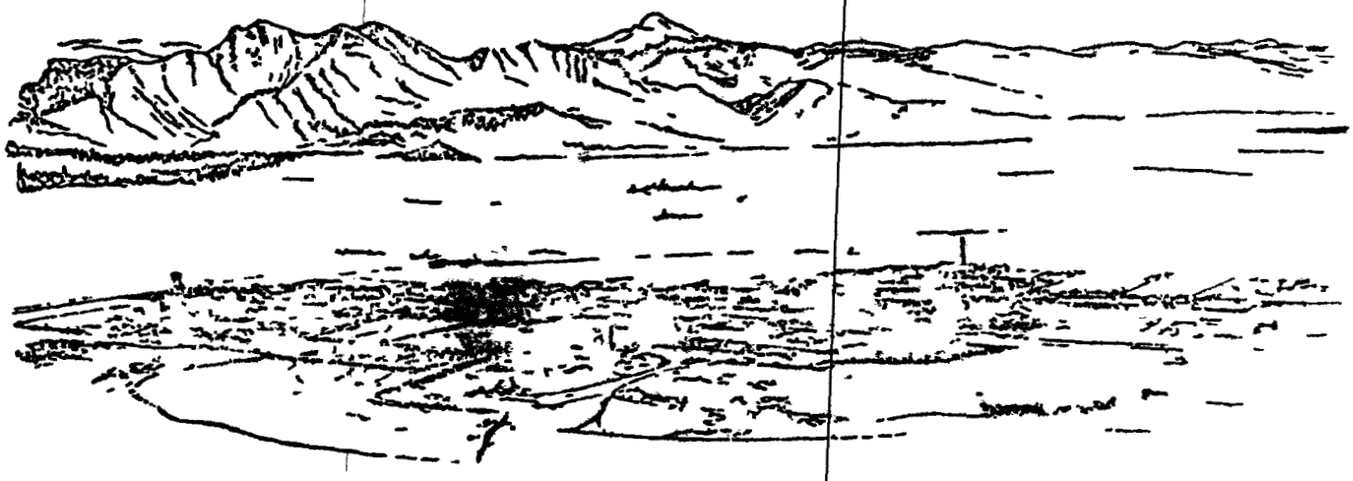
'It is our belief that the nuclear industry can serve the needs of the public without undue risk to our health or to our environment But we also believe that we have the important responsibility of assuring that this continues to be the case in the future

Joseph A Liberman
Deputy Assistant Administrator
Radiation Programs
Environmental Protection Agency
July 1971



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FOREWORD

This report was prepared for submission to the U S Atomic Energy Commission by the Health Physics Research and Ecology Department of the Rocky Flats Division Dow Chemical U S.A The analyses of all samples described within this report were performed by the Health Physics Bioassay Laboratory and the Service Laboratories at Rocky Flats

All effluents with potential adverse health and safety or environmental effects have been monitored evaluated and appropriately controlled

The AEC has initiated more comprehensive procedures for more complete reporting of environmental impact information Due to the new reporting procedures and format the data contained within this report are not directly comparable with previous reports in this series. This is the first report to be prepared under the new AEC guidelines

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ANNUAL REPORT ENVIRONMENTAL SAFEGUARD 1971

Radioactive Monitoring and Environmental Surveillance
January Through December 1971

L M Steward
M R Boss

I ABSTRACT

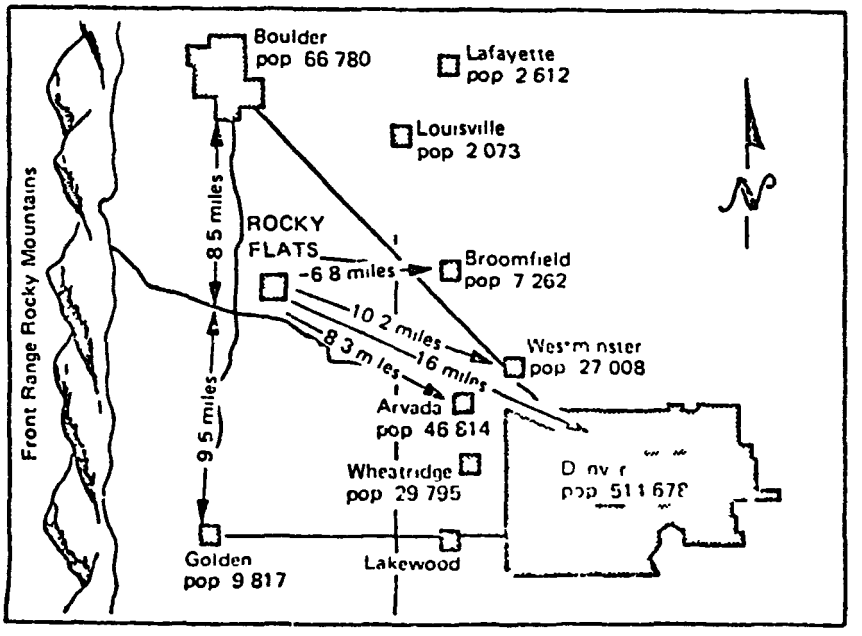
The Rocky Flats Plant maintains an extensive environmental surveillance program to assess effluent levels and to determine if any accidental release of environmental contaminants has occurred Analyses of over 50 000 air water vegetation soil sediment and effluent samples for the year indicated that in no manner did Rocky Flats contribute significant quantities of environmental contaminants to the surrounding environs all radioactive and nonradioactive effluent levels were below the most stringent and/or restrictive standards established by regulatory agencies and that radioactive levels in the environs of Rocky Flats have not changed significantly either on or off site in the past year

II INTRODUCTIONS

Rocky Flats

The Rocky Flats Division of Dow Chemical U S A manages a plutonium processing facility for the U S Atomic Energy Commission It s located on a gently sloping plain on the eastern edge of the front range of the Rocky Mountains and is situated about halfway between Golden and Boulder Colorado To the east lie the beginnings of the Great Plains of Colorado and a panorama of Denver about 16 miles to the southeast The grassy gently rolling hills surrounding the plant provide grazing grounds and winter shelter for deer local livestock and small animals

Rocky Flats Plantsite Located about Halfway between Golden and Boulder Colorado



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The climate for which the State of Colorado is so justly famous favors Rocky Flats with about 300 days of sunshine a year Rainfall averages just under 14 inches a year and the average temperature is 50 degrees

The plant handles both plutonium and uranium as well as other potentially hazardous materials as part of its normal function within the AEC complex Rocky Flats maintains a constant surveillance program which continuously monitors the control of effluents and releases from the plant site and its operations

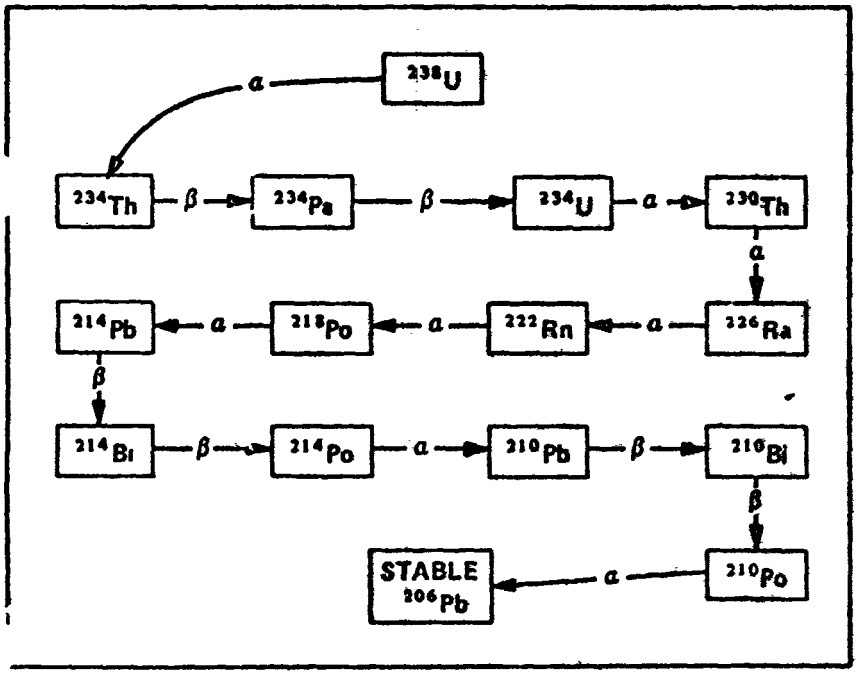
Rocky Flats Handles Plutonium and Uranium as Processing Facility for U.S.AEC

Radiation

There are many naturally occurring, unstable radioactive nuclides among the elements with atomic numbers from 81 (thallium) to 92 (uranium) The majority of these can be grouped into the uranium series the actinium series and the thorium series Each decay series begins with a very long lived nuclide (parent) as the first member These parents transform by radioactive disintegration into intermediate members (daughters) until a final stable, nonradioactive isotope of lead results Where found in nature the uranium and naturally occurring members of the actinide series are always found together

Where ^{239}plutonium comes from ^{238}uranium is bombarded by neutrons in a reactor to produce ^{239}plutonium by the following steps.

1. $^{238}_{92}U + ^{1}_{0}n \longrightarrow ^{239}_{92}U$
2. $^{239}_{92}U \xrightarrow{2.3\ \text{minute}} ^{0}_{1}\beta + ^{239}_{93}Np$
3. $^{239}_{93}Np \xrightarrow{2.3\ \text{days}} ^{0}_{1}\beta + ^{239}_{94}Pu$



The series of disintegrations is known as radioactive decay The new elements formed from the original or parent" atoms are called daughters When a nucleus undergoes this decay process to form a daughter energy is emitted in the form of particulate or electromagnetic radiation The most common types of radiation are alpha and beta particles gamma rays x rays and neutrons The alpha particle is the positively charged nucleus of a helium atom ($^{4}_{2}He^{+2}$) and is very stable The beta particle is a negatively charged, high-speed electron that originates in the nucleus Gamma and x rays are electro magnetic radiations similar to ordinary radio waves and visible light waves xcept their frequencies are higher and they are not visible to the human ye Neutrons are neutrally charged particles of mass 1 Of these types of radiation the high energy gamma ray and the neutron have the greatest rang

Radioactive Decay Parent Elements Decay to Form New Daughter Elements

Alpha Beta, and Gamma are the Most Common Types of Radiation

Alpha and Beta Both Particulate Radiations Gamma is Electro magnetic like X-Ray

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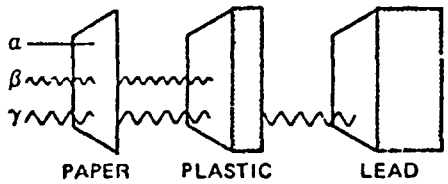

and penetrating ability easily penetrating several inches of steel Beta particles although less penetrating than gamma still have enough penetrating ability to penetrate the skin of man The alpha particle that of most concern at Rocky Flats has the least penetrating power In fact the alpha particle is unable to penetrate an ordinary sheet of paper or the relatively thick skin of man Since both plutonium and uranium are primary alpha emitters the alpha particle receives the most attention in this report

Alpha Radiation has Least Penetrating Ability Will not Normally Penetrate Skin of Man This is the primary Radiation of Concern to Rocky Flats

Before delineating standards the actual measurement criteria should be explained In relating measured values to the predicted or actual biological effects two separate units have arisen

Two Units for Measuring Radioactivity

The first is based on the number of radioactive disintegrations per unit of time and is thus a quantitative measure of the radioisotope present Based on radium 226 the first naturally occurring radioisotope to be isolated in any quantity the curie (Ci) became the unit used for expressing quantities of all isotopes In 1950 this unit was standardized and is now defined as that quantity of any radioactive nuclide undergoing 3.7×10^{10} disintegrations per second [1] [Disintegrations per unit time are usually abbreviated as dps (second) or dpm (minute)]

Curie (Based on Disintegrations per Unit Time) is Measurement of Quantity of Isotope Present

Disintegrations per Minute (dpm) and per Second (dps) are Usual Notations

The curie is a very large unit especially for reporting minute quantities such as found in environmental radiation measurements Therefore subunits of the curie are usually used These are the millicurie (mCi 10^{-3} Ci) the microcurie (μCi 10^{-6} Ci) the nanocurie (nCi 10^{-9} Ci) and the picocurie (pCi 10^{-12} Ci)

Curie Very Large Unit (37 000 000 000 dps) so Subunits Usually Used

1 curie = 37 000 000 000 dps (16 3 g Pu^{239})
1 millicurie = 37 000 000 dps (0 016 g Pu^{239})
1 microcurie – 37 000 dps (0 000016 g Pu^{239})
1 picocurie = 0 037 dps (0 0000000000163 g Pu^{239})

It must be emphasized that these units express only quantities of isotopes present and not the radiation dose these quantities could produce

The interaction of radiation with matter creates ions by imparting energy to orbital electrons and stripping them from atoms The ions thus produced have either a positive or negative electrical charge It is this phenomenon that allows us to detect the presence of radiation and also determines the amount of biological damage that a given radiation dose can produce

Radiation Produces Ions Amount of Ionization is Deciding Factor in Biological Damage so Unit of Dose Must be in Terms of Ionization

Since radiation effects on organisms are due to ionization the only quantitative measurement of radiation dose that can be directly related to biological effects must be stated in terms of this ionization and the amount of energy absorbed by that organism

The basic measurement unit as described by the International Commission on Radiological Units and Measurements (ICRU) is the roentgen (R) This was established in 1928 a time when only x ray or gamma radiations were considered important It is defined in terms of energy transfer or ionization to a specific volume of air as the result of an exposure dose of x or gamma radiation [2] Thus it is not directly relatable to other types of radiation in tissues or biological systems

Basic Unit is Roentgen Based on the Ionization Produced by X Ray and Gamma Radiation Only Not Directly Relatable to Other Units of Radiation

This shortcoming in the definition of the roentgen has led to the introduction of another unit the roentgen equivalent (for) man or the rem This unit is that quantity of ionizing radiation which when absorbed by man produces an effect or biological response equivalent to the absorption of one roentgen of x or gamma radiation [3] Since the biological effects due to radiation are known to vary a quality factor ranging from one to twenty is included in the rem [4] A primary subunit of the rem the millirem(mrem) or 0 001 rem is very often used in describing biological radiation exposures

Modified Unit is Roentgen Equivalent Man (REM), which Includes Modification Factor to Account for Differences in Types of Radiation [4]

Radiation Standards

In 1928 an international group was convened to establish standards for ionizing radiation and formed the International Commission on Radiological Protection (ICRP) The committee charged with establishing those standards was composed of scientists from Great Britain the United States, Germany and Sweden Later they were joined by members from France and Italy

International Commission on Radiological Protection (ICRP) Formed in 1928

To establish unanimity among representatives to the ICRP it was decided that each member nation should have one official representative Thus in 1929 what became the National Committee on Radiation Protection and Measurements was established under the auspices of the National Bureau of Standards [5]

U S. Representative to ICRP is National Council on Radiation Protection and Measurements (NCRP)

In 1964 this national committee was granted an independent status and charter by Congress and changed its name slightly to become the National Council on Radiation Protection and Measurements (NCRP) The NCRP in conjunction with its international counterpart the ICRP has, since 1929 provided the basic standards and guidance in the field of radiation protection [5]

NCRP, an Independent Objective Organization has Provided Basic Guidance in Radiation Protection Since 1929

In 1959 the Federal Radiation Council (FRC) was formed to provide a federal policy on human exposures to ionizing radiation The FRC whose responsibilities were absorbed in 1970 by the new Environmental Protection Agency (EPA) adopted those guidelines recommended by both the NCRP and ICRP These guidelines were based on five principles in determining permissible levels [6]

Federal Radiation Council Functions Absorbed by Environmental Protection Agency in 1970

1 It is appropriate to set different standards for different sources of emissions and exposures

2 Exposure to radiation should always be as low as possible

Whereas all radiations produce the same types of biological effects, the magnitude of response per unit of absorbed dose is not the same The inverse ratio of the absorbed dose from one radiation type to that of a reference radiation required to produce the same degree of a stipulated effect is referred to as Relative Biological Effectiveness (RBE) There is actually no one RBE for a given type of radiation the value depends on the total dose dose rate tissue cell and/or the biological effect being studied [4]

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3 No exposure should be allowed without expectation of benefit

4 That all radiation is assumed to be harmful or potentially so

5 And that the biological risk associated with higher levels of exposure is proportional to those risks at lower levels

(Since the e lower levels refer to exposures due to or comparable with natural background radiation this assumption of proportionality provides a most conservative guideline)[6]

Both FRC and EPA Followed Five Basic Premises in Establishment of Radiation Protection Guidelines

The U S Atomic Energy Commission has incorporated the guidelines and recommendations of the NCRP ICRP and the FRC into its own operational procedures for AEC installations and those of contractors and licensees [8]

The entire history of the derivation of radiation standards has been one of objective conservative evaluation of the best data ava lable Guidelines have been internat onally derived accepted and endorsed [5]

Entire History of Present Standards is One of Objective Conservative Evaluation

The permissible dose of occupationally exposed individuals 5 rem per year to the whole body is defined by the Nat onal Council on Radiation Protection and Measurements as [4]

> that dose accumulated over a long period of time or from a single exposure which in the light of present knowledge carries a negligible probability of severe somatic or genetic injuries

Occupational Dose is 5 REM Per Year Limit to Whole Body

Based on all present technical knowledge authorities have concluded that this level can be absorbed per year by a man throughout his working lifetime[4] without his sustaining any measurable damage

In contrast to this controlled group (i e the occupationally exposed) individual members of the general public include persons of all ages and degrees of health The established standards reflect this prudent conserva tive attitude toward exposures to the general public

Since General Population is Uncontrolled Group (i e contains all ages health e c) General Standards Far More Conservative

For an *individual* in the general population the whole body radiation exposure guide is given as 0 5 rem per year one tenth that of the occupational expsoure level When a group of individuals is at risk the whole body radiation exposure for the average of a suitable sample of the group must be less than 0 17 rem [4]

Standards are in Terms of Group Portion of Body Irradiated and Period of Time Over Which Dose Delivered

It must be noted then that the established standards accepted by international authorities are in terms of portions of the body irradiated and the period of time over which that dose is delivered

Important too is the relatively low penetration power of the alpha particle Alpha particles must be taken into the body to do any radiation damage to man i e in the foods we eat (ingestion) the air we breathe (inhalation) or through a wound or break in the skin

Alpha Particles Must Be Taken Into Body to Do Any Radiation Damage to Man

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For perspective it should be emphasized that the NCRP believes that its recommendations provide a system that offers far lower occupational risk than is found in many occupations normally considered not to be extra hazardous [4]

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III STANDARDS

Air

Radioactive

The short range alpha particle will be completely absorbed by a small amount of tissue when taken into the body This complete absorption represents a greater dose or exposure than that received from a gamma ray having the same energy The gamma ray with its higher penetration power can pass completely through the body and thus transfer only a portion of its energy to the body tissue

Most Restrictive Standards are for Alpha Emitters in Air

Therefore when materials with an emit alpha particles are inhaled they can stay in one portion of the lung and irradiate one small area of tissue quite heavily * To prevent this effect the most restrictive standards are those for plutonium in air

The current established standard for soluble plutonium in air is 0 06 x 10^{-12} μCi/ml of air in terms of exposure to an individual in the population and 0 02 x 10^{-12} μCi/ml to a suitable sample of the population[7 8 9] in terms of yearly averages

STANDARDS FOR SOLUBLE Pu^{239} IN AIR.
Radiation Workers 2 0 x 10^{-12} μCi/ml
General Populace Individual 0.06 X 10^{-12} μCi/ml
Total Population (suitable sample) 0 02 X 10^{-12} μCi/ml
Source NBS Handbook 69 USAEC Manual Chapter 0524

For uranium (soluble 238) the applicable standards are 3 x 10^{-12} μCi/ml for an individual and 1 x 10^{-12} μCi/ml for a suitable sample of the total population[7 8 9] These standards are based on the soluble materials, are stated in terms of yearly averages above the levels of naturally occurring alpha activity and apply at the plant boundary the point of public access[4 9]

STANDARD FOR URANIUM IN AIR
INDIVIDUAL 3 x 10^{-1} μCi/ml
TOTAL POP.. 1 x 10^{-1} μCi/ml

Total population standard for soluble plutonium 239 is 0 02 X 10^{-12} μCi/ml This is equivalent to about 3 3 X 10^{-19} (0 00000000000000000033) gram of plutonium or 1 2 X 10^{-20} (0 00000000000000000012) ounce of plutonium per milliliter of air Based on the specific activity of plutonium 239 this would be just one particle about 3/1000 micron (0 00000013 inch) in diameter/ml of air

Non Radioactive

The standard most applicable to nonradioactive operations at Rocky Flats is that for beryllium In terms of monthly averages this standard is 1 x 10^{-5} milligrams per cubic meter (mg/M^3) of effluent air This standard was established by action of the American Conference of Governmental Hygienists and modified by an Advisory Committee to the AEC[10]

Beyllium Standard in Air = 0 01 , grams PerCubic Meter (1 x 10^{-5} mg/M^3)

*It must also be noted that since fewer cells are involved this possibility might in effect do lesser damage than originally presumed

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The EPA used these guidelines in their proposed beryllium standards as published in the December 7 1971 Federal Register The proposed standard states that total beryllium releases shall not result in outplant concentrations that exceed 10 grams in any 24 hour day or concentrations of greater than 0 01 micrograms/cubic meter (1×10^{-5} mg/M^3) as averaged over 30 days [11]

EPA 1971 Standard is Same as AEC Beryllium Standard for its Contractors and Licensees

The Rocky Flats self imposed internal goal for beryllium in air is one half the official standard or 5×10^{-6} mg/M^3

Water

Radioactive

STANDARDS FOR SOLUBLE Pu^{235} IN WATER Radiation Workers 100×10^{-6} μCi/ml General Populace Individual 5×10^{-6} μCi/ml Total Population (suitable sample) 1.67×10^{-6} μCi/ml

The most restrictive recommended guideline for plutonium 239 (soluble) in water is 1.67×10^{-6} μCi/ml to a suitable sample of a population on a yearly average For an individual within that population that guideline is given as 5×10^{-6} μCi/ml on a yearly average [7 8 9]

Most Restrictive Standard for Uranium in Water (Soluble U^{235} Is 3×10^{-5} μCi/ml for Individual 1×10^{-5} μCi/ml for Total Population (suitable sample)

The most restrictive standard for uranium that for the uranium 235 isotope is 3×10^{-5} μCi/ml in terms of an individual in the population or 1×10^{-5} μCi/ml for a suitable sample of the total population on a yearly basis [7 8 9]

In addition gross alpha and gross beta guidelines to limit total radioactive nuclide content have also been established by the NCRP [4] the AEC [7 8] the Colorado Department of Health [12] and U S Public Health Service [13] Those standards adopted by the latter two agencies are based primarily on the recommendations of the Federal Radiation Council and thus the NCRP Gross alpha standards for Rocky Flats effluents would be the same as the given standard for plutonium since it is one of the constituents of the mixture and has the most restrictive limit Where the identity and concentration of both uranium and plutonium are known a somewhat more complex derived standard is applicable [7 8 9]

U.S Public Health Service and Colorado Department of Health Guidelines are Based on NCRP Recommendations

Established standards for soluble americium 241 in water are 4×10^{-6} μCi/ml for individual and 1.33×10^{-6} μCi/ml for a suitable sample of a population in terms of yearly averages [7 8 9]

Non Radioactive

The U S Public Health Service Drinking Water Standards (1962) are the primary guidelines followed at Rocky Flats The Water Pollution Control Commission of the Colorado Department of Health is however the agency to which Rocky Flats is directly responsible That agency is responsible for the administration of the USPHS guidelines and in some cases has established standards of its own In addition the Water Pollution Control Commission has compiled classifications for the major water sources of Colorado according to uses Although Walnut Creek has not been classified the most restrictive classifications (A B_1 C and D_1) are those adhered to The basic Colorado Standards were revised effective September 1 1971 [12] These new standards for Class A B_1 C and D_1 water sources are summarized below Also summarized are those chemical guidelines delineated by the U S Public Health Service in the Drinking Water Standards of 1962 [13]

For Chemical Contaminants in Effluent Waste Waters Rocky Flats Responsible to Colorado Department of Health

Rocky Flats Effluents Discharged into Walnut Creek

WATER QUALITY STANDARDS

Water Pollution Control Commission Colorado Department of Health

I Basic (Non Radioactive) Standards Applicable to All Waters of the State

A All waters capable of treatment or control prior to discharge into any waters of the state shall receive secondary treatment with disinfection or its industrial waste equivalent

Waters shall be free from substances attributable to municipal domestic or industrial wastes that

B Will either settle to form unsightly putrescent or odorous bottom deposits or will interfere with the classified use of the water

C. Create unsightly floating debris such as oil, grease or scum.

D Will produce objectionable odor color, taste, or turbidity or objectionable aquatic life

E. May, in sufficient levels concentrations, or combinations prove deleterious to human or animal life

II Additional Water Quality Standards (most restrictive from Class A B_1 C and D_1)

A. General (Colorado Department o Health)

Parameter	Limits	Classification
Fecal Coliform Bacteria	<1000/ml	A B_1
Dissolved Oxygen	6 mg/l	B_1
pH	6.5-8 5	B_1
Turbidity	Not to impair natural and developed fisheries	B_1
Total Dissolved Solids	Less than 500 mg/l (annual volume-weighted average)	A B_1
Toxic Materials (Biocides Pesticides, etc)	Free From	All
Temperature (°F)	70	B_1
Sodium Adsorption Ratio	Review of Commission	C D_1
Taste & Odor	Free From	A B_1

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B Chemical

Parameters	Limits (mg/l) CDH A B_1	Suggested Maximum (USPHS)	Grounds for Rejection (USPHS CDH)
Alkyl Benzene Sulfonate	–	0 500	–
Arsenic	0 05	0 010	0 05
Barium	1 00	–	1 00
Cadmium	0 01	–	0 01
Chloride	–	250	–
Cr^{6+}	0 05	–	0 05
Copper	0 05	1 00	–
Carbon Chloroform Extract	–	0 200	–
Cyanide	0 20	0 010	0 20
Fluoride	–	1 200	2 40
Iron	–	0 300	–
Lead	0 05	–	0 05
Manganese	–	0 050	–
Nitrate	–	45 0	–
Phenols	–	0 001	–
Selenium	0 01	–	0 01
Sulfates	–	250	–
Silver	0 05	–	0 05
Zinc	–	5 00	–

A Colorado guideline for the Biochemical Oxygen Demand (BOD) – the amount of oxygen needed to allow for natural biological oxidation of organic matter – has been established primarily as a measu ement of sewage treatment effectiveness The BOD guideline for Rocky Flats is 30 mg/l

Measure of Success of Secondary Waste Treatment is BOD

No standards have been established for phosphate levels

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Other Standards

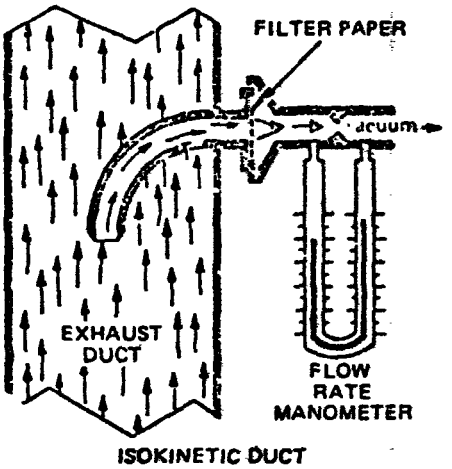
Although no directly applicable standards currently exist for plutonium and/or uranium levels or non radioactive materials in soil sediments vegetation or dustfall samples the guide at Rocky Flats has always been to maintain these levels as low as is practicable in accordance with the guide lines of the National Council on Radiation Protection and Measurement [4]

No Applicable Standards for Soil Sediments Vegetation or Dustfall so Guideline is that of the NCRP Maintain Levels as Low as Practicable

IV Sample Collection and Analysis Summary

Stack Effluents

Exhaust ducts from buildings involved with processing of plutonium uranium and/or beryllium are continuously sampled An iso kinetic technique is used whereby the air moving into the sample device is at the same velocity as the air inside the duct This technique allows improved trapping of particulate matter by eliminating turbulence at the mouth of the sample tube Samples are taken continuously and analyzed for total long-lived alpha activity (including natural long-lived alpha emitting materials) and/or beryllium where applicable Total activity released is then calculated from total effluent volumes.



ISOKINETIC DUCT SAMPLER

Exhaust Ducts of Proce s Buildings Continously Sampled Using Isokinetic Device for Better Particulate Trapping

Samples Analyzed fo- Gross Alpha and/or Beryllium Where Applicable

Since most standards apply o concentrations measured at the point of public access (plant boundaries) [4 9] measurements taken at the stack discount any dilution effect and thus provide an additional safety factor The guides for effluents are for contributions (above naturally occurring activity) after dilution by the atmosphere in terms of timed averages *The values obtained at Rocky Flats are taken at the stack and include natural activity before any atmospheric dilution* These results summarized in Tables IA and IB indicate a maximum (one month average) long-lived alpha concentration of 0 095 x 10^{-12} μCi/ml for all plutonium operations

Standards Apply at Pl ı Boundaries Samples Taken and Result- ' eported at the Stack Before Appropriate Atmospheric Dilution

Results Summarized in Tables IA and IB

The yearly average (the pertinent value in terms of the guidelines) was 0 009 x 10^{-12} μCi/ml about 15% of the standard

Maximum Concentration for All Plu tonium Releases Occurred During Filter Change

The maximum (one-month average) total emission from all uranium operations (Table IC and ID) was 0 05 x 10^{-12} μCi/ml. The yearly average was 0 008 x 10^{-12} μCi/ml which is about 0 3% of the applicable (population) standard

Maximum (one month average) beryllium emission was 1 5 x 10^{-5} mg/cubic meter (before atmospheric dilution). The 12 month average stack release for beryllium operations was 1 3 x 10^{-9} milligrams per cubic meter or about of the standard Beryllium results are tabulated in Tables IIA and IIB

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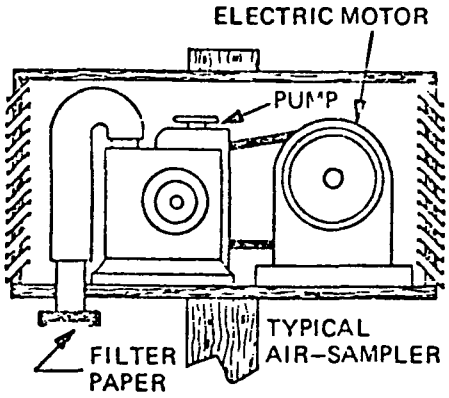
Air Samplers

To provide further detection and measurement of any accidental release of any contaminated effluents Rocky Flats maintains an extensive network of continuously operating air sampling devices to monitor contamination levels in the surrounding atmosphere

Extensive Network of Air Samplers Maintained to Detect Levels and Accidental Releases



Continuous samples are obtained from 12 on site air sampling stations (Map 1) which sample about 82 cubic meters of air per day (the equivalent of 2 cubic feet per minute) These samples are collected and analyzed daily for *total long lived alpha concentrations* (which would include plutonium uranium and other long lived alpha emitters) and specifically for beryllium (see Map 1)

12 Continuous Operation Air Samplers on Plantsite Sample About 2 Cubic Feet Per Minute Samples Analyzed for *Long Lived Alpha*

Twelve high volume air samplers are located at a radius of about 2 miles from the plant perimeter (Map 2) These samples are collected on a 4 inch filter paper which is changed daily composited and analyzed specifically for *plutonium* The 437 composite samples for 1971 represent volumes of over 2 000 000 cubic meters (about 70 000 000 cubic feet) of air actually filtered in 1971

12 High Volume Samplers Offsite Surrounding Plant at About 2 Mile Radius Samples Analyzed for *Plutonium*

High volume samples are also taken weekly from Wagner Site (S 18 Map 2) and from Coal Creek Canyon (S 11 Map 2) about 2 5 miles southeast and 3 miles west southwest of the plant respectively For 1971 the 77 samples taken represent volumes of about 17 000 cubic meters of air (nearly 600 000 cubic feet) These were analyzed specifically for *plutonium*

Special High Volume Samples Also Taken Onsite and at Two Offsite Locations on Regular Basis Analyzed for *Plutonium*

Results for the year indicated a maximum of 0 06 x 10^{12} μCi/ml High volume grab samples were also taken to the east of an asphalt pad covering some contaminated soil (former drum storage area in the southwest corner of the plant site proper) The 180 samples taken in 1971 represent over 40 000 cubic meters of air actually filtered and were analyzed for *total plutonium content* The results varied from a single sample maximum of 0 049 x 10^{-12} μCi/ml to a yearly average of 0 0030 x 10^{-12} μCi/ml

Nine low volume air samplers programmed to sample for 10 minutes of each hour are located in Boulder Broomfield Denver Coal Creek Canyon Golden Lafayette Westminster and Marshall (Map 3) These samples are collected weekly and analyzed for total *long lived alpha activity* The low volume samplers represent about 44 000 cubic meters of air during 1971

Low Volume Programmed Samplers Located in Surrounding Communities

Weekly Samples Analyzed for Total Long-Lived Alpha (Nearly 10 000 Samples Per Year)

This complex of air samplers produces nearly 10 000 samples per year These are analyzed to make certain that effluent levels as well as any redistribution effects are kept well below guideline concentrations Summaries of these results for 1971 are presented in Tables III IV and V On site air samples varied from a maximum average *long lived alpha concentration* (one month average) of 0 0128 X 10^{-12} μCi/ml with a 12 month average of 0 0049 X 10^{-12} μCi/ml about 24 5% of the standard

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Low volume off site air sample results were also quite low The programmed samplers indicated a maximum *long lived alpha concentration* (one month (average) of 0 01 X 10^{-12} µCi/ml with a yearly average of 0 0044 X 10^{-12} µCi/ml about 66% of the guidelines The high volume, off site samplers much more indicative of chronic exposure levels revealed much lower concentrations The maximum (one month *plutonium* average) was 0 004 x 10^{-12} µCi/ml whereas the average for the year was 0 0003 x 10^{-12} µCi/ml about 1 3% of the guideline

Data from the air sampling network indicate that the average contaminant concentrations in air effluents from Rocky Flats were below the established standards

Average Concentrations Below Established Guidelines

Beryllium sample results were also far below guideline concentrations (Table VI) Nearly 12,000 analyses of these air samples indicate that in no case did off site beryllium concentrations exceed 1.87 x 10^{-5} milligrams per cubic meter* and that the yearly average was 2.8 x 10^{-6} mg/M^3 roughly 30% of the applicable standard On-site results were considerably lower ranging from a maximum of 2 3 x 10^{-6} mg/M^3 to a yearly average of 1 2 x 10^{-6} mg/M^3 indicating that cross contamination occurred in an analysis of the off-site samples.

Beryllium Results Also Below Guidelines

Dustfall Samples

In addition to the air samples obtained specially designed trays atop all the off-site air stations collect dustfall samples for specific plutonium analysis In addition more remote samples are collected from locations near Berthoud and from Castle Rock Table VII tabulates these results for the year All samples are collected on a bi monthly basis and represent fallout from atmospheric weapons testing and of course any contribution from Rocky Flats Castle Rock and Berthoud samples are collected to provide an indication of plutonium in dustfall samples from background The values obtained in this extensive sampling program are on the same order of magnitude as reported for world wide fallout measurements.[14] These levels represent no health or safety hazard There is possibly some insignificant but nonetheless real contribution from Rocky Flats. Studies are now underway to determine what (if any) contribution is directly attributable to Rocky Flats

Dustfall Collection Trays Mounted Atop all Offsite Air Samplers

Dustfall Results Same Order of Magnitude as Worldwide Fallout But Possibly Some Contribution From Rocky Flats This Under Intensive Study

Levels Represent No Health or Safety Hazard.

Water Samples

Rocky Flats is drained by three streams North and South Walnut Creeks to the north of the plant site and Woman Creek to the south For reference, North Walnut Creek is classified as the plant's 'A drainage South Walnut Creek as the B drainage and Woman Creek as the C drainage

Three Drainage Streams North Walnut Creek (A) South Walnut Creek (B) Woman Creek (C) (Discharges Made Only to South Walnut Creek (B) Through Four Holding Ponds)

Sanitary and process waste waters are released after treatment to South Walnut Creek through a series of four holding ponds (Ponds B 1 B 2 B 3 B-4) Effluents released through the sewage plant meet all Water Quality Standards as established by the Colorado Department of Health[12] or the U S Public Health Service Drinking Water Standards Act (1962) [13] The overflow from the pond system (Ponds B 1 through B-4) flows into Great Western Reservoir

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*Though these data are believed to be the result of analytical error due to their high deviation from the average it is felt that it would be rather better to err on the conservative side and they are thus presented as maximums

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Continuous flow into this reservoir is comprised mainly of liquid wastes from Rocky Flats and makes up a small portion of the drinking water for the community of Broomfield

Holding Ponds Also Located on (A) and (C) Drainages

Holding ponds are also located on North Walnut Creek (Pond A) and on Woman Creek (Pond C) but no effluents are discharged directly into these holding ponds

Daily water samples are collected from Pond B 4 and three times weekly from the Ponds A and C These samples are composited into a weekly sample and analyzed for their gross alpha (uranium and plutonium) content as well as specifically for plutonium and for americium

Water Samples Collected Daily From B-4 Three Times Each Week From (A) and (C)

Tap water samples from the surrounding communities (Arvada Boulder Broomfield Denver Golden Lafayette Lousiville Thornton and Westminster) and water samples from four reservoirs in the area are collected every 2 weeks and analyzed specifically for gross alpha and plutonium Standley and Great Western Reservoir water samples are also analyzed for americium

Tap Water Samples Taken From Surrounding Communities Every 2 Weeks Along with Four Reservoirs in Area

Weekly grab samples are taken from Walnut Creek below the confluence of the North and South branches and analyzed for gross alpha and specifically for plutonium and americium content As a further safeguard nearly all waters in the immediate vicinity are surveyed semi annually and analyzed for gross alpha (uranium and plutonium) and for plutonium content There are 34 such bodies of waters surveyed 18 within 5 miles of the plant site and 16 at distances greater than 5 miles

Most Waters in Area Sampled for Gross Alpha and Plutonium

The most restrictive standard that for soluble plutonium 239 is 1 67 x 10^{-6} μCi/ml in terms of yearly averages to a suitable sample of a population *Gross alpha concentrations* in samples from B 4 pond had a maximum of 36 6 x 10^{-9} μCi/ml and a yearly average of 11 69 x 10^{-9} μCi/ml These gross alpha concentrations are contributions from both plutonium and uranium All other naturally occurring long lived alpha emitters are removed from the samples during the analytical procedure

Total *maximum plutonium concentration* in Pond B 4 was 7 23 x 10^{-9} μCi/ml with a yearly average of 2 06 x 10^{-9} μCi/ml *Americium 241 maximum* was 3 07 x 10^{-9} μCi/ml with a yearly average of 1 x 10^{-9} μCi/ml

Average Gross Alpha Americium and Plutonium Concentrations Below Guidelines

Grab samples from Pond A showed a maximum *gross alpha concentration* of 17 65 x 10^{-9} μCi/ml with a yearly average of 7 28 x 10^{-9} μCi/ml Pond C showed similar low concentrations with a yearly maximum (gross alpha) of 23 64 x 10^{-9} μCi/ml and a yearly average of 6 14 x 10^{-9} μCi/ml

Those grab samples taken at the confluence of North and South Walnut Creeks showed a maximum gross alpha of 19 34 x 10^{-9} μCi/ml Maximum *plutonium* concentration found was 8 47 x 10^{-9} μC /ml and maximum americium was about one half that amount *Average gross alpha was 11 55 average plutonium 2 56 and average americium 0 80 all x 10* $^{-9}$ *μCi/ml*

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Tap water results averaged 3 33 x 10^{-9} µCi/ml with a maximum of 18 58 x 10^{-9} µCi/ml *gross alpha activity* Gross alpha concentrations in the eservoirs averaged 6 38 x 10^{-9} µCi/ml with a maximum of 28 8 x 10^{-9} µCi/ml in Broomfield

Tap Water From Surrounding Commun ities and Reservoir Samples Below Gross Alpha (U + Pu) Guidelines

Average plutonium concentrations, summarized in Tables VIIIA and B show that all water samples from tap water reservoirs and holding ponds were 1000 to 10 000 times less than the most restrictive standard for soluble plutonium

Average *Plutonium* Content of Tap Water and Reservoir Samples 1000 to 10 000 Times Less Than Guidelines

In addition to the radionuclide analyses performed on these effluents the daily chemical analyses of the B holding ponds sanitary and process waste effluents and weekly grab samples taken from Ponds A and C show them to be within both State and Federal specifications (Table VIIID and VIIIE)

Chemical Analyses Also Below USPHS and Colorado Guidelines

Sediment Samples

Sediment samples from the four major reservoirs are collected semi annually and more frequent sediment samples are taken from each of the six holding ponds Additional samples are also taken from Walnut and Woman Creeks. These samples are taken to a depth of 4 centimeters No specific standard now exists for plutonium in sediment samples The results tabulated in Table IX indicate a maximum of 0 641 x 10^{-3} µCi/gram (dry) within the controlled area The yearly average within the controlled area was 0 03 x 10^{-6} µCi/gram (dry) The maximum concentration found outside the controlled access area of the plant site was 7 x 10^{-6} µCi/gram with a yearly average of x 10^{-9} µCi/gram

No Standards for Sediment Samples

No analyses are performed for nonradioactive materials in sediment samples

Soil Samples

The Rocky Flats Health Physics Department has maintained an extensive soil sampling program on a routine basis since mid 1969 Previous to that time samples were taken on a random basis and analyzed for gross alpha content Although this gross alpha analysis would include plutonium and uranium as well as naturally occurring radionuclides no specific plutonium analyses were routinely performed on these soil samples prior to that time

Routine Soil Sampling Since Mid 1969

The current program draws samples from a rough grid at 1 2 and 5-mile distances from the center of the plant About 75 locations predominantly east and south of the plant site (corresponding to prevailing wind directions) but covering all areas between the perimeter and cattle fences are sampled twice each year In addition locations along public right of way are also sampled and samples are taken from Denver Arvada West minster between Boulder and Fort Collins between Leyden and Golden along 104th Avenue and in Coal Creek Canyon All samples are to a depth of 1 centimeter In all 159 soil samples were collected in 1971 and analyzed specifically for plutonium

Current Program Uses 1 2 and 5-Mile Grids. 159 Samples in 1971 Analyzed Specifically for Plutonium

No specific standard has been set for plutonium in soils The levels obtained in this sampling program are summarized in Table X

No Standard for Plutonium in Soils

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All evidence gathered to date by the Rocky Flats Health Physics Department and other official agencies indicate that the plant has made some contribution to plutonium soil concentrations in the immediate vicinity of the site There is however no evidence to indicate that there has been any measurable or significant contribution to the Greater Denver Metro areas surrounding the plant Nor is there any evidence that the levels found closer to the plant represent any health hazard

Plant Made Some Contribution to Pu Soil Concentrations in Immediate Vicinity No Evidence of Any Measurable or Significant Contribution to Greater Denver Metro Areas nor Any Evidence That Levels Found Represent Health or Safety Hazard

Vegetation Samples

Vegetation samples are collected from 75 locations within a radius of 20 miles from the plant site These are taken from public right of way twice each year and are confined to those plants normally consumed by grazing domestic animals The various samples are analyzed specifically for plutonium

Vegetation Samples Collected Twice Yearly from 75 Locations Analyzed Specifically for Plutonium

Results for 1971 (Table XI) show that plutonium levels were a maximum of 2.54×10^{-6} μCi/gram (dry) One notable aspect of this sampling program is that the plant is analyzed without any prior washing Thus the plant becomes a form of dustfall collector as well as a measurement of the amount of plutonium physically incorporated into the plant through normal growth activities Although no specific standard has been established for plutonium in or on plants these levels are considered by most experts to be insignificant especially in light of empirically derived dilution factors [15]

No Standard for *Plutonium* In Vegetation Levels Found Are Considered Safe

No specific *routine* analyses are performed at Rocky Flats on food or biological samples Specific studies are now under way on vegetation and biological samples by Rocky Flats and by C S U

Rocky Flats has contracted with the Radiobiology Department of Colorado State University to make ecological studies of the flora and fauna in the immediate environs of the plant This will be a continuing project

C S U Ecology Studies of Plant Site A Continuing Project

V Tabular Data 1971

Map 1 On site high volume air sampling stations and weather summary

Map 2 Off site high volume air sampling stations

Map 3 Programmed environmental sampling network

Map 4 Rocky Flats effluent water flow

Table I Radioactive stack effluent releases

- A Plutonium concentrations
- B Yearly summation plutonium concentrations
- C Uranium concentrations
- D Yearly summation uranium concentrations

Table II Non radioactive stack effluent releases

- A Beryllium concentrations
- B Yearly summation beryllium concentrations

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Table III Average monthly air sample concentrations on site radioactive

- A Long lived alpha concentrations
- B Yearly summation long-lived alpha concentrations.

Table IV Average monthly air sample concentrations off site radioactive

- A. Low-volume programmed samplers
  - 1 Long-lived alpha concentrations
  - 2. Yearly summation, long-lived alpha concentrations.
- B High volume off site samplers
  - 1 Plutonium concentrations
  - 2. Yearly summation off site plutonium concentrations

Table V Special high volume air samples radioactive

- A. On site grab samples and summation
- B Off-site grab samples and summation

Table VI Average monthly beryllium concentrations in air samples, on- and off-site

Table VII Dustfall sample summary

Table VIII Water surveys

- A Radioactivity in holding ponds and effluent waste waters.
  - 1 Pond B-4
  - 2 Grab samples Ponds A and C
  - 3 Walnut Creek at Indiana (confluence)
- B Radioactivity in reservoir and tap water samples
  - 1 Reservoir water samples.
  - 2. Community tap water samples
- C Semi-annual water collection
- D Chemical concentrations in holding ponds and effluent waste waters
  - 1 Pond B 4
  - 2 Pond B 4 summary
  - 3 Pond B 4 elemental analyses.
- E Chemical concentrations in holding ponds and effluent waste waters
  - 1 Grab samples Ponds A and C
  - 2. Yearly summary, Pond A
  - 3. Yearly summary, Pond C

Table IX Sediment samples.

Table X Semi annual surface soil analyses off site contours.

Table XI Vegetation samples

Analytical Note For all samples below detection limits a value was assigned. This value is a fraction of the detection limit i.e the number of samples above the detection limit divided by the total number of samples that were analyzed

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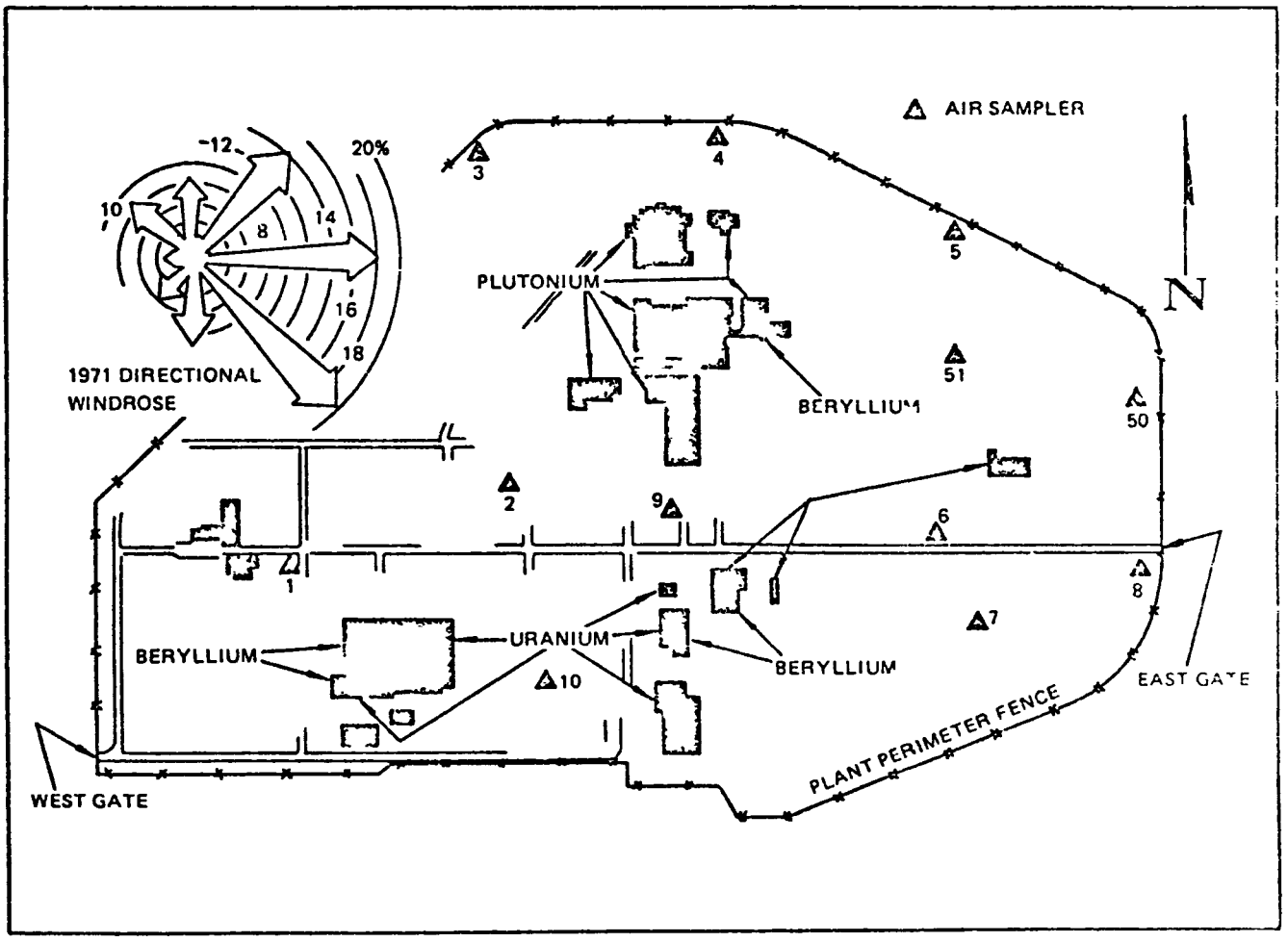
Weather Summary, 1971

For 1971 weather records show that the average temperature was 50 2 degrees Fahrenheit and anged from minus 2 to 102 degrees The average relative humidity was 48 1% Monthly precipitation ranged from 0 15 inch in November to a maximum 3 78 inches in April The average precipitation for the year was about 1 2 inches per month with a total for the year of 14 3 inches Although wind at Rocky Flats averaged only 8 7 miles per hour peak wind velocities exceeded 40 miles per hour in all 12 months ranging from 43 miles per hour in May 1971 to 95 in January Average peak velocity for all 12 months was 31 miles per hour The prevailing winds below from the northwest 20% of the time and from the west about 18% of the time (A directional wind rose is included with Map 1)



Map 1 On Site Air Sampler Locations and Material Areas

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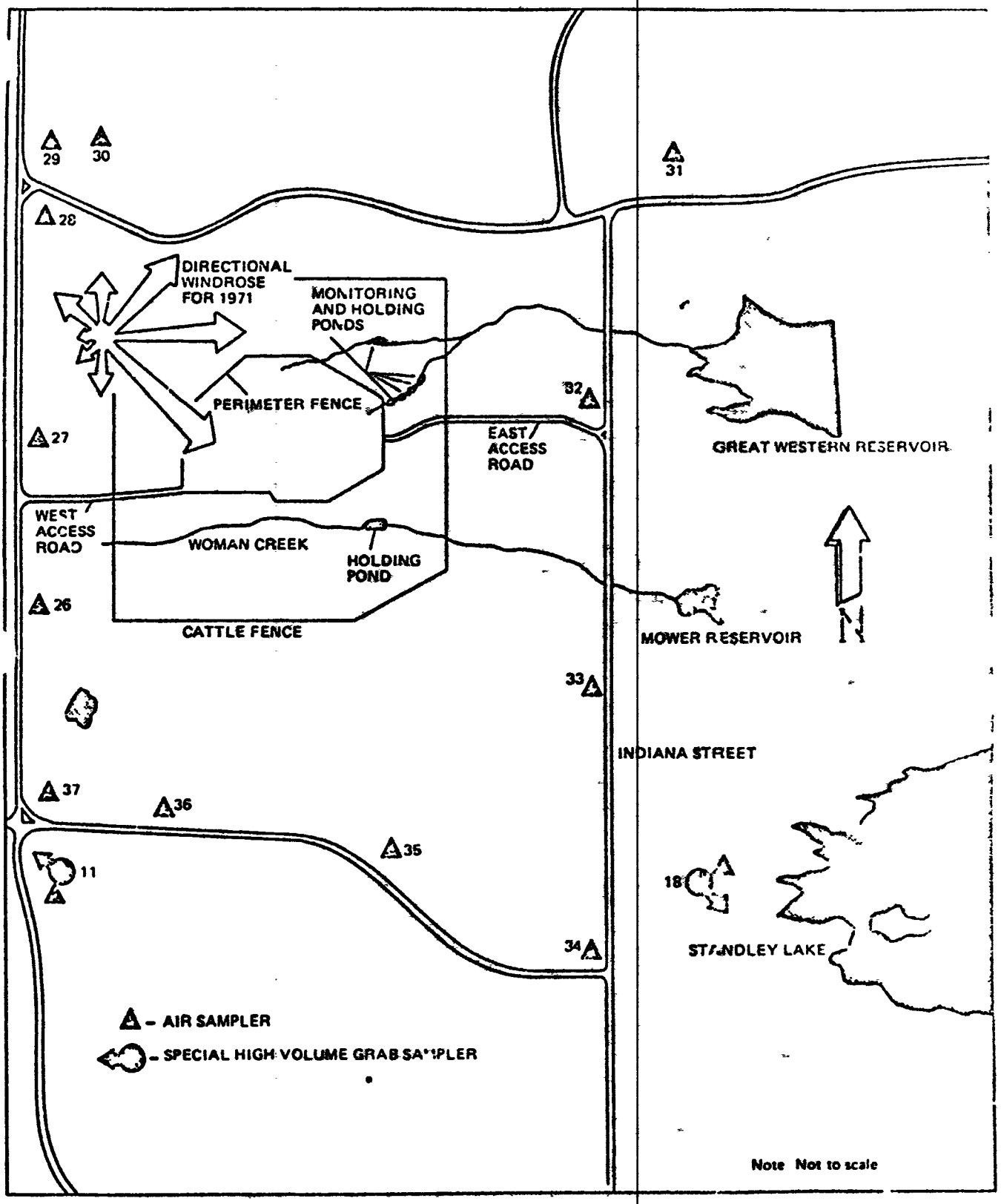

ap 2 Off Site High Volume Environmental Air Sampling Network

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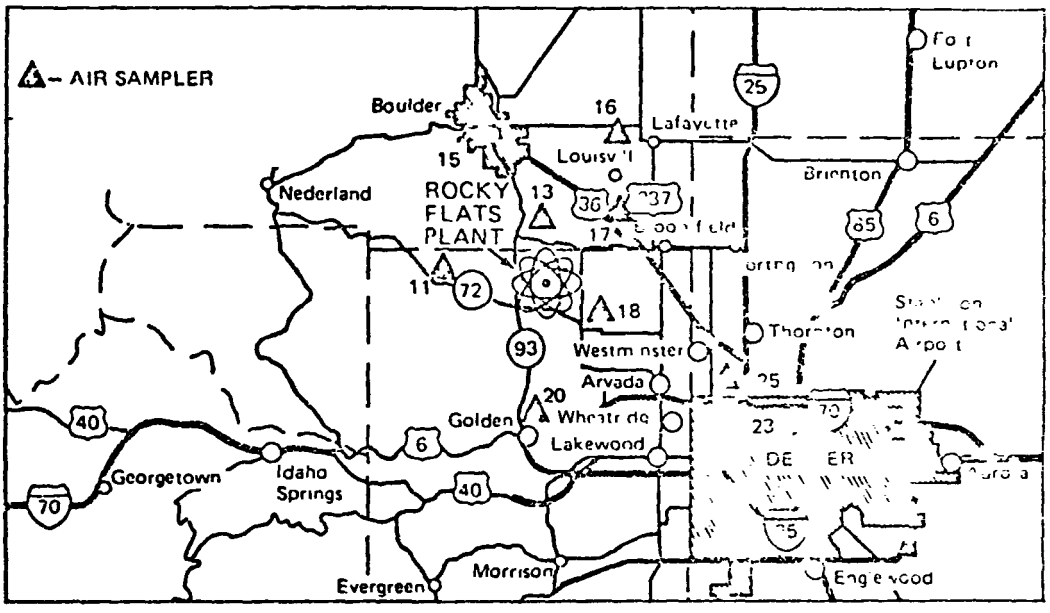

Map 3 Programmed Environmental Air Sampling Network

Map 4 Rocky Flats Effluent Water Flow

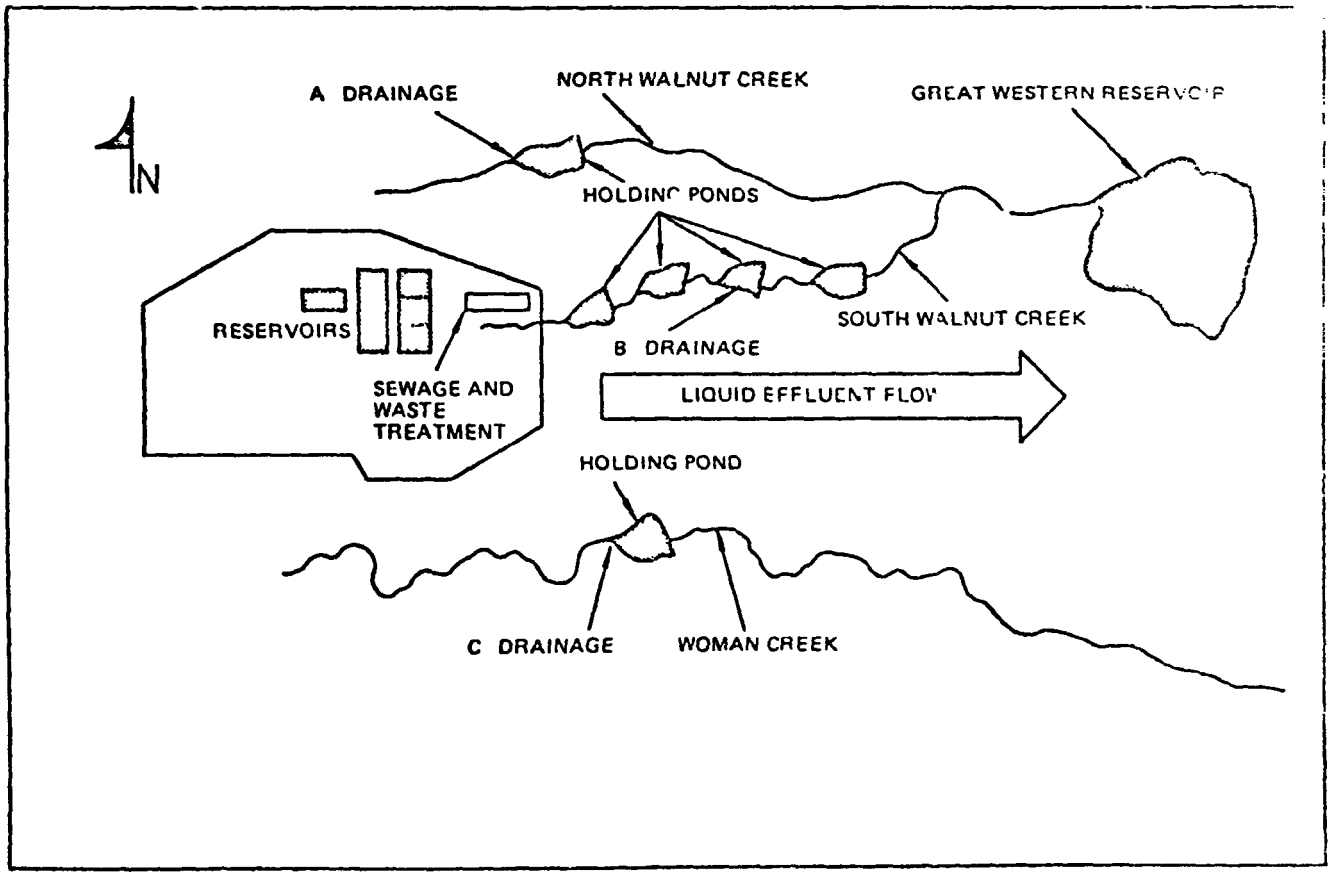

Table I Radioactive Stack Effluent Releases 1971

(A) Plutonium

Monthly Concentrations (X 10^{-12} μCi/ml)

Building	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	[illegible]
771	0 005	0 005	0.005	0 015	0 007	0 012	0 007	0 006	0.015	0 01[illegible]	0 00[illegible]	[illegible]
774	0 015	0 010	0 011	0-014	0 060*	0 013	0 008	0 007	0.012	0 010	0 013	0 0[illegible]5
776	0 004	0 095*	0 033	0 006	0 018	0 011	0.003	0 003	0 002	0 009	0 00	0 0[illegible]
779	0 007	0 002	0 002	0 002	0 002	0 002	0.002	0 002	0 002	0 002	0 00	0 00[illegible]
559	0 003	0 002	0 002	0 002	0 003	0 003	0 003	0 002	0 002	0 002	0 00	0 [illegible]
707	0 003	0.002	0 005	0 003	0 005	0 004	0 003	0.004	0 003	0 002	0 0[illegible]	[illegible]
Total Releases by Month (μCi)	2 552	17 240	8 017	5 989	8 286	5 838	2 671	2 630	5 096	5 [illegible]70	554	54

Applicable Standard (Soluble ^{239}Pu) = 0.06 X 10^{-12} μCi ml

(B) Yearly Summary – Plutonium

Concentrations (X 10^{-12} μCi/ml)

Building	January – June: Maximum Concentration (Single Sample)	January – June: (Monthly) Average Concentration	July – December: Maximum Concentration (Single Sample)	July – December: (Monthly) Average Concentration	Total Year: Concentration Max (Bldg)	Total Year: Concentration Av (Bldg)	Total Year: % Std (Av Conc)	Total Year: Total Release (μCi)
771	0 015	0 008	0 008	0.002	0 015	0 008	13 3	[illegible]6 42[illegible]
774	0 109	0 021	0 013	0 011	*0.109	0 016	6 7	6 034
776	0.087	0.028	0 009	0 004	0 087	0 016	6 7	33 05[illegible]
779	0 006	0.003	0 002	0 002	0 006	0 002	3 3	0 344
559	0 004	0.003	0.004	0.002	0 004	0 00[illegible]	3 3	0 766
707	0 004	0.004	0.080	0 016	0 080	0 010	16 7	7 726
Total Plutonium Operations Yearly Summation					0 109	0 009	15%	74 349

*The maximum monthly average emission (which occurred during filter changing operations in Building 776 in February) was 0 095 X 10^{-12} μCi/ml The maximum single sample emission (0 10 X 10^{-12} μCi/ml) was from Building 774 It must be noted that these values are take at the stack BEFORE appropriate atmospheric dilution The standards apply at the plant perime er and are in t rms of average [illegible] up to one year The annual average Pu emission from ALL Pu operations was 0 009 X 10^{-12} μCi/ml, about 15% of the appli abl stand rd (0 06 X 10^{-12} μCi/ml).

*Filter changing operations

***Effluents leaking around one stage of filter plenum Discovered and corrected

(C) Uranium

Monthly Average Concentrations (X 10^{-12} μCi/ml)

Building	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
444	0 009	0 005	0 002	0.002	0 002	0.002	0 002	0 002	0 001	0 001	0 017	0 0[illegible]
447	0 071*	0 070	0 029	0 033	0 040	0.023	0 002	0 017	0 030*	0 018	0 007	0 0[illegible]
881	0 004	0 017	0.018	0 049	0.005	0.005	0 005	0 006	0 002	0 00	0 00[illegible]	0 [illegible]
883 (A)	0 010	0.008	0 010	0.012	0.041	0.034	0.008	0.013	0 013	0.010	0 015	0 011
883 (B)	0.010	0 006	0.003	0 004	0.008	0 005	0.003	0 003	0 002	0 00	0 003	0 0[illegible]
886	0 003	0.001	0 002	0 002	0.002	0 002	0.002	0.002	0 001	0 001	0 003	0 003
889	0 003	0.002	0.002	0 002	0.002	0 002	0 002	0 002	0 001	0 003	0 00[illegible]	0 003
865	0.002	0 001	0 002	0.002	0 002	0 002	0 002	0 002	0.001	0 001	0 001	0 001
991 T	–	0 002	0 002	0 001	0 001	0 002	0 002	0 002	0 001	0 001	0 001	0 001
Total Release by Month (μCi)	11 [illegible]64	12 148	8.959	21 935	40 052	7 270	2 976	[illegible] 149	4 405	3 151	6 801	3 [illegible]41

Applicable Standard *** (Soluble ^{238}U) = 3 x 10^{-12} μCi/ml

(D) Yearly Summary – Uranium

Concentrations (X 10^{-12} μCi/ml)

Building	January – June: Maximum Concentration (Single Sample)	January – June: (Monthly) Average Concentration	July – December: Maximum Concentration (Single Sample)	July – December: (Monthly) Average Concentration	Total Year: Concentration Max (Bldg)	Total Year: Concentration Av (Bldg)	Total Year: % Std (Av Conc)	Total Year: Total Release (μCi)
444	0 009	0 004	0 017	0 004	0 017	0.004	0 1	9 9[illegible]0
447	0 077	0 044	0.033	0 016	0 0[illegible]7	0 030	1 0	25 756
881	0 050	0 016	0 006	0 003	0 050	0 010	[illegible] 0 3	35 440
883A	0 040	0.019	0.014	0.012	0 0[illegible]0	0 016	0 5	20 680
882B	0 012	0 006	0 003	0.002	0 012	0.004	0 1	5 740
886	0 004	0 002	0.004	0 002	0.004	0 002	0 1	0 132
889	0 005	0 002	0.003	0.002	0.005	0 002	0 1	0 146

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Table I Radioactive Stack Effluent Release 1971 (continued)

(D) Yearly Summary – Uranium (continued)

Concentrations (X 10 ^{12} μCi/ml)

Building	January – June Maximum Concentration (one month average)	January – June (Monthly) Average Concentration	July – December Maximum Concentration (one month average)	July – December (Monthly) Average Concentration	Total Year Concentration Max (Bldg)	Total Year Concentration Av (Bldg)	Total Year Std (Av Conc)	Total Year Release (μCi)
895	0 004	0 002	0 001	0 001	0 004	0 002	0 [illegible]	0 [illegible]
991 T	0 007	0 002	0 007	0 001	0 007	0 00[illegible]	0 [illegible]	[illegible]
Total Uranium Operations Yearly Summation					0 077	0 008	0 3	98 6[illegible]0

*Maximum monthly average emission 0 071 X 10 ^{12} μCi/ml (Building 447 January)
Maximum single sample concentration Both maximums associated with filter changes in the plenums of this building
Although Rocky Flats effluents would include several isotopes of uranium the guideline for soluble 238 is the most restrictive [illegible] must be noted that this standard applies at the plant boundary and is in terms of yearly averages to an individual in the general population
The values here all well below that standard are taken at the stack before any atmospheric dilution

Table II Non Radioactive Stack Effluent Releases 1971

(A) Beryllium

Monthly Average Concentrations (X 10 ^{6} mg/M^3)

Building	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
444-447	2 2	5 1	3 0	2 2	1 9	0 7	15 0	2 0	2 8	1 2	0 2	14 1
883A	1 0	3 2	0 5	0 2	0 2	0 2	0 5	0 2	1 1	0 2	0 2	0 [illegible]
779	0 3	0 7	0 3	0 3	0 3	0 3	0 3	0 5	0 2	0 6	3 6	0 6
774	0 8	0 6	0 6	0 5	0 5	0 5	0 4	0 6	0 2	0 4	0 8	0 8
865	0 5	2 0	0 4	0 2	0 5	0 5	0 2	0 2	0 2	1 1	0 2	0 [illegible]
Total Monthly Release (grams)	0 8.26	2 0923	1 2391	0 6988	0 6192	0 3700	4 4909	0 8021	0 8809	0 5191	0 0[illegible] 0	4 [illegible]10

(B) Annual Summary

Beryllium Stack Effluent Releases (X 10 ^{6} mg/M^3)

Building	January – June Maximum Single Sample Concentration	January – June Average Concentration*	July – December Maximum Single Sample Concentration	July – December Average Concentration	Totals for Year Max Conc	Totals for Year Av Conc	Totals for Year Std	Total Release (g)
444-447	45 0	2 6	209 2	5 8	209 2	4 2	42	15 1879
883A	25 2	0 6	1 2	0 5	25 2	0 6	6	0 0793
779	5 1	0 4	7 7	0 9	7 7	0 6	6	0 0262
774	2 4	0 7	0 4	0 2	2 4	0 5	5	0 8146
865	9 8	1 0	7 0	0 4	9 8	0 7	7	0 7[illegible]0
Total Beryllium Operations Yearly Summation					209 2	1 3	13 0	Total 16 8301

*Applicable Standard is 10 X 10 ^{6} mg/M^3 (Division Internal Goal is 5 X 10 ^{6} mg/M^3)

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Table III Average Monthly Air Sample Concentrations On Site Radioactive

(A) Total Long Lived Alpha Concentrations (U Pu and naturally occurring alpha emitters)

Monthly Average Concentrations (X 10^{-12} μCi/ml)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S-1	0 0044	0 0033	0.0046	0 0036	0 0057	0 0052	0 0034	0 0040	0 0045	0.0049	0 0035	[illegible]
S 2	0 0045	0 0044	0.0039	0 0046	0 0050	0 0027	0 0025	0 0055	0 00 9	0 0044	0 0[illegible]0	[illegible]
S 3	0 0033	0 0028	0.0033	0 0059	0 0052	0 0048	0 0054	0 0066	0 0057	0 0052	0 0046	[illegible]
S-4	0 0021	0 0044	0.0047	0.0067	0 0042	0 0040	0 0046	0 0041	0 0035	0 003[illegible]	0 0034	[illegible]
S-5	0 0017	0 0040	0.0032	0 0036	0 0047	0.0060	0 0053	0 0026	0 0034	0 0058	0 0069	[illegible]
S-6	0 0031	0 0030	0.0028	0 0037	0 0052	0 0034	0 0145	0 0020	0.0032	0 00[illegible]1	0 0068	[illegible]
S-7	0 0082	0 0066	0.0054	0 0082	0 0043	0 0047	0 0026	0 00 [illegible]	0 0022	0 0033	0 0012	[illegible]
S-8	0 0058	0 0069	0.0078	0 0324	0 0090	0 0103	0.0096	0 0110	0 0056	0 0128	0 0114	[illegible]
S-9	0 0043	0 0040	0.0041	0 0039	0 0036	0 0042	0 0043	0 0036	0 0026	0 0028	0 0013	[illegible]
S-10	0 0046	0 0052	0.0041	0 0072	0.0047	0 0073	0 0029	0 0030	0 0040	0 0062	0 0040	[illegible]
S-50	0 0042	0 0026	0.0045	0 0085	0 0048	0 0078	0.0052	0 0086	0 0059	0 0076	0 0064	[illegible]
S-51	0 0044	0 0051	0.0036	0 0067	0 0046	0 0037	0.0024	0 0020	0 0041	0 0054	0 0044	[illegible]

Applicable Standard (Soluble Plutonium 239) = 0 02 X 10^{-12} μCi/ml

(B) Summary Total Long Lived Alpha On-Site 1971

Concentration (X 10^{-12} μCi/ml)

Location	No. of Samples	<Det	C_{Max}	C_{Avg}	% of S[illegible]
S-1	243	125	0.0218	0.0043	21 6
S-2	241	140	0 0420	0 0040	[illegible]0 0
S-3	245	124	0 0218	0 0047	16
S-4	244	142	0.0333	0 0040	0 0
S-5	245	132	0 0278	0 0042	[illegible]
S-6	245	161	0 2723	0 0043	21 5
S-7	245	136	0 0822	0.0046	8
S-8	245	81	0 1864	0 0104	52 0
S-9	244	146	0 0368	0.0036	1[illegible] 9
S-10	237	112	0.0228	0 0047	3 4
S-50	244	120	0.1436	0.0058	[illegible]8 8
S-51	244	135	0.0341	0 0043	[illegible] 5
Yearly Summation, Total Averages	2922	1554	0.2723	0 0049	4 5

*This sampler (S-8) is located within the strongest, most frequent wind vector and is adjacent to the asphalt pad cover ng some contamina[illegible] soil The large volumes of dirt thus seen by this sampler may be indicative of resuspension mechanisms. It is worthy of note that this [illegible] highest-concentration location is still less than 40% of the applicable standard when stated in terms of yearly averages

Table IV Average Monthly Air Sample Concentrations O Y Site Radioactive.

(A) Low-Volume Programmed Samplers

1 Total Long Lived Alpha Concentrations, 1971 (U, Pu and naturally occurring alpha emitters)

Monthly Average Concentrations (X 10^{-12} μCi/ml)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boulder (S 15)	0 0036	0 0039	UD	0.0049	0 0074	0.0061	0 0044	0 0156	0 0077	0 0078	0 0036	0 0034
Broomfield (S-17)	0 0041	0 0060	0 0066	0 0056	0 0026	0.0031	UD	0.0044	0 0046	UD	0 0031	0 0035
Coal Creek (S 11)	0 0031	0 0031	0.00[illegible]2	0 0067	0 0022	0 0036	UD	UD	UD	0 0027	0 00 9	0 00 3
Denver (S 23)	0 0022	0 0014	0 0085	0 0068	0 0029	0 0055	0 0024	0 0069	0 0059	0 0032	0 0030	0 00 1
Golden (S-20)	0 0039	0 0047	0 0061	0 0062	0 0052	UD	UD	UD	0 0040	0 0118	UD	0 0037
Lafayette (S-16)	0 0063	0.0079	0.0055	0 0068	0 0078	0 0065	0 0034	0 0033	0 0073	0 0031	0 00 5	0 0053
Marshall (S-13)	0 0042	0.0024	UD	UD	0 0073	UD	0.0023	0 0 2	0 0036	0 0021	UD	UD
Wagner (S-18)	0 0053	UD	UD	0 0105	0 0080	0 0130	0 0083	0 0133	0 0052	0.0032	0 00 3	0 0050
Westminster (S 25)	0 0050	UD	0 0076	0 0085	UD	0 0137	0 0052	0 0163	UD	0 0060	0 00 4	0 0038

Applicable Standard (unidentified alpha emitters) = 0 0067 X 10^{-12} μCi/ml

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Table IV Average Monthly Air Sample Concentrations Off Site Radioactive (continued)

A) Low Volume Programmed Samplers

2 Yearly Summary Long Lived Alpha Concentrations (U Pu and naturally occurring alpha emitters)

Concentrations (X 10^{12} μCi/ml)

Location	No of Samples	<Det	January – June C_{Max}	January – June C_{Avg}	July – December C_{Max}	July – December C_{Avg}	CY 1971 C_{Avg}	[illegible]
Boulder (S 15)	46	22	0 0128	0 0044	0 0174	0 0056	0 0049	[illegible]
Broomfield (S 17)	46	29	0 0134	0 0045	0 0128	0 00[illegible]7	0 0036	[illegible]
Coal Creek (S 11)	46	37	0 0129	0 0034	0 0099	0 0013	0 00[illegible]	[illegible]
Denver (S 23)	46	27	0 0160	0 0035	0 0098	0 0039	0 00[illegible]	[illegible]
Golden (S 20)	46	32	0 0134	0 0044	0 0368	0 0033	0 0039	[illegible]
Lafayette (S 16)	46	22	0 0112	0 0068	0 0163	0 0048	0 0058	
Marshall (S 13)	45	36	0 0082	0 0017	0 00[illegible]0	0 0018	0 0018	[illegible]
Wagner (S 18)	46	27	0 0197	0 0061	0 0167	0 0053	0 005[illegible]	[illegible]
Westminster (S 25)	42	29	0 0270	0 0037	0 0[illegible]98	0 0043	0 0039	[illegible]
Summary	409	261	0 0270	0 0052	0 0368	0 0036	0 0044	[illegible]

(B) High Volume Offsite Samplers

1 Plutonium Concentrations

Monthly Concentrations (X 10^{12} μCi/ml)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S-26	–**	0 00010	0 00019	0 00013	0 00023	0 00021	0 00005	0 00025	0 00024	0 00011	0 00016	0 0[illegible]0
S-27	–	0 00003	0 00023	0 00010	0 00024	0 00026	0 00011	0 00032	0 00006	0 00036	–	0 001[illegible]
S-28	–	0 00012	0 00019	0 00012	0 00020	0 00027	0 00009	0 00030	0 00038	0 00012	–	–
S-29	–	0 00014	0 00015	0 00009	0 00022	0 00040	0 00025	0 00085	0 00022	0 00011	0 00014	0 0[illegible]
S-30	–	0 00008	0 00016	0 00011	0 00020	0 000[illegible]	0 00016	0 00026	0 00011	–	–	–
S-31	–	0 00006	0 00013	0 00074	0 00032	0 00028	0 00019	0 00040	0 00074	0 00019	0 00015	0 0[illegible]
S-32	–	0 00014	0 00033	0 00017	0 00028	0 00131	0 00010	0 00039	0 00021	0 00193	–	[illegible]
S-33	–	0 00019	0 00033	0 00022	0 00031	0 00031	0 00018	0 00028	0 00072	0 00014	0 00010	[illegible]
S-34	–	0 00014	0 00026	0 00014	0 00029	0 00040	0 00008	0 00023	UD	–	–	
S-35	–	0 00012	0 00020	0 00015	0 00025	0 00030	0 00014	0 00023	0 00010	0 00019	UD	[illegible]
S 36	–	0 00008	0 00034	0 00018	0 00023	0 00027	0 00010	0 00025	0 00016	0 000[illegible]0	0 00014	0 0[illegible]
S-37	–	0 00012	0 00092	0 00032	0 00021	0 00030	0 00008	0 00030	0 00010	0 00464	UD	

Applicable Standard (Soluble ^{239}Pu) is 0 02 X 10^{12} μCi/ml

(B) High Volume Off site Samplers

2 Yearly Summary Plutonium

Concent[illegible]ons (X 10^{12} μCi/ml)

Location	February – June Max Conc / Single Sample	February – June Average	July – December Max Conc / Single Sample	July – December Average	Totals for Year Average Conc	Totals for Year % of Std	Totals for Year Total No Samples	Totals for Year No [illegible] Detection [illegible]
S 26	0 00038	0 00018	0 00041	0 00012	0 00014	0 [illegible]	40	10
S 27	0 00038	0 00016	0 00343	0 00035	0 00026	1 3	34	6
S-28	0 00044	0 00018	0 00073	0 00021	0 000[illegible]0	1 0	32	2
S-29	0 00068	0 000[illegible]0	0 00132	0 00028	0 00025	1 2	44	5
S-30	0 00050	0 00017	0 00043	0 00017	0 00017	0 9	30	3
S-31	0 00064	0 00021	0 00059	0 00023	0 000[illegible]2	1 1	43	2
S 32	0 00428	0 00045	0 00193	0 00058	0 00051	[illegible]6	32	2
S-33	0 00063	0 00027	0 00045	0 00018	0 00022	1 1	44	4
S 34	0 00092	0 000[illegible]5	0 00028	0 00010	0 00019	1 0	28	3
S-35	0 00043	0 00020	0 00066	0 00017	0 00018	0 9	36	5
S-36	0 00070	0 000[illegible]2	0 00087	0 00017	0 00018	0 9	42	5
S-37	0 00222	0 00036	0 00464	0 00068	0 00065	3 2	32	6
Yearly Summation Total Averages					0 00026	1 3%	437	53

Undetectable (below dete tion l m ts)

This network of samp lers began o eration in February 1971

Air Samplers inoperative due to pump failure

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Table V Special High Volume Air Samples, On- and Off Site Radioactive

(A) On site Grab Samples

Plutonium Concentrations (X 10^{-12} μCi/ml)

Location of Grab	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	[illegible]
903-20	0 00039	0 00109	0 00055	0 00158	0 00135	0 00234	0.00054	0 00313	0 00373	0 00161	0 00[illegible]	[illegible]
903-15	0 00004	0 00192	0 00029	0 00307	UD**	0 00220	0 00324	0 00962	0 00852	0 00123	0 00019	[illegible]
903-10	0 00039	0 00176	0 00109	0 00162	0 00018	0 00132	0 00090	0 00060	0 00120	UD	0 00111	[illegible]
903-5	0 00011	0 00175	0 00030	0.00088	0 00042	0 01370	0 00067	0.00218	0 00051	NA**	0 00325	[illegible]

Yearly Summation

Location	Single Sample Maximum	Average Concentration	Percent of Standard **	Number of Samples	Number Less than Detection Limits
903 20	0 001800	0 000200	3 3	48	
903-15	0 002970	0 000261	4 4	46	[illegible]
903-10	0.001110	0 000104	1 7	44	
903-5	0.004960	0 000187	3 1	42	—
Totals (averages)		0 00013	2 2%	180	

*Taken just to east of asphalt pad covering contaminated soil on plant site.
**Undetectable (below detection limits).
***No analysis.
****Standard for these on-site samples is taken as 0.06 X 10^{-12} μCi/ml

(B) Off site Grab samples

Concentrations (X 10^{-12} μCi/ml)

Location of Grab	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wagner	0 00038	0 00220	0.00120	0 00306	0.00145	0.00340	0.00214	0 00375	0 00743	0 01827	0 00040	0 00185
Coal Creek	NA	0 00390	0.00153	0.00213	0 00078	0 01455	0 00141	0 00318	0.00510	0 00015	0 00091	0 00 8

Yearly Summation

Location	Single Sample Maximum	Average Concentration	Percent of Standard	Number of Samples	Number Less Than Detection Limits
Wagner	0 00570	0 000345	17.2	42	7
Coal Creek	0.06020	0 000344	17 2	35	8
Totals (averages)		0 000266	13.3	77	15

Table VI Beryllium Concentration in Air Samples.

Concentration (X 10^{-5} mg/M^3)

	Location: On-Site	Location: Off-Site	% of Standard: On Site	% of Standard: Off Site
Jan	.009	.010	9	0
Feb	.012	** 187	12	187
Mar	.012	.011	12	11
Apr	.010	.012	10	1[illegible]
May	020	.015	20	15
Jun	.010	.012	10	12
Summary	.012	.041	12%	41%
Jul	.007	.017	7	17
Aug	010	011	10	11
Sep	023	009	23	9
Oct	.014	025	14	25
Nov	010	.011	10	11
Dec	010	011	10	11
Summary	.012	014	12%	14%

*Beryllium standard in ambient air is 1 X 10^{-5} mg/M^3 – Rocky Flats self imposed standard is ½ that or 0 5 X 10^{-5} mg/M^3
**This concentration represents cross contamination in the analytical laboratory

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Table VII Dustfall Samples 1971 Yearly Summary

(Plutonium)

	No Samples Taken	No Samples Less Than Detection Limit	Sample Days	1971 Maximum (Single Sample) Concentration (pCi/M³)	Total Deposition (pCi/M²)	Deposition Rate (pCi/M²/month)
Arvada	23	4	362	16 11	77 44	5 30
Broomfield	22	11	348	28 88	74 48	3 21
Boulder	18	14	334	28 59	85 69	1 71
Coal Creek	19	11	292	21 66	50 76	2 20
Denver	22	11	341	53 87	118 27	5 [illegible]0
Eastlake	23	11	362	6 00	49 84	[illegible] 15
Golden	22 (21)	8	348 (334)	*(174 16)	*219 55 (45 39)	1[illegible] 04 ([illegible])
Lafayette	22	13	348	11 77	46 26	1 63
Marshall	23	10	362	67 70	149 04	6 98
Superior	21	8	334	16 11	74 20	4 13
Wagner	20	6	292	13 17	9 61	0 69
Westminster	22	7	341	17 30	41 36	2 48
Summary	*257 (256)	114	*4064 (4050)	(174 16) (67 70)	996 50 (822 34)	4 09 ([illegible])
Berthoud	7	2	310	5 58	12 98	0 90
Castle Rock	9	7	358	2 46	7 73	0 14
Summary	16	9	668	5 28	20 73	0 41

Based on highly suspect data The removal of one single-aliquot sample reduces the total deposition at Golden to 45 39 pCi/M² and the to[illegible] (summary) deposition rate to 3 38 pCi/M²/month

Table VIII Water Surveys.

(A) Radioactivity in Holding Ponds and Effluent Waste Water

1 Pond B 4 (Effluent Waste Water)

Concentrations (X 10⁻⁹ μCi/ml)

Sample Period	No Samples	Effluent Volume (million liters)	U + Pu Concentrations Max	U + Pu Concentrations Avg	U + Pu Release (mCi)	Pu Concentrations Max	Pu Concentrations Avg	Pu Release (mCi)	Am Concentrations Avg	Am Concentrations Max	Am Release (mCi)
January	4	36 01	36 64	14 33	0 516	4 01	2 [illegible]9	0 082	3 07	–	0 1[illegible]
February	4	34 85	27 73	24 74	0 862	7 23	2 92	0 101	1 20	1 36	0 0[illegible]
March	4	49 18	19 19	13 15	0 647	4 32	2 86	0 141	1 89	2 6[illegible]	[illegible]
April	5	41 21	19 29	14 75	0 608	5 23	2 99	0 123	1 51	2 39	0 0[illegible]
May	4	32 36	19 98	12 54	0 406	4 59	2 63	0 085	0 94	2 26	0 0[illegible]0
June	5	28 15	10 30	8 33	0 234	2 61	1 60	0 045	1 37	2 18	0 [illegible] 9
July	5	23 95	8 95	6 14	0 147	6 09	2 92	0 070	1 03	1 29	0 [illegible]
August	4	30 47	18 75	11 34	0 346	2 77	1 05	0 032	0 42	0 5[illegible]	0 [illegible]
September	5	33 69	11 19	7 4	0 241	7 04	2 72	0 092	0 65	1 08	[illegible]
October	4	42 64	5 75	5 61	0 239	1 59	1 01	0 043	0 06	0 16	[illegible]3
November	4	47 61	(15 08)	10 67	0 508	0 98	0 59	0 028	NA	NA	NA
December	5	53 79	(28 89)	11 48	0 618	1 56	1 09	0 059	NA	NA	NA

( ) denotes suspect dat NA – No Analysis

2 Yearly Summation Pond B 4 (Effluent Waste Water Total Volume 1971 = 232 150 000 Liters)

Concentrations (X 10⁻⁹ μCi/ml)

Sample Period	Number Samples Taken	U + Pu Concentrations Max	U + Pu Concentrations Avg	U + Pu Release (mCi)	Number Samples Taken	Pu Concentrations Max	Pu Concentrations Avg	Pu Release (mCi)	Am Concentrations Max	Am Concentrations Avg	Am Release (mCi)
Jan Jun	[illegible]6	36 64	14 64	3 273	26	7 23	2 55	[illegible] 577	3 07	1 50	[illegible]
Jul Dec	27	(28 89)	8 73	2 098	27	6 09	1 56	[illegible] 324	1 29	0 53	[illegible]
Summary	53	36 64	11 69	5 371	53	7 2[illegible]	2 06	0 901	3 07	1 00	0 4[illegible]

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Table VIII Water Surveys (continued)

(A) Radioactivity in Holding Ponds and Effluent Waste Waters

3. Grab Water Samples – Ponds A and C (Holding Ponds)

	Pond (A) X 10⁻⁹ μCi/ml				Pond (C) X 10⁻⁹ μCi/ml			
	No Samples		Concentrations		No Samples		Concentrations	
	Taken	<Det	U+Pu	Pu	Taken	<Det	U+Pu	Pu
Jan	4	0	7.00	0.51	4	0	6.98	0.76
Feb	4	0	8.88	0.42	4	0	10.98	0.72
Mar	4	0	7.09	0.31	4	0	5.66	0.5
Apr	5	0	6.62	1.12	5	0	6.44	1.15
May	4	0	6.23	0.85	4	0	6.73	0.31
Jun	5	0	4.63	1.21	5	0	4.52	0.94
Jul	4	0	3.93	0.97	4	0	4.19	0.47
Aug	4	0	7.27	0.66	4	0	8.63	0.50
Sep	5	0	6.13	0.58	5	0	6.90	0.57
Oct	4	0	6.85	0.32	4	0	4.32	0.4[illegible]
Nov	4	0	9.04	0.40	4	0	3.80	0.79
Dec	5	0	13.75	0.79	5	0	4.47	0.41

1971 Summary

	U + Pu X 10⁻⁹ μCi/ml						Plutonium X 10⁻⁹ μCi/ml					
	No Samples		Concentrations			Percent of	No. Samples		Concentrations			Percent of
	Taken	<Det	Min	Max	Avg.	Standard[1]	Taken	<Det	Min.	Max	Avg	Standard[2]
Pond A	26	0	1.33	17.62	7.28	0.11	26	0	0.04	2.76	0.68	0.04
Pond C	26	0	1.06	23.64	6.14	0.09	26	0	0.06	2.40	0.57	0.03

[1] Gross alpha standard is $\frac{C_U}{MPC_U} + \frac{CPu}{MPC_{Pu}} < 1$ Where $MPC_U = 10{,}000 \times 10^{-9}$ μCi/ml, $MPC_{Pu} = 1667 \times 10^{-9}$ μCi/ml

[2] The plutonium standard is 1667 X 10⁻⁹ μCi/mL.

(A) Radioactivity in Holding Ponds and Effluent Waste Waters

4 Walnut Creek at Indiana Water Samples (Rocky Flats Effluent Water Course)

Concentrations (X 10⁻⁹ μCi/ml)

	U + Pu				Pu				Am			
Sample	Number	Concentrations			Number	Concentrations			Number	Concentrations		
Period	Samples	Min	Max	Avg.	Samples	Min	Max	Avg.	Samples	Min	Max	Avg
January	3	2.85	19.71	11.93	3	1.10	2.68	1.69	1	0.73	0.73	0.73
February	4	13.69	30.06	19.30	4	0.86	8.47	4.36	3	0.68	1.40	1.25
March	5	4.76	11.53	8.74	5	1.36	3.33	2.52	5	0.18	4.39	1.9[illegible]
April	4	6.32	13.68	11.18	4	1.14	3.10	2.09	4	0.01	2.68	0.93
May	4	7.15	12.43	9.91	4	0.67	6.59	2.68	2	0.40	0.47	0.44
June	4	6.40	11.43	9.12	4	1.28	2.37	2.04	2	0.30	1.25	0.57
July	4	3.87	29.54	11.67	4	1.54	3.61	2.56	2	0.41	0.80	0.60
August	5	3.73	36.58	13.16	5	1.03	3.14	1.65	5	0.30	0.68	0.49
September	4	2.18	22.10	9.07	4	0.08	7.99	2.41	4	0.01	0.29	0.14
October	4	3.12	49.34	16.87	4	0.41	2.84	1.96	3	0.21	0.77	0.[illegible]
November	5	3.97	6.87	5.85	5	0.67	3.80	1.64	0	–	–	–
December	3	5.77	12.81	8.96	3	0.83	1.33	1.03	0	–	–	–

Yearly Summary

	U + Pu				Pu				Am			
Sample	Number	Concentrations			Number	Concentrations			Number	Concentrations		
Period	Samples	Min	Max	Avg.	Samples	Min.	Max	Avg	Samples	Min	Max	Avg
Jan Jun	24	2.85	30.06	12.23	24	0.67	8.47	2.56	19	0.01	4.39	1.11
Jul Dec	25	2.18	49.34	10.90	25	0.41	7.99	0.96	14	0.01	0.80	0.42
Summary	49 (0)	2.18	49.34	11.55	49 (0)	0.41	8.47	2.56	33 (2)	0.01	4.39	0.83

( ) Denotes less than detection limits.

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Table VIII Water Surveys (continued)

(A) Radioactivity in Holding Ponds and Effluent Waste Waters (continued)

4 Walnut Creek at Indiana Water Samples (Rocky Flats Effluent Water Course) (continued)

Yearly Summation

Concentrations (X 10 ^{9} μCi/ml)

U + Pu			Pu				Am			
Concentrations		% of	Concentrations			% of	Concentrations			% of
Max	Avg	Standard[1]	Min	Max	Avg	Standard[2]	Min	Max	Avg	Standard[3]
49 34	11 55	0 24	0 41	8 47	2 56	0 15	0 01	4 39	0 80	0 06

[1] $\frac{C_U}{MPC_U} + \frac{C_{Pu}}{MPC_{Pu}} < 1$ where $MPC_U = 10\,000 \times 10^{9}$ μCi/ml and $MPC_{Pu} = 1\,667 \times 10^{9}$ μCi/ml

[2] Based on the soluble ^{239}Pu in water standard of 1667 X 10 ^{9} μCi/ml

[3] Based on the soluble ^{241}Am in water standard of 1333 X 10 ^{9} μCi/ml

(B) Radioactivity in Reservoirs and Tap Water Samples

1 Reservoir Water Samples

Concentrations (X 10 ^{9} μCi/ml)

January – June 1971

	U + Pu			Pu			Am		
	Number Samples	Concentrations		Number Samples	Concentrations		Number Samples	Concentrations	
Location	Taken	Max	Avg	Taken	Max	Avg	Taken	Max	Avg
Baseline Reservoir	12	6 06	3 25	11	1 68	0 33	–	–	–
Great Western Reservoir	12	6 29	3 12	10	0 64	0 14	4	1 13	0 60
Ralston Reservoir	12	28 79	20 50	10	0 04	UD	–	–	–
Standley Reservoir	12	17 44	5 22	9	0 95	0 30	1	0 10	0 10

July – December 1971

	U + Pu			Pu				Am		
	Number Samples			Number Samples				Number Samples		
Location	Taken	Max	Avg	Taken	<Det	Max	Avg	Taken	Max	Avg
Baseline Reservoir	7	6 92	3 63	7	2	0 46	0 11	–	–	–
Great Western Reservoir	9	16 06	2 97	10	1	0 82	0 27	5	0 46	0 13
Ralston Reservoir	11	22 04	10 79	8	5	0 24	0 03	–	–	–
Standley Reservoir	10	5 16	3 22	10	4	0 24	0 05	3	0 12	[illegible]

Summation 1971

Concentrations (X 10 ^{9} μCi/ml)

	U + Pu					Pu					Am			
	No Samples				% of	No Samples				% of	Number			% of
Reservoir	Taken	<Det	Max	Avg	Std[1]	Taken	<Det	Max	Avg	Std[2]	Samples	Max	Avg	Std[3]
Baseline	19	0	6 92	3 39	0 05	18	2	1 68	0 25	0 02	–	–	–	–
Great Western	21	0	16 06	3 05	0 04	20	3	0 82	0 24	0 01	9	1 13	0 35	0 06
Ralston	23	0	28 79	15 62	0 15	18	15	0 24	0 04	0 002	–	–	–	–
Standley	22	0	17 44	3 44	0 04	19	4	0 95	0 16	0 01	4	0 12	0 06	0 0
Summary	85	0	28 79	6 38	0 06	65	24	1 68	0 11	0 01	13	1 13		

Table VIII Water Surveys (continued)

2 Community Tap Water Samples

January – June 1971

Concentrations (X 10 ⁹ μCi/ml)

	U + Pu				Pu			
	Number Samples		Concentrations		Number Samples		Concentrations	
	Taken	<Det	Max	Avg.	Taken	<Det	Max	Avg
Arvada	12	0	16 20	7 64	2	0	0.77	0 45
Boulder	12	0	6.93	2 34	10	2	0 97	0 [illegible]3
Broomfield	12	0	18.58	2 54	6	0	(5 03)	0 98
Denver	12	0	17 19	5 73	11	2	2 79	0 36
Golden	12	0	8.79	3.40	11	4	0 45	0 09
Lafayette	12	0	3.23	1 40	6	1	0 77	0 2[illegible]
Louisville	12	0	2.45	1 24	3	1	0 52	0 [illegible]
Thornton	12	0	17 48	9 29	3	0	0.30	0 18
Westminster	12	0	6.49	2.26	9	0	0 60	0 27

(B) Radioactivity in Reservoirs and Tap Water Samples (continued)

July – December 1971

	U + Pu				Pu			
	Number Samples		Concentrations		Number Samples		Concentrations	
	Taken	<Det	Max	Avg.	Taken	<Det.	Max	Avg
Arvada	11	0	7.02	4.04	7	3	0.49	0 37
Boulder	11	0	8.62	1.67	10	5	0.65	0 18
Broomfield	11	0	9.00	1.97	7	3	0 59	0 18
Denver	11	0	5.77	2 85	9	5	0 46	0 13
Golden	11	0	9.76	2 91	7	2	0 47	0 26
Lafayette	9	0	4 19	1 35	7	3	0 82	0 43
Louisville	10	0	4 82	1 64	6	1	0.39	0 15
Thornton	10	0	8.31	5 12	7	3	0.45	0 17
Westminster	10	0	4 95	1 74	6	1	0 53	0 2[illegible]

1971 Summary

	U + Pu					Pu				
	No Samples		Concentrations		% of	No. Samples		Concentrations		% of
	Taken	<Det	Max	Avg.	Standard[1]	Taken	<Det	Max	Avg	Standard
Arvada	23	0	16 20	5 92	0 07	9	3	0 77	0 13	0 0[illegible]
Boulder	23	0	8 62	2 02	0 03	20	7	0.97	0 15	0 01
Broomfield	23	0	18.58	2 27	0 04	13	3	(5 03)	0 42	0 03
Denver	23	0	17 19	4 35	0 05	20	7	2 79	0 18	0 01
Golden	23	0	9 76	3 17	0 04	18	6	0.46	0 12	0 01
Lafayette	21	0	4 19	1 38	0 03	13	4	0 82	0 25	0 02
Louisville	22	0	4.82	1 42	0 02	9	2	0 52	0 16	0 0[illegible]
Thornton	22	0	17 48	7 39	0 08	10	3	0 46	0 12	0 01
Westminster	22	0	6 49	2 02	0 03	15	1	0.60	0 25	0 0[illegible]
Summary	202	0	18.58	3 33	0 04	127	36	(5.03)	0 19	0 01

( ) Denotes suspect data

[1] The standard for a mixture of soluble U + Pu in water is $\frac{C_U}{MPC_U} + \frac{C_{Pu}}{MPC_{Pu}} = <1$ where $MPC_U = 10\,000 \times 10^{-9}$ μCi/ml and $MPC_{Pu} = 1.667 \times 10^{-9}$ μCi/ml

[2] The standard for soluble ^{239}Pu in water is 1667 X 10 ⁻⁹ μCi/ml

[3] Based on soluble ^{241}Am (in water) standard of 1333 X 10 ⁻⁹ μCi/ml

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Table VIII Water Surveys (continued)

(C) Semiannual Water Collection (Summary 1971)

Concentrations X 10^{-9} μCi/ml

Location	No Samples	U + Pu Concentrations Min	Max	Avg.	% of Standard[1]	No Samples	Pu Concentrations Min	Max	Avg	% of Standard[2]
<5 Miles	14	0 55	16 34	3 32	0 06	13	0 05	2 76	0 41	0 02
>5 Miles	16	1 09	34 40	5 85	0 07	16	0 08	0 92	0 25	0 01
Summary	30	0 55	34 40	4 70	0 06	29	0 05	2 76	0 32	0 0[illegible]

[1] The standard for a soluble mixture of U + Pu in water is $\frac{C_U}{MPC_U} + \frac{C_{Pu}}{MPC_{Pu}} < 1$ Where MPC_U is 10 000 X 10^{-9} μCi/ml and MPC_{Pu} is 1 667 X 10^{-9} μCi/ml

[2] The standard for soluble ^{239}Pu in water is 1 677 X 10^{-9} μCi/ml

(D) Chemical Concentrations in Holding Ponds and Effluent Waste Waters

1 Pond B-4

Sample Period	Number Samples	Range of pH	Average Concentration (mg/l) NO_3	PO_4 [3]	F	BOD_5	DO	Total Solids	Cr^{6}
January	20	7 3-8 0	16 7	10 9	0 5	5 4	26 3	400	<0 005
February	20	7 4 7 6	6 2	9 2	0 4	9 9	10 8	(681)	<0 005
March	22	7 2 7 9	9 4	6 3	0 4	4 5	10 8	406	<0 005
April	19	7 2 7 8	8 4	4 3	0 4	6 4	11 0	392	<0 005
May	19	7 6 8 4	5 5	12 5	0 4	5 8	9 9	456	<0 005
June	22	7 7 8 5	3 8	13 3	0 5	7 3	10 3	3[illegible]8	<0 0[illegible]
Summary	122	7 2 8 4	8 3	9 4	0 4	6 6	13 2	450	<0 0[illegible]5
July	21	7 2 8 2	3 4	8 9	0 4	NA	4 4	NA	<0 005
August	22	7 1 9 6	4 1	7 9	0 4	8 2	4 4	NA	<0 005
September	21	7 2 7 9	3 6	15 4	0 4	7 9	5 3	60	<0 0[illegible]
October	21	7 1 8 1	7 2	20 7	0 4	6 7	6 2	309	<0 0[illegible]
November	20	7 2 7 7	7 1	22 6	0 7	4 2	8 8	393	<0 0[illegible]
December	21	7 2 7 8	4 9	17 2	0 4	6 0	9 2	332	<0 005
Summary	126	7 1 9 6	5 1	15 4	0 4	6 6	6 4	324	<0 005

***Dissolved oxygen

1971 Summary

	Average Concentration (mg/l)								
Jan Jun	122	7 2 8 4	8 3	9 4	0 4	6 6	13 2	450	<0 005
Jul Dec	126	7 1 9 6	5 1	15 4	0 4	6 6	6 4	324	<0 005
Summary	248	7 1 9 6	6 7	12 4	0 4	6 6	9 8	392	<0 005
Applicable Std	–	6 5 8 5	<45 0	–	<1 2	<30 0	>6	<500	<0 050
% of Std	–	–	14 9	–	28 6	22 0	38 8	78 4	<10

2 Elemental Analyses (Pond B-4)

Concentrations mg/l

	Number Samples	As	Ba	Be	Cd	Cr	Pb	Mn
Yearly Summary	10	0 02	0 005	0 0004	0 005	0 03	0 00[illegible]	0 006
Applicable Std	(2)	0 05	1 00	–	0 01	1 00	0 05	0 05
% Std	–	40	0 05	–	50	3 0	4 0	12

Run in compliance with State guidelines instead of Sodium Adsorption Ratio

These are not standards relating to the safety of the water but are suggested maximums relating to consumer acceptance thereof

NOTE Cyanide and selenium are not currently run by Rocky Flats Health Physics Department Historically we have depended on the guidance of the Colorado Department of Health Water Pollution Control Commission for the analysis Since basis for limits for these analyses however they will be performed in the future as a means of further protection and compliance with both the spirit and the letter of the law

The 196 Drinking Water Standards of the U S Public Health Service call for semiannual analysis of these parameter

Table VIII Water Surveys (continued)

(F) Chemical Concentrations in Holding Ponds and Effluent Waste Waters

1 Pond Grab Water Samples

Monthly Averages (mg/l)

	Pond A						Pond C					
	pH	NO_3	PO_4^{-3}	F^-	Total Solids	Cr^{+6}	pH	NO_3	PO_4^{-3}	F	Total Solids	Cr^{+6}
January	7 8	11 1	0 6	0.4	173	<0 005	7 8	0.5	0 6	0 4	243	<0 005
February	7 6	13 7	1 1	0.4	101	<0.005	7 7	0.9	1 3	0 4	212	<0 005
March	7 5	19 6	0.6	0 4	164	<0.005	7.5	0.4	0 6	0 4	205	<0 005
April	7 8	29 7	0 7	0 4	183	<0 005	7 5	0.4	0 6	0 4	249	<0 005
May	7 9	85 0	0 6	0 4	393	<0 005	8 0	0.3	0.6	0 4	272	<0 005
June	8 0	20 1	0 6	0 4	233	<0 005	7 8	0.3	0.6	0.4	188	<0 005
Summary	7 8	29 9	07	0.4	208	<0 005	7 7	0.5	0.7	0.4	228	<0 005
July	7 8	23 0	0.6	0 3	*NA	<0 005	7 8	0.3	0.6	0 3	NA	<0 005
August	9.2	23 4	0 6	0 4	NA	<0.005	8.4	0.6	0 6	0 4	NA	<0 005
September	8.5	36.3	0 6	0 4	300	<0.005	8 5	1.2	0.6	0.3	175	<0 005
October	7 6	52 9	0.4	0.4	384	<0 005	8.2	1.3	0.6	0 4	227	<0 00
November	7 8	58.9	0 6	0.5	429	<0 005	8.1	1.5	0 6	0 8	185	<0 005
December	7 7	78.6	0 6	0.4	488	<0.005	7 7	0.9	0.6	0 4	194	<0 005
Summary	8.1	45 5	0.6	0.4	267	<0 005	8.1	1.0	0 6	0 4	195	<0 005

*NA is no analysis.

2. Yearly Summary – Pond A

Elemental Analyses	Number Samples	As	Ba	Be	Cd	Cu	Pb	Mn	NA
(Yearly Summary)	10	0.01	0.01	0.0005	0.005	0.01	0.001	0 01	21 3
Applicable Std	(2)	0.05	1 00	–	0.01	1.00**	0.05	0 05*	–
% of Standard	–	20%	1%	–	50%	1.0%	2%	20%	–

3. Yearly Summary – Pond C

(Yearly Summary)	10	0.01	0 01	0.0002	0.006	0.01	0.01	0 002	17 6
Applicable Std	(2)	0 05	1.00	–	0.01	1.00**	0 05	0.05	–
% of Standard	–	20%	1%	–	60%	1.0%	20%	4 0%	–

*Run in compliance with State guidelines instead of Sodium Adsorption Ratio.

**These are not standards relating to the safety of the water but are suggested maximums relating to consumer acceptance thereof

NOTE Cyanide and selenium are not currently run by Rocky Flats Health Physics Department Historically we have depended on the guidance of the Colorado Department of Health Water Pollution Control Commission for these analyses Since basic facilities exist for these analyses however they will be performed in the future as a means of further protection and compliance with both the spirit and the letter of the law

Table IX. Sediment Samples Yearly Summary

Concentrations (X 10 ^{6} μCi/gram)*

	Location	No Samples	Maximum	Average
A	Pond A	4	26.06	17 53
	Pond B-1	3	641 67	246 32
	Pond B-2	3	385 53	199 00
	Bond B-3	3	174 85	67 99
	Pond B-4	3	181 34	65 68
	Pond C	3	8.47	3 36
		Averages	0.385 μCi/gram	0 030 μCi/gram
B	Baseline Reservoir	2	7 03	3 68
	Great Western Reservoir	2	1 87	1 08
	Ralston Reservoir	2	0 65	0 43
	Standley Reservoir	2	0 42	0 57
		Averages	0 007 μCi/gram	0.0007 μCi/gram

*Samples Dry depth 4 centimeters

A = Controlled Area B = Outside Controlled Area

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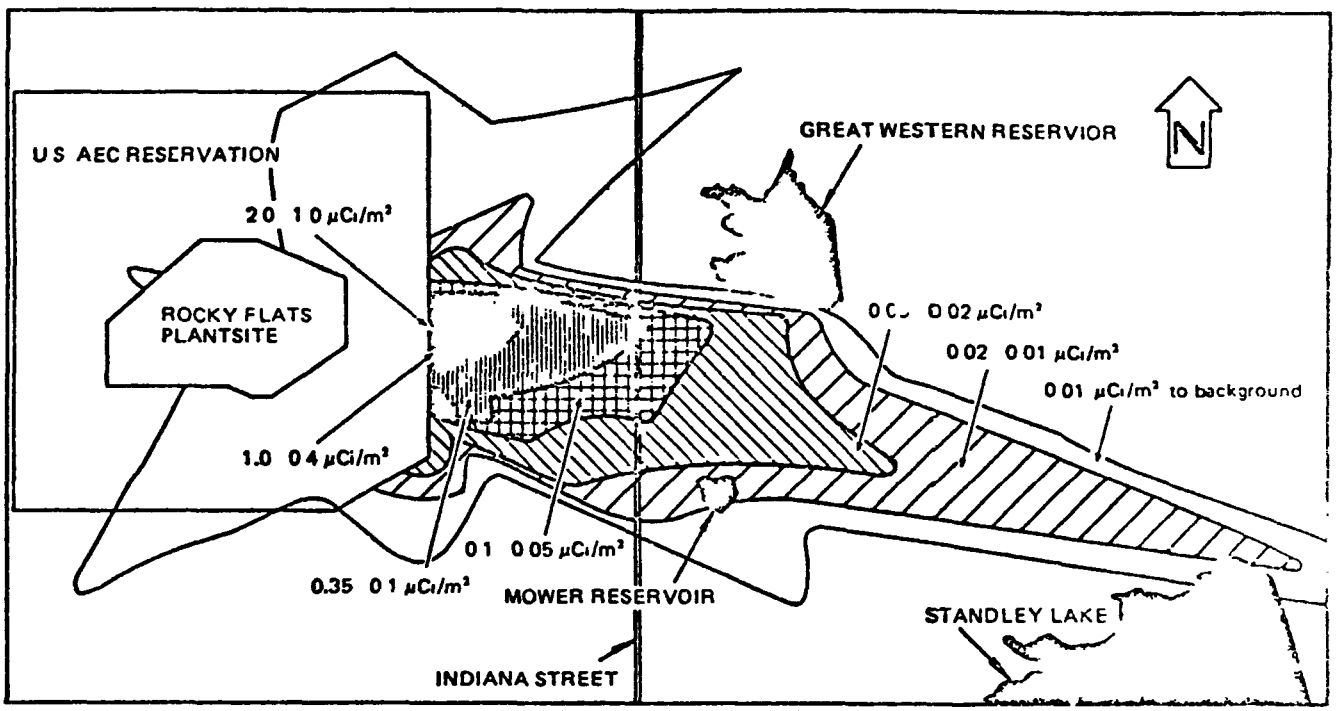


Table X. Surface Soil Analysis off site contours

NOTE These contours were empirically derived by means of a computer curve fitting program using the method of least squares This results in a mathematical express on for grid sectors giving the activity of the plutonium in the soil as a function of radial distance from the on site barrel storage area Three hundred for y two soil samples were used in generating these contours Eighteen samples were taken by the Colorado Committee on Environmental Information 18 by U S AEC Health and Safety Laboratory 306 by the Rocky Flats Health Physics Department The values assume a soil density of 1 g/cm³ at a depth of one centimeter

Table XI Vegetation Samples 1971

Concentrations (X 10^{-6} μCi/gram Dry)

	June 1971				September 1971			
	No Sampl s		Concen'rations		No Samples		Concentr t s	
	Taken	<D t	Max	Avg	Taken	<Det	Max	A g
<1 Mile	1[illegible]	5	0 00130	0 00009	14	4	0 00016	0 0[illegible]003
1 5 Miles	42	3	0 00254	0 00018	44	11	0 00013	0 0000[illegible]
>5 Miles	23	5	0 000 5	0 00004	24	10	0 00017	0 0[illegible]
Summary	77	13	0 00254	0 00005	82	25	0 00039	0 00[illegible]

VI Summary and Conclusions

The principal protection for our environment must be provided at the very source of potential degradation and/or potential pollution No program can replace adequate controls at the source any environmental program is after the fact

Environmental Protection Must Be At Source

This is especially true for radioactive isotopes. Rocky Flats is working toward total containment of radioactive materials The data contained in this report are the result of the controls employed at this plant site and do not in any way describe those complex controls in themselves That these controls are effective can be seen by comparing releases with those established standards over the applicable time periods

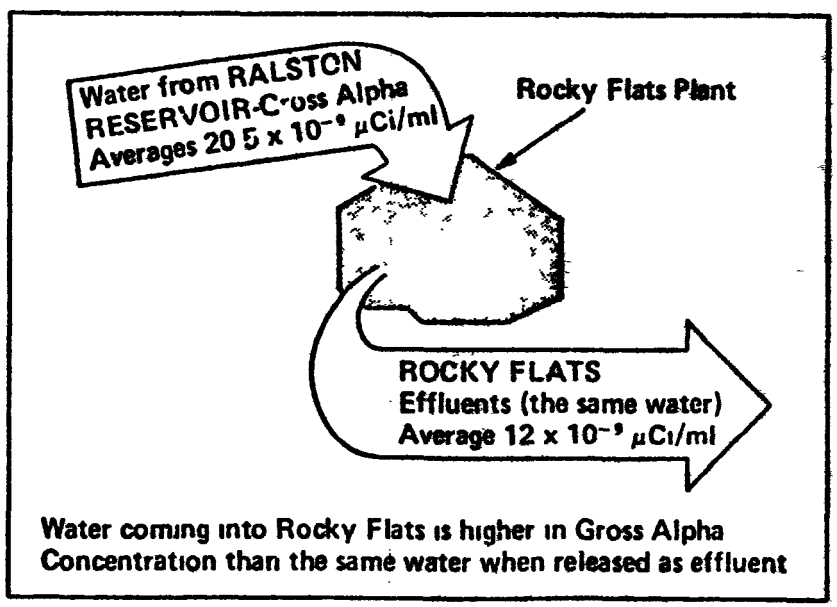
Rocky Flats Working Toward Total Containment of Radioactive Material

Data are not meaningful without a frame of reference It is appropriate to provide some background information to better understand this report

Frame of Reference for Data

The State of Colorado and the immediate environs of Rocky Flats are most interesting from a radiological point of view For example water taken from wells in Maine has about 3000 times the natural radioactivity as that taken from the Potomac River near Washington D C But even that level is low when compared with water taken from wells near Boulder (or, for that matter Joachimsthal Czechoslovokia) where natural radioactivity concentrations are 10 000 times that amount [16] Rocky Flats receives its water from Ralston Reservoir near Golden Background radiation surveys indicate that this water is higher in gross alpha content when it enters the plant than when it is released as effluent after being used to process radioactive materials

Water From Wells Near Boulder Has 10,000 Times Natural Radioactivity as Water From Potomac Near Washington D C



Water coming into Rocky Flats is higher in Gross Alpha Concentration than the same water when released as effluent

Residents of Colorado receive an annual cosmic ray dose of about 120 millirem about three times that received by the average resident of California (40 mrem) and about twice th ar nual gamma ray dosage from naturally occurring errestrial radioactivity [4] In fact a 1971 survey released by the EPA showed that Colorado has the highest natural rad ation levels in the U S

1971 EPA Survey Shows Colorado Has Highest Na ral Radiation Level in U.S

It is well known that the contribution of man made radiation (other than medical) to the total population dose has been only a small fraction of the contribution from background radiation in fact it is even smaller than the natural fluctuations in that background [6] Even this background level of about 130 mrem per person per year (about twice that high in Colorado) has not shown any adverse effects on man

Man-Made Radiation Contribution To Total Population Dose is Even Less Than Natural Fluctuations in Natural Background Level

Studies to date indicate that radiation at or below occupational levels (at least ten times higher than standards for the general populace) has not been shown to be harmful Comparisons between about 35 000 workers who received approximately 50 000 000 mrem over 25 years and the general population show that the radiation workers had a 25% lower leukemia rate a 42% lower malignant death rate and a 46% lower death rate from all causes in each male and female age group The conclusion to this study was "All one can deduce from these various studies is that there is no indication of any health hazards to any employed [17]

Radiation Levels at Least 10 Times Higher Than General Population Standards Has Not Been Harmful Exposure to Ten Times General Population Standards Showed Lower Leukemia Rate Malignant Death Rate and Total Death Rate Than General Population

More specifically the average annual death rate due to cancer in the U S is 130 deaths per 100 000 people [18] The average annual death rate for the employees at Rocky Flats is 52 deaths due to cancer per 100 000 population or less than half that of the general population

Present Data Indicate Rocky Flats Death Rate Due to Cancer Less Than One Half That For General Population

It should be noted that this represents a small statistical sample and the only conclusion that can be drawn is that there is no *evidence* of any adverse effects to the Rocky Flats employees A continuing effort exists to gather more data on all workers in this field Rocky Flats is actively cooperating with the U S Transuranium Registry in this study

There is one important distinction to be made at this point The terms pollution and contamination are often although incorrectly used interchangeably Pollution must be defined as concentrations of foreign material in excess of normal values This concentration in air water soil etc must have an adverse effect on man to be a true pollutant A contaminant is that material not normally found but where present can be attributed to man s activities Environmental contamination while definitely not desirable is still not necessarily pollution unless that contaminant can and does have an adverse effect on man or some other life form

Contamination vs Pollution

Following a fire at Rocky Flats in May 1969 intensified soil and monitoring surveys disclosed some soil contamination in the vicinity of the plant site primarily to the east of the perimeter fence Subsequent investigations indicated that no measurable radioactive contamination had escaped from the buildings involved in that fire and that the primary source of contamination had come from waste drums of contaminated oil stored near the east fence Since it is felt that some resuspension of this material is inevitable even though the most affected area is now covered with a thick asphalt pad steps have been taken to reduce this possibility to an absolute minimum

No Measurable Radioactive Contamination Released in 1969 Fire

Soil Contamination

The affected areas are under constant surveillance The contours in Table X have been empirically derived using the best data available from all sources i e the U S AEC Health and Safety Laboratory and the Colorado Committee for Environmental Information as well as the surveillance activities of the Rocky Flats Health Physics Department

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Rocky Flats is committed to a soil sampling program This program requires that samples be taken at a minimum of 6 months At the present time however soil samples are being taken more frequently Constant evaluation of the data thus generated shows no significant change in the contours

Dustfall samples taken from the surrounding area may well represent some of this contaminated material that has been resuspended Wind in the vicinity of Rocky Flats could deposit very small quantities of this material in the Boulder Golden Marshall, and Coal Creek areas Dustfall sampling in these areas indicate that this may very well be the case There are however other factors that might be creating anomalies as great as or even greater than any contribution from Rocky Flats Wind currents, sweeping down through Boulder and Coal Creek Canyons and along the Front Range could be depositing greater than to be expected concentrations of materials associated with world wide fallout* in these areas. *It Must Be Emphasized that these Concentrations Even Including Any Contributions from Rocky Flats Are Still on the Same Order of Magnitude as that to Be Expected from World Wide Fallout* [14] *and as such Provide no Known Health and/or Safety Hazard to the Public.* There is probably a very real contribution from Rocky Flats This contribution is so low as to provide no significant exposure risk to the population in the area Ways of reducing this contribution are however under intensive study

Dustfall Samples Even Including Rocky Flats Contribution (If Any) Still Same Order of Magnitude As World Wide Fallout — No Known Health and/or Safety Hazard to the Public.

The Water Quality Office of the Environmental Protection Agency conducted their own independent study of the environment and especially the water courses and effluents from and around Rocky Flats. The conclusion stated in that report[20] was as follows

WQO of EPA Studied Rocky Flats and made Conclusion.

> "Monitoring data do not indicate any public health hazard associated with the routine discharge of radioactive wastes to Walnut Creek There has been no measurable degradation of (Rocky Flats) plant origin in the radiological water quality of Great Western Reservoir the source of public supply for the City of Broomfield This reflects the general adequacy of the liquid waste management program carried on at the Rocky Flats Plant In this respect additional abatement requirements are not indicated at this time

In that report the EPA did however make some recommendations Those recommendations and the response to them are included as Appendix A to this report

Total plutonium releases during 1971 by both stack effluent discharge and effluent water release were a total of 0.975 millicuries (0 016 grams)

Total Plutonium Releases During 1971 were 0 975 mCi (0.016 grams)

Total uranium releases which include relatively high concentrations of naturally occurring isotopes were about 5 millicuries Total beryllium released during the entire year was about 17 grams

Total Uranium Releases (Including Naturally Occurring Isotope) About 5mCi Total Beryllium About 17 grams

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Fallout is actually the radioactive debris from nuclear weapons tests conducted in the atmosphere It essentially consists of fission products unexpended fissile material such as plutonium and uranium and activation products These radioactive products vaporized and blown into the atmosphere by the tremendous force of the explosion condense to form particulate matter that whenest finally falls to the earth is called fallout Fission products from nuclear explosions have been in the atmosphere for more than 25 years The lifetimes of the various radioactive materials in fallout can range from fractions of a second to many years and thus make actual empirical measurement quite complex [19]

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Plutonium stack effluent releases from Rocky Flats have on a single sample or single month maximum basis exceeded both recommended guidelines and especially internal plant goals for limiting effluent concentrations The same is true although less frequently for beryllium and uranium releases Although insignificant in terms of the yearly average concentrations methods to limit and control these releases are being studied

Beryllium and Uranium Releases Have Exceeded Guidelines on Single Sample but not Applicable Average Basis

The primary reason for these higher than ordinary releases has been the system employed in changing filters in the exhaust plenums of process buildings The time interval and the physical implementation of better techniques for these filter changes is under intensive study

Studies Under Way on Filter Changes to Better Limit Extraordinary Releases

The material contained in this report has been released on a monthly basis to the Colorado Department of Health and the regional office of the EPA. In addition the state agency maintains its own survey and monitoring procedures

Material Contained in This Report Released monthly to Colorado Department of Health and Regional EPA Office

Analyses of over 50 000 samples have shown the ambient levels of radioactivity in effluents from Rocky Flats to be below even the most restrictive standards available Rocky Flats personnel are continually striving to reduce these levels even further by providing valuable technological and innovative advances in the field of nuclear materials control and safeguards The Health Physics Department has recently been administratively joined with the research function to create a totally new group concept that of Health Physics Research and Ecology We hope this will lead to even better communications of advances and pertinent information to the public at large as well as to the scientific community The goal of this and every other group at Rocky Flats as well as the nuclear industry as a whole must be to reduce radiation releases even lower than the current insignificant levels As technology in the field has increased emissions have gone down and this trend will continue

Over 50 000 Environmental Samples Analyzed Rocky Flats Effluents Below Standards

Health Physics Joined with Research New Group Health Physics Research and Ecology

As a pioneer in the field of nuclear materials Rocky Flats will have a valuable part to play in this essential transition by providing experience and information And as more and more knowledge is gained in the field Rocky Flats will be able to take advantage of a wider range of technology to better protect its own environs

Rocky Flats is Pioneer in Nuclear Materials

Increased Technology will Help Rocky Flats Reduce Emissions Even Further

Rocky Flats has an essential part to play in the defense of this country and of our way of life It has an equally important part to play as an integral part of the business and industrial community of Colorado and as a good neighbor to the people in the area

Rocky Flats Impact

In summation then while Rocky Flats has met and mostly surpassed its goals for maintaining radioactive effluent emissions below the most restrictive standards available to do even better is the implicit goal of the entire operation

Rocky Flats Goal To Do Even Better

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VIII Appendix A

Recommendations of the Environmental Protection Agency Water Quality Office Report on Rocky Flats April 1 1971 and response to those recommendations

Recommendation 1

Routine analysis of suspended vs dissolved radioactive materials in the water samples from effluent to Walnut Creek and Great Western Reservoir

Response

We are in the process of studying the nature of the plutonium found in our effluent and the nature of the plutonium found in the ponds Our initial studies (in conjunction with CSU) indicate that much of the plutonium becomes incorporated with the algae At this point we have not been able to determine if it is a physical incorporation or a biochemical mechanism Algae vary in size over a wide range It is difficult to ascertain how much is truly in solution versus very small undissolved suspended particles of plutonium dioxide incorporated into small suspended algae By using different size filters one would obtain different answers The total amount of plutonium found is very small As we learn more about the nature of the plutonium carried in the effluent water we will be in a much better position to understand any potential value which could be derived from separate routine analysis of suspended and dissolved plutonium differentiated from routine analysis of the total plutonium found in the water sample We will continue to study this and keep the Water Quality Office of the EPA informed of our progress and findings

Recommendation 2

In addition to gross alpha activity determinations specific analyses should be conducted for plutonium 239 and uranium

Response

Specific analyses for plutonium 239 and uranium are being completed This change was effective January 1970

Recommendation 3

At least annually preferably semi annually levels of plutonium in the various trophic levels of the aquatic populations inhabiting Great Western Reservoir and Standley Lake should be determined

Response

This recommendation requires an extensive full scale research project The first phase of this project has been initiated in conjunction with Colorado State University Phase One relates to the settling ponds on the plant site After the results of the first phase are interpreted we will proceed with studies on the various trophic levels of the aquatic populations inhabiting Great Western Reservoir and Standley Lake We intend to continue our program with Colorado State University and also conduct more in house studies on the aquatic systems of interest Perhaps after the research programs are finished we can develop some type of routine (annual or semi annual) measurement on the various trophic levels in the aquatic system We will keep the Water Quality Office of the EPA informed of our progress on these research programs

Recommendation 4

Semi-annual monitoring reports should be expanded to include data on effluent flow and radioactivity concentrations in the effluent to the south fork of Walnut Creek. Sufficient data should be presented to permit the calculation of at least the monthly amounts (curies) of plutonium and uranium (suspended and dissolved) discharged to the creek

Response

With the exception of separating suspended from dissolved activity (being studied) these types of data are being incorporated into monthly reports furnished the Colorado Department of Health They are being included in semi-annual reports, copies of which are being forwarded to the EPA.

024777

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April 11 1973

ERRATA Annual Report Environmental Safeguard 1971, dated 4/11/73
18 pages

ERRATA
ANNUAL REPORT. ENVIRONMENTAL SAFEGUARD '71

Health Physics Research & Ecology

Rocky Flats Division

Dow Chemical U S A

U S ATOMIC ENERGY COMMISSION CONTRACT AT(29 1) 1106

024717

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The Rocky Flats Division annual environmental report (RFP-ENV-71B) Annual Report Environmental Safeguard '71 March 10, 1972, contained several tabular and typographical errors These errors although insignificant in terms of compliance with existing environmental guidelines are inconsistent with the desired high degree of accuracy in reporting environmental surveillance activities

The following represents pages 15 through 31 of RFP ENV 71B as corrected. The entire tabular summation of that report is herein reproduced including data correct as stated and corrections where necessary. The noted corrections are the result of a complete recomputation of totals, averages, percent of standards and summations

The accompanying changes in the text are also included

024718

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ERRATA ANNUAL REPORT ENVIRONMENTAL SAFEGUARD 71 RFP ENV 71B

Textual Corrections (change to read as follows)

Page 3 paragraph 5

It must be emphasized that these units express only quantities of isotopes present and not the radiation dose these quantities could produce

Page 4 QRC Index paragraph 1

Basic unit is roentgen based on the ionization produced by x ray and gamma radiation only not directly relatable to other *units* of radiation

Page 6 paragraph 2

Therefore when *materials which emit* alpha particles are inhaled they can stay in one portion of the lung and irradiate one small area of tissue quite heavily

Page 7 QRC Index paragraph 2

Standards for Soluble Pu^{239} in Water

Page 9 Part B

0 05 is incorrectly stated as a Colorado Department of Health A B_1 limit for copper In actuality the suggested limit of the USPHS (1 mg/l) is the only guideline

Section V Tabular Data 1971

Table I Radioactive stack effluent releases

A Long lived alpha releases from plutonium operations
B Yearly summations plutonium operations
C Long lived alpha releases from uranium operations
D Yearly summations uranium operations

Table II Non radioactive stack effluent releases

A Beryllium concentrations
B Yearly summations beryllium concentrations

02 17 9

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Table III Average monthly air sample concentrations on site radioactive

- A Long lived alpha concentrations
- B Yearly summation long lived alpha concentrations.

Table IV Average monthly air sample concentrations off site radioactive

- A Low volume programmed samplers
  - 1 Long lived alpha concentrations
  - 2 Yearly summation, long-lived alpha concentrations
- B High volume off site samplers
  - 1 Plutonium concentrations
  - 2 Yearly summation, off site plutonium concentrations

Table V Special high volume air samples radioactive

- A On site grab samples and summation
- B Off site grab samples and summation

Table VI Average monthly beryllium concentrations in air samples on- and off site

Table VII Dustfall sample summary

Table VIII Water surveys

- A Radioactivity in holding ponds and effluent waste waters
  - 1 Pond B 4
  - 2 Yearly summation
  - 3 Grab samples Ponds A and C
  - 4 Walnut Creek at Indiana
- B Radioactivity in reservoir and tap water samples
  - 1 Reservoir water samples
  - 2 Community tap water samples.
- C Semi annual water collection
- D Chemical concentrations in holding ponds and effluent waste waters.
  - 1 Pond B 4
  - 2 Pond B 4 summary
  - 3 Pond B 4 elemental analyses
- E Chemical concentration in holding ponds and effluent waste waters
  - 1 Grab samples Ponds A and C
  - 2 Yearly summary, Pond A
  - 3 Yearly summary, Pond C

Table IX Sediment samples yearly summary

Table X Surface soil analyses off site contours

Table XI Vegetation samples

Analytical Note For all samples below detection limits a value was assigned This value is a fraction of the detection limit i e the number of samples above the detection limit divided by the total number of samples that were analyzed

Table I Radioactive Stack Effluent Releases 1971

(A) Plutonium Areas Total Long Lived Alpha Releases

Monthly Concentrations ($\times 10^{-12}$ μCi/ml)

Building	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
771	0.005	0.005	0.005	0.015	0.007	0.012	0.007	0.006	0.015	0.012	0.004	0.006
774	0.015	0.010	0.011	0.014	0.060	0.013	0.008	0.008	0.01[illegible]	0.010	0.013	0.01[illegible]
776	0.004	0.095	0.033	0.006	0.018	0.011	0.003	0.003	0.00[illegible]	0.009	0.00	0.0[illegible]
779	0.007	0.002	0.002	0.001	0.002	0.001	0.002	0.002	0.00	0.00	0.00	0.[illegible]
559	0.003	0.001	0.001	0.001	0.003	0.003	0.00[illegible]	0.002	0.002	0.00[illegible]	0.00	0.00
707	0.003	0.002	0.005	0.003	0.005	0.004	0.003	0.004	0.003	0.00[illegible]	0.080	0.0[illegible]4
Total Releases by Month (μCi)	3.1	17.0	8.0	5.9	8.4	5.9	2.8	8	5.0	5.2	7.8	2.6

Applicable Standard (Soluble ^{239}Pu) = 0.06×10^{-12} μCi/ml

(B) Yearly Summary – Plutonium Areas Total Long Lived Alpha Releases

Concentrations ($\times 10^{-12}$ μCi/ml)

	January – June		July – December		Total Year			
					Concentration		% Std	Total
Building	Maximum Concentration (Single Sample)	(Monthly) Average Concentration	Maximum Concentration (Single Sample)	(Monthly) Average Concentration)	Max (Bldg)	Av (Bldg)	(Av Conc)	Release (μCi)
771	0.11	0.008	0.18	0.008	0.18	0.008	13.3	26.00
774	0.75	0.020	0.30	0.011	*0.75	0.016	26.7	6.00
776	24.00	0.028	0.34	0.004	24.00	0.016	26.7	33.00
779	0.31	0.002	0.026	0.002	0.31	0.00[illegible]	3.3	0.50
559	0.039	0.002	0.05	0.002	0.05	0.002	3.3	0.86
707	0.36	0.004	4.1 *	0.016	4.10	0.010	16.7	7.90
	Long Lived Alpha Releases Plutonium Operations Yearly Summation				24.00	0.009	15%	74.[illegible]

The maximum monthly average emission (which occurred during filter changing operations in Building 776 in February) was 0.095×10^{-12} μCi/ml. The maximum single sample emission (24.0×10^{-12} μCi/ml) was from Building 776. It must be noted that these values are taken at the stack BEFORE appropriate atmospheric dilution. The standards apply at the plant perimeter and are in terms of averages of up to one year. The annual average Pu emission from ALL Pu operation was 0.009×10^{-12} μCi/ml, about 15% of the applicable standard (0.06×10^{-12} μCi/ml).

Filter changing operations

Effluents leaking around one stage of filter plenum. Discovered and corrected

(C) Uranium Areas Total Long Lived Alpha Releases

Monthly Average Concentrations ($\times 10^{-12}$ μCi/ml)

Building	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
444	0.009	0.005	0.002	0.002	0.002	0.001	0.00[illegible]	0.002	0.001	0.001	0.017	0.00[illegible]
447	0.071	0.0[illegible]0	0.029	0.033	0.040	0.023	0.002	0.017	0.030	0.0[illegible]8	0.007	0.0[illegible]1
881	0.004	0.017	0.018	0.049	0.005	0.005	0.005	0.006	0.00[illegible]	0.002	0.00	0.00[illegible]
883 (A)	0.010	0.008	0.010	0.012	0.041	0.034	0.008	0.013	0.013	0.010	0.015	0.0[illegible]1
883 (B)	0.010	0.006	0.003	0.004	0.008	0.005	0.003	0.003	0.002	0.002	0.003	0.00
886	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.003
889	0.003	0.002	0.001	0.003	0.002	0.001	0.002	0.00	0.001	0.003	0.00	0.003
865	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
991 T	–	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00[illegible]
Total Release by Month (μCi)	11.0	12.0	9.0	22.0	10.0	7.3	3.0	6.2	4.4	3.2	6.8	3.7

Applicable Standard *** (Soluble ^{234}U) = 3×10^{-12} μCi/ml

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Table I Radioactive Stack Effluent Release 1971 (continued)

(D) Yearly Summary – Uranium Areas Total Long Lived Alpha Releases.

Concentrations (X 10^{-12} μCi/ml)

	January – June		July – December		Total Year			
					Concentration		% Std	Total
Building	Maximum Concentration (Single Sample)	(Monthly) Average Concentration	Maximum Concentration (Single Sample)	(Monthly) Average Concentration	Max. (Bldg)	Av (Bldg)	(Av Conc)	Release (μCi)
444	0 098	0.004	0 10	0 004	0 100	0.004	0 1	10 00
447	0 270	0.044	0 67	0.016	**0.670	0.030	1.0	26 00
881	0 150	0 016	0 018	0.003	0 150	0.010	0.3	35 00
883A	0 110	0 019	0 026	0.012	0.110	0.016	0 5	21 00
883B	0 015	0 006	0.006	0.002	0.015	0.004	0 1	5 70
886	0 013	0 001	0 010	0.002	0.013	0.002	0 1	0 13
889	0 011	0.002	0 011	0.002	0.011	0.002	0 1	0 15
865	0 006	0 001	0.002	0.001	0.006	0.001	0 03	0 97
991 T	0 002	0.001	0.003	0.001	0.003	0.001	0 03	0 03
Long-Lived Alpha Releases, Uranium Operations, Yearly Summation					0.67	0.008	0.3	99 00

*Maximum (monthly average) emission, 0.071 X 10^{-12} μCi/ml occurred during filter changing operations in Building 774 in January
*Maximum (single sample) emission 0 67 X 10^{-12} μCi/ml occurred during filter plenum fan repair in Building 774 in October
***Although Rocky Flats effluents would include several isotopes of uranium the guideline for soluble 238 is the most restrictive in air It must be noted that this standard applies at the plant boundary and is in terms of yearly averages to an individual in the general population The values here all well below that standard are taken at the stack before any atmospheric dilution

NOTE Tables I (A D) and II (B) are simple averages not weighted by fractional MDA concentrations (see note on Page 16)

Table II Non-Radioactive Stack Effluent Releases 1971

(A) Beryllium

Monthly Average Concentrations (X 10^{-6} mg/M³)

Building	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
444-447	2 2	5 1	3.0	2 2	1 8	0 7	15.0	3.0	2 8	1 2	0 2	15 7
883A	1.0	3 2	0 5	0 2	0 2	0 2	0 4	0 2	0 2	0 2	0.2	0 2
779	0 3	0 7	0.3	0 3	0 3	0.3	0 3	0.8	0 2	0.6	3 6	0 6
774	0 8	0 6	0.5	0 5	0 5	0 5	0.5	0.5	0 5	0 5	0 5	0 5
865	0 5	2 0	0.4	0.2	0 5	0 5	0.2	0.2	0 2	1 0	0 2	0 2
Total Monthly Release (grams)	0 82	2 10	1 24	0 70	0 61	0.37	4 49	0.80	0.88	0 51	0 09	4 70

(B) Annual Summary

Beryllium Stack Effluent Releases (X 10^{-6} mg/M³)

	January – June		July – December		Totals for Year			
Building	Maximum Single Sample Concentration	Average Concentration	Maximum Single Sample Concentration	Average Concentration	Max. Conc	Av Conc	% Std	Total Release (g)
444-447	45 0	2 5	209 2	6 2	209 2	4 4	44	16 00
883A	25 2	0 9	1 2	0 2	25 2	0 6	6	0 68
779	5 1	0 4	21.0	1 0	21.0	0 7	7	0 03
774	2 4	0 6	0.6	0 5	2 4	0 6	6	0 07
865	9 8	0 7	7.0	0 3	9 8	0.5	5	0 80
Total Beryllium Operations, Yearly Summation					209 2	1 4	14 0	18 0

Applicable Standard is 10 X 10^{-6} mg/M³ (Division Internal Goal is 5 X 10^{-6} mg/M³)

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Table III Average Monthly Air Sample Concentrations On Site Radioactive

(A) Total Long Lived Alpha Concentrations (U Pu and naturally occurring alpha emitters)

Monthly Average Concentrations (X 10 ^{12} μCi/ml)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S 1	0 0044	0 0033	0 0045	0 0036	0 0057	0 0047	0 0033	0 0040	0 0045	0 0049	0 0035	0 0035
S 2	0 0045	0 0044	0 0039	0 0046	0 0046	0 0025	0 0025	0 0049	0 0031	0 0044	0 0040	0 0044
S 3	0 0033	0 0028	0 0033	0 0059	0 0052	0 0043	0 0055	0 0066	0 0070	0 0052	0 0050	0 0039
S-4	0 0070	0 0044	0 0047	0 0066	0 0042	0 0036	0 0046	0 0041	0 0035	0 0034	0 0034	0 0037
S 5	0 0017	0 0040	0 003	0 0036	0 0047	0 0054	0 0053	0 0026	0 0034	0 0058	0 0069	0 0033
S 6	0 0031	0 0030	0 0028	0 0037	0 0052	0 0030	0 0146	0 0020	0 0032	0 0029	0 0068	0 00
S-7	0 0082	0 0066	0 0054	0 0082	0 0043	0 0043	0 0027	0 0034	0 0022	0 0034	0 0017	0 0043
S 8	0 00 8	0 0069	0 0078	0 0322	0 0090	0 0081	0 0105	0 0110	0 0056	0 0128	0 0114	0 00 6
S-9	0 0043	0 0040	0 0041	0 0039	0 0036	0 0038	0 0044	0 0036	0 0026	0 0027	0 0013	0 0035
S 10	0 0046	0 0052	0 0041	0 0060	0 0042	0 0056	0 0034	0 0030	0 0040	0 0063	0 0041	0 0035
S 50	0 0042	0 0026	0 0041	0 0085	0 0048	0 0071	0 0053	0 0086	0 0061	0 0076	0 0064	0 0033
S 51	0 0044	0 0051	0 0036	0 0066	0 0046	0 0033	0 0025	0 0020	0 0041	0 0054	0 0044	0 0052

Applicable Standard (Soluble Plutonium 239) = 0 02 x 10 ^{12} μCi ml

(B) Summary Total Long Lived Alpha On Site 1971

Concentration (X 10 ^{12} μCi/ml)

Location	No of Samples	<Det	C_{Max}	C_{Avg}	% of Std
S 1	242	125	0 0218	0 0042	21 0
S 2	239	140	0 0420	0 0040	20 0
S 3	244	124	0 0218	0 0048	24 0
S-4	243	142	0 0333	0 0039	19 5
S 5	244	132	0 0228	0 0041	20 5
S 6	244	161	0 2723	0 0043	21 5
S 7	244	136	0 0822	0 0045	22 5
S 8	243	81	0 5653	0 010	51 5
S 9	242	147	0 0210	0 0035	17 5
S 10	237	125	0 0228	0 0045	22 5
S 50	243	120	0 1436	0 0057	28 5
S 51	244	135	0 0341	0 0043	21 5
Yearly Summation	2909	1568	0 565		
Total Averages				0 0048	24 0

This sampler (S-8) is located within the strongest most frequent wind vector and is adjacent to the asphalt pad covering some contaminated soil The large volumes of dirt thus seen by this sampler may be indicative of resuspension mechanisms It is worthy of note that the highest concentration location is still only about 50% of the applicable standard when stated in terms of yearly averages

NOTE For averaging purposes all samples below minimum detectable amounts (MDA) were assigned a fractional value (No of samples > MDA divided by total No analyses) of the appropriate MDA

Table IV Average Monthly Air Sample Concentrations Off Site Radioactive

(A) Low Volume Programmed Samplers

1 Total Long Lived Alpha Concentrations 1971 (U Pu and naturally occurring alpha emitters)

Monthly Average Concentrations (X 10 ^{12} μCi/ml)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boulder (S 15)	0 0040	0 0041	0 0005	0 0059	0 0072	0 0061	0 0035	0 0083	0 0060	0 0067	0 0067	0 0039
Broomfield (S 17)	0 0032	0 0067	0 0056	0 0051	0 0030	0 00 8	0 0004	0 00 4	0 0034	0 0001	0 0031	0 0035
Coal Creek (S 11)	0 0001	0 0040	0 0072	0 0056	0 00 5	0 0035	UD	UD	0 0002	0 0074	0 00 7	0 00 1
Denver (S 23)	0 00 0	0 0013	0 0089	0 0050	0 0037	0 0048	0 0025	0 00	0 0056	0 0013	0 0035	0 00 5
Golden (S 20)	0 0031	0 00 0	0 0054	0 0057	0 0057	UD	UD	0 0003	0 0108	0 0038	0 00 1	0 0015
Lafayette (S 16)	0 0073	0 007	0 0064	0 0085	0 0057	0 005	0 0030	0 00-	0 0079	0 0030	0 0021	0 0067
Marshall (S 13)	0 0043	0 00 1	UD	UD	0 00 0	0 0003	0 00 0	0 003	0 0038	0 0015	UD	0 0
Wagner (S 18)	0 00 6	UD	0 00 9	0 0083	0 009	0 0123	0 0063	0 00 1	0 0055	0 00 9	0 00 7	0 0050
Westminster (S 25)	0 00 7	0 0001	0 00 7	0 0067	0 0002	0 0073	0 0049	0 005-	0 0014	0 0050	0 0026	0 006

Applicable Standard (unidentified alpha emitters) = 0 0067 x 10 ^{12} μCi/ml

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Table IV Average Monthly Air Sample Concentrations, Off-Site Radioactive (continued)

(A) Low Volume Programmed Samplers

Yearly Summary Long Lived Alpha Concentrations (U Pu and naturally occurring alpha emitters)

Concentrations (X 10^{12} μCi/ml)

Location	No. of Samples	<Det	January – June C_{Max}	January – June C_{Avg}	July – December C_{Max}	July – December $C_{Avg.}$	CY 1971 C_{Avg}	CY 1971 % of Std
Boulder (S 15)	48	23	0 0128	0.0050	0 0174	0 0061	C 0056	82.9
Broomfield (S 17)	48	32	0.0134	0 0045	0 0128	0 0019	0 0037	55.2
Coal Creek (S-11)	48	39	0 0129	0 0030	0.0083	0.0013	0 0021	32 0
Denver (S 23)	47	27	0.0160	0.0016	0 0098	0.0041	0.0038	57 2
Golden (S 20)	48	34	0 0134	0 0044	0.0368	0.0014	0.0040	59 3
Lafayette (S 16)	48	23	0 0160	0 0070	0.0163	0.0019	0.0060	89 5
Marshall (S-13)	47	37	0 0082	0 0017	0.0070	0.0019	0.0018	27.6
Wagner (S 18)	48	29	0 0197	0 0013	0.0167	0.0011	0.0057	84 9
Westminster (S-25)	44	35	0.0270	0.0031	0 0298	0.0047	0.0039	58.4
Summary Averages	426	275	0.0270	0.0043	0.0368	0.0037	0 0040	60 0

(B) High Volume Offsite Samplers

1 Plutonium Concentrations

Monthly Concentrations (X 10^{12} μCi/ml)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S-26	–**	0.00014	0 00020	0 00022	0.00024	0.00019	0.00007	0.00023	0 00012	0.00022	0 00017	0 00003
S-27	–	0 00008	0 00022	0 00012	0.00025	0.00027	0.00015	0.00031	0 00014	0 00046	–	0 00047
S-28	–	0 00017	0 00019	0 00012	0.00020	0.00027	0.00013	0.00019	0 00033	0 00012	–	–
S-29	–	0 0019	0 00016	0 00011	0.00023	0.00041	0.00028	0 00033	0 00022	0 00014	0 00017	0 000 4
S-30	–	0 00011	0 00016	0 00010	0 00026	0.00030	0 00019	0.00024	C 00012	–***	–***	–
S-31	–	0 00009	0.00015	0 00022	0.00033	0 00028	0.00019	0.00039	0 00023	0 00014	0 00020	0 000.0
S-32	–	0.00019	0 00033	0 00016	0.00028	0.00124	0 00011	0.00028	0 00026	0 00193	–	0 00008
S-33	–	0.00025	0.00030	0 00020	0 00033	0.00030	0.00018	0.00026	0.00021	0.00009	0 00013	0 00022
S-34	–	0.00020	0 00025	0 00014	0 00031	0 00039	0 00012	0.00022	UD*	–***	–***	0 00017
S-35	–	0 00016	0 00021	0.00016	0.00027	0.00029	0.00016	0.00022	0 00016	0 00031	UD	0.00039
S-36	–	0.00011	0 00035	0 00021	0 00025	0.00026	0 00012	0.00024	0.00022	0 00020	0 00017	0 00010
S-37	–	0 00016	0 00092	0.00030	0.00027	0.00028	0.00011	0.00032	0.00024	0 00460	UD*	–

Applicable Standard (Soluble ^{239}Pu) is 0 02 X 10^{12} μCi/ml

UD = Undetectable (below detection limits)

(B) High Volume Off site Samplers

2 Yearly Summary Plutonium

Concentrations (X 10^{12} μCi/ml)

Location	**February – June Max Conc / Single Sample	**February – June Average	July – December Max Conc./ Single Sample	July – December Average	Totals for Year Average Conc.	Totals for Year % of Std	Total No Samples	No Below Detection Limit
S-26	0 00041	0 00021	0 00041	0.00013	0 00017	0 84	41	11
S-27	0 00044	0 00020	0.00343	0 00024	0 00021	1 07	35	5
S-28	0 00044	0 00019	0 00073	0 00025	0 00021	1 06	33	2
S-29	0 00068	0 00022	0 00132	0 00029	0.00026	1 30	44	5
S-30	0 00050	0 00019	0 00043	0 00020	0 00019	0 97	30	3
S-31	0.00064	0 00023	0.00059	0 00024	0 00024	1 18	43	2
S-32	0.00428	0 00046	0 00193	0 00022	0 00036	1.80	34	4
S-33	0 00063	0 00028	0 00083	0 00019	0 00023	1 16	44	4
S-34	0 00092	0 00026	0 00028	0.00016	0 00023	1 14	28	4
S 35	0 00043	0 00022	0 00066	0 00021	0.00022	1 08	37	5
S-36	0.00070	0 00025	0 00087	0 00018	0 00021	1 05	43	6
S-37	0 00222	0 00041	0 00464	0.00023	0.00034	1 70	39	6
Yearly Summation							444	57
Total Averages					0 00024	1.20		

This network of samplers began operation in February 1971

** Air Samplers inoperative due to pump failure

NOTE For averaging purposes all samples below minimum detectable amounts (MDA) were assigned a fractional value (No of samples > MDA divided by total no analyses) of the appropriate MDA

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Table V Special High Volume Air Samples On- and Off Site Radioactive

(A) On site Grab Samples

Plutonium Concentrations (X 10^{12} μCi/ml)

Location of Grab	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
903 20	0 00093	0 00085	0 00236	0 00109	0 00136	0 00272	0 00106	0 00250	0 00710	0 00[illegible]59	0 00301	0 00[illegible]5
903 15	0 00055	0 00138	0 00415	0 00130	0 00038	0 00154	0 00696	0 00789	0 11000	0 01851	0 00041	0 00[illegible]
903 10	0 00091	0 00143	0 00403	0 00094	0 00050	0 00124	0 00087	0 00110	0 16819	0 03911	0 00152	0 0031
903 5	0 00045	0 00102	0 00040	0 00123	0 00079	0 02116	0 00081	0 00156	0 1256	NA	0 00431	0 00 6[illegible]

Yearly Summation

Location	Single Sample Maximum	Average Concentration	Perent of Standard*	Number of Samples	Number Less Than Detection Limits
903 20	0 01800	0 0024	4 0	49	13
903-15	0 40840	0 014676	2 5	49	20
903 10	0 51640	0 022319	3.2	50	16
903-5	0 04960	0 003371	5 6	41	14
Totals (averages)		0 0115	9 1	189	63

*Taken just o east of asphalt pad covering contaminated soil on plant site

* *No analysis

****Standard for these on site samples is taken as 0 06 X 10^{12} μCi/ml

(B) Off site Grab samples

Concentrations (X 10^{12} μCi/ml)

Location of Grab	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wagner	0 00064	0 00196	0 00176	0 00273	0 00145	0 00195	0 00741	0 00722	0 01324	0 01437	0 001 9	0 00[illegible]
Coal Creek	NA	0 00427	0 00138	0 00186	0 00131	0 01209	0 00106	0 00359	0 00142	0 00038	0 00117	0 00 8[illegible]

Yearly Summation

Location	Single Sample Maximum	Average Concentration	Percent of Standard	Number of Samples	Number Less Than Detection Limits
Wagner	0 04950	0 003438	1[illegible]2	44	10
Coal Creek	0 06020	0 003142	1 7	38	11
Totals (averages)		0 0033	1[illegible]6	82	21

*Off site Standard = 0 02 X 10^{12} μCi/ml

Table VI Beryllium Concentration in Air Samples

Concentration (X 10^{6} mg/M^3)

	Location		% of Standard	
	On Site	Off Site	On Site	Off Site
Jan	0 008	†0 130	8	†130
Feb	0 011	0 009	11	9
Mar	0 009	0 012	9	12
Apr	0 008	0 012	8	1[illegible]
May	0 019	0 021	19	21
Jun	0 008	0 012	8	12
Summary	0 010	0 032	10%	32[illegible]
Jul	0 012	0 019	12	19
Aug	0 008	0 011	8	11
Sep	0 025	0 008	25	8
Oct	0 014	0 022	14	22
Nov	0 009	0 011	9	11
Dec	0 008	0 011	8	11
Summary	0 012	0 014	12%	14
Yearly Averages	0 0115	0 0235	11 5%	23 5[illegible]

Beryllium standard in ambient air [illegible] 1 X 10^{5} mg/M^3 – Rocky Flats self imposed standard is [illegible] or 0 5 X 10^{5} mg/M^3

†Highly Suspect Data

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Table VII Dustfall Samples 1971 Yearly Summary

(Plutonium)

	No Samples Taken	No Samples Less Than Detection Limit	Sample Days	1971 Maximum (Single Sample) Concentration (pCi/M²)	Total Deposition (pCi/M²)	Deposition Rate (pCi/M²/month)
Arvada	23	9	362	16.11	76 45	6 35
Broomfield	22	12	348	28.88	74 48	6.42
Boulder	22	14	334	38.59	85 69	7 70
Coal Creek	20	12	306	21.66	51 26	5 02
Denver	23	11	341	53.87	118 27	10.41
Eastlake	23	11	362	10.59	49.84	4 13
Golden	22	9	348	*174.16	*219.56	*18 93
Lafayette	22	13	362	35.83	82.50	6 84
Marshall	23	11	362	67.70	149.04	12.35
Superior	21	8	334	16.11	74.20	6 66
Wagner	20	6	313	13.17	70.32	6 75
Westminster	23	9	362	*1127.11	*1166.90	*96 84
Berthoud	7	2	316	3 58	12 98	1 23
Castle Rock	9	7	335	2.46	6.46	.55

*Based on highly suspect data

Table VIII Water Surveys.

(A) Radioactivity in Holding Ponds and Effluent Waste Water

1 Pond B-4 (Effluent Waste Water)

Concentrations (X 10⁻⁹ μCi/ml)

Sample Period	No Samples	Effluent Volume (million liters)	U + Pu Concentrations Max	U + Pu Concentrations Avg.	U + Pu Total Release (mCi)	Pu Concentration Max	Pu Concentration Avg.	Pu Total Release (mCi)	Am Concentrations Avg.	Am Concentrations Max	Am Total Release (mCi)
January	4	36 01	36 64	14 33	0 516	4.01	2 29	0.082	3.07	3 07	0 111
February	4	34 85	27 73	24 74	0.862	7 23	2.92	0.101	1 20	1 36	0 042
March	4	49 18	19 29	13 15	0 647	4 32	2.86	0 141	1 89	2.67	0 093
April	5	41 21	19 98	14 75	0 603	5.23	2 99	0 123	1 61	2 39	0 066
May	4	32 36	19 06	12 54	0 406	4 59	2 63	0 085	0 94	2 26	0 030
June	5	28 15	10 30	8 33	0.234	2 61	1 60	0 045	1 37	2 18	0 039
July	4	23 95	8 95	5 79	0.139	6.09	3.20	0.076	1 03	1.29	0.025
August	4	30 47	18 75	11 34	0 346	2 77	1.05	0 032	0 42	0 52	0 013
September	5	33 69	11 19	6.93	0.233	2 04	1 29	0.043	0 65	1 08	0 022
October	4	42 64	5 75	5 61	0.239	1.59	1 01	0 043	0 06	0 14	0 003
November	4	47 61	15 08	10 67	0 508	0.98	0.59	0 028	0 76	1 30	0 036
December	5	53.79	18 59	11 48	0.618	1 56	1.09	0 058	NA	NA	NA

NA – No Analysis

2 Yearly Summation Pond B-4 (Effluent Waste Water Total Volume 1971 = 453 910,000 Liters)

Concentrations (X 10⁻⁹ μCi/ml)

Sample Period	Number Samples Taken	U + Pu Concentrations Max	U + Pu Concentrations Avg	U + Pu Total Release (mCi)	Number Samples Taken	Pu Concentrations Max	Pu Concentrations Avg	Pu Total Release (mCi)	Am(1) Concentrations Max	Am(1) Concentrations Avg	Am(1) Total Release (mCi)
Jan Jun	26	36.64	14 76	3 273	26	7 23	2 61	.578	3 07	1 72	381
Jul Dec	26	18 59	8 97	2.082	26	6 09	1 21	[illegible]	1 79	.55	127
Summary	52	36 64		5 355	52	7 23		.8e0	3 07		508
Averages			11 79				1.89			1 12	

(1) July December Am average calculated from five months data July December release = average concentration X July December effluent summary average = 0 508 divided by total effluent

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Table VIII Water Surveys (continued)

(A) Radioactivity in Holding Ponds and Effluent Waste Waters

3 Grab Water Samples – Ponds A and C (Holding Ponds)

	Pond (A) X 10 ⁹ μCi/ml				Pond (C) X 10 ⁹ μCi/ml			
	No Samples		Concentrations		No Samples		Concentrations	
	Taken	<Det	U+Pu	Pu	Taken	<Det	U+Pu	Pu
Jan	4	0	7 07	0 51	4	0	6 98	0 26
Feb	4	0	8 88	0 42	4	0	10 98	0 72
Mar	4	0	7 09	0 31	4	0	5 66	0 5
Apr	5	0	6 62	1 12	5	0	6 44	1 13
May	4	0	6 23	0 85	4	0	6.73	0 31
Jun	5	0	4 63	1 21	5	0	4 52	0 94
Jul	4	0	9.93	0 97	4	0	4 19	0 47
Aug	4	0	7 27	0 66	4	0	8.68	0 50
Sep	5	0	6 13	0 51	5	0	6 90	0 52
Oct	4	0	6 85	0 32	4	0	4 32	0 48
Nov	3	0	9 04	0 38	4	0	3 80	0 9
Dec	5	0	13 75	0 79	5	0	4.47	0 41

1971 Summary

	U + Pu X 10 ⁹ μCi/ml						Plutonium X 10 ⁹ μCi/ml					
	No Samples		Concentrations			Percent of	No Samples		Concentrations			Percent of
	Taken	<Det	Min	Max	Avg	Standard[1]	Taken	<Det	Min	Max	Avg	Standard[2]
Pond A	51	0	1 33	28 89	7 30	0 11	49	0	0 04	2 76	0 68	0 04
Pond C	51	0	0 82	23 64	6 14	0 09	52	0	0 06	3 84	0 58	0 03

[1] Gross alpha standard is $\frac{C_U}{MPC_U} + \frac{C_{Pu}}{MPC_{Pu}} \leq 1$ Where $MPC_U = 10\,000 \times 10^{9}$ μCi/ml, $MPC_{Pu} = 1667 \times 10^{9}$ μCi/ml

[2] The plutonium standard is 1667 X 10 ⁹ μCi/ml

(A) Radioactivity in Holding Ponds and Effluent Waste Waters

4 Walnut Creek at Indiana Water Samples (Rocky Flats Effluent Water Course)

Concentrations (X 10 ⁹ μCi/ml)

	U + Pu				Pu				Am			
Sample	Number	Concentrations			Number	Concentrations			Number	Concentrations		
Period	Samples	Min	Max	Avg	Samples	Min	Max	Avg	Samples	Min	Max	Avg
January	2	2 85	19 71	11 28	2	1 28	2 68	1 95	1	0 73	0 73	0 73
February	4	13 69	30 06	19 30	4	0 86	8 47	4 35	3	0 68	1 67	1 25
March	5	4 76	11 53	8 91	5	1 36	3 33	2 52	2	0 70	1 60	1 15
April	4	6 32	13 68	11 18	4	1 14	3 10	2 00	3	0 49	0 93	0 [illegible]
May	4	7 15	12 43	9 91	4	0 67	6 59	2 63	2	0 40	0 47	0 44
June	5	6 40	11 43	9 05	5	1 28	3 21	2 04	5	0 30	1 25	0 58
July	4	3 87	29 54	11 67	4	1 54	3 61	2 56	2	0 41	0 80	0 61
August	5	3 73	36 58	13 16	5	1 03	3 14	1 65	5	0 30	0 68	0 49
September	4	2 18	22 10	9 07	4	0 08	7 99	2 [illegible]	4	0 01	0 29	0 19
October	4	3 12	49 34	16 87	4	0 41	3 71	1 95	2	0 [illegible]1	0 77	0 49
November	5	3 97	56 05	15 89	5	0 67	3 80	1 64	5	0 20	1 05	0 [illegible]6
December	3	5 77	12 81	8 96	3	0 83	1 33	1 03	0	–	–	–

Yearly Summary

	U + Pu				Pu				Am			
Sample	Number	Concentrations			Number	Concentrations			Number	Concentrations		
Period	Samples	Min	Max	Avg	Samples	Min	Max	Avg	Samples	Min	Max	Avg
Jan Jun	24	2 85	30 06	11 41	24	0 67	8 47	2 64	16	0 30	1 67	0 79
Jul Dec	25	2 18	56 05	12.90	25	0 41	7 99	1 [illegible]	18	0 01	1 05	0 [illegible]3
Summary	49 (0)	2 18	56 05		49 (0)	0 41	8 [illegible]		34(1)	0 01	1 67	
Averages				12 17				2 26				0 60

( ) Denotes less than detection limits

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Table VIII Water Surveys (continued)

(A) Radioactivity in Holding Ponds and Effluent Waste Waters (continued)

4 Walnut Creek at Indiana Water Samples (Rocky Flats Effluent Water Course) (continued)

Yearly Summation

Concentrations (X 10^{9} μCi/ml)

U + Pu			Pu				Am			
Concentrations		% of	Concentrations			% of	Concentrations			% of
Max	Avg	Standard[1]	Min	Max.	Avg	Standard[2]	Min	Max	Avg	Standard[3]
49 34	12 17	0.23	0 41	8.47	2 26	0.14	0.01	1.67	0.60	0 05

[1] $\frac{C_U}{MPC_U} + \frac{C_{Pu}}{MPC_{Pu}} < 1$ where $MPC_U = 10\,000 \times 10^{9}$ μCi/ml and $MPC_{Pu} = 1\,667 \times 10^{9}$ μCi/ml

[2] Based on the soluble ^{239}Pu in water standard of 1667×10^{-9} μCi/ml

[3] Based on the soluble ^{241}Am in water standard of 1333×10^{9} μCi/ml

(B) Radioactivity in Reservoirs and Tap Water Samples

1 Reservoir Water Samples

Concentrations (X 10^{9} μCi/ml)

January – June 1971

Location	U + Pu Number Samples Taken	U + Pu Concentrations Max	U + Pu Concentrations Avg.	Pu Number Samples Taken	Pu Concentrations Max	Pu Concentrations Avg.	Am Number Samples Taken	Am Concentrations Max	Am Concentrations Avg
Baseline Reservoir	12	6 06	3 25	11(0)	1 68	0 33	–	–	–
Great Western Reservoir	12	6 29	3 12	12(2)	0 64	0.14	4	1 13	0 60
Ralston Reservoir	12	30 40	20 50	10(9)	2.53	0.26	–	–	–
Standley Reservoir	11	17 44	5.23	10(0)	4.93	0.76	1	0.10	0.10

( ) Denotes number of samples less than detection limits

July – December 1971

Location	U + Pu Number Samples Taken	U + Pu Max	U + Pu Avg	Pu Number Samples Taken	Pu Number Samples <Det.	Pu Max	Pu Avg	Am Number Samples Taken	Am Max	Am A
Baseline Reservoir	8	6 92	3 29	8	3	0.46	0 13	–	–	–
Great Western Reservoir	12	16 06	3.70	12	1	0 82	0 26	8	0 49	0 13
Ralston Reservoir	12	22 04	10 22	9	3	0 96	0 20	–	–	–
Standley Reservoir	11	6 05	3 17	11	2	0.24	0 09	4	0.12	0 06

Summation 1971

Concentrations (X 10^{9} μCi/ml)

Reservo	U + Pu No. Samples Taken	U + Pu <Det	U + Pu Max	U + Pu Avg.	U + Pu % of Std[2]	Pu No. Samples Taken	Pu <Det	Pu Max	Pu Avg.	Pu % of Std[2]	Am Number Samples	Am Max	Am Av	Am % of St[3]
Baseline	20	0	6 92	3 2[illegible]	0 05	19	3	1 68	0.25	0 02	–	–	–	–
Great Western	24	1	16 06	3 41	0 04	24	3	0 82	0.20	0 01	12	1 13	0 29	0 02
Ralston	24	0	30 40	15 36	0 17	19	12	2 53	0.29	0.01	–	–	–	–
Standley	23	0	17 44	4 20	0 06	19	4	4 93	0.39	0.02	5	0 1[illegible]	0 07	0 01
Summary	90	1	30 40			81	22	4 93			17	1 13		
Averages				6 76	0 08				0.26	0 02			0 21	0 0[illegible]

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Table VIII Water Surveys (continued)

2 Community Tap Water Samples

January – June 1971

Concentrations (X 10 [illegible] µCi/ml)

	U + Pu				Pu			
	Number Samples		Concentrations		Number Samples		Concentrations	
	Taken	<Det	Max	Avg	Taken	<Det	Max	Avg
Arvada	12	0	16 20	7 64	9	7	0 77	0 10
Boulder	12	0	6 93	2 32	9	0	0 97	0 32
Broomfield	12	0	18 58	2 54	6	0	(5 03)	0 98
Denver	12	0	17 19	5 73	11	2	2 79	0 44
Golden	12	0	8 79	3 40	10	2	0 45	0 16
Lafayette	12	0	3 23	1 40	5	0	0 77	0 33
Louisville	12	0	2 45	1 25	4	0	0 52	0 28
Thornton	12	0	17 48	9 29	10	7	0 30	0 05
Westminster	12	0	6 49	2 26	11	1	1 80	0 3[illegible]

(B) Radioactivity in Reservoirs and Tap Water Samples (continued)

July – December 1971

	U + Pu				Pu			
	Number Samples		Concentrations		Number Samples		Concentrations	
	Taken	<Det	Max	Avg	Taken	<Det	Max	Avg
Arvada	12	0	7 02	4 08	7	1	0 78	0 2[illegible]
Boulder	12	0	8 62	1 66	10	5	0 65	0 1[illegible]
Broomfield	12	0	9 00	2 84	9	3	0 82	0 [illegible]
Denver	12	0	5 77	2 89	9	3	2 03	0 43
Golden	12	0	9 76	2 8[illegible]	7	1	0 47	0
Lafayette	10	0	4 19	1 46	7	2	0 82	0 [illegible]
Louisville	11	0	3 15	1 31	7	1	1 60	0 39
Thornton	11	0	8 60	4 88	6	1	0 46	0 [illegible]
Westminster	11	0	4 95	1 74	7	1	1 41	0 43

NOTE For averaging purposes all samples below minimum detectable amounts (MDA) were assigned a fractional value (No of samples > MDA divided by total No analyses) of the appropriate MDA

1971 Summary

	U + Pu					Pu				
	No Samples		Concentrations		% of	No Samples		Concentrations		% of
	Taken	<Det	Max	Avg	Standard[1]	Taken	<Det	Max	Avg	Standard[2]
Arvada	[illegible]4	0	16 20	5 86	0 07	16	8	0 78	0 16	0 01
Boulder	4	0	8 62	1 99	0 03	19	5	0 9[illegible]	0 [illegible]4	0 01
Broomfield	[illegible]4	0	18 58	2 69	0 05	15	3	(5 03)	0 54	0 03
Denver	[illegible]4	0	17 19	4 31	0 06	20	5	2 79	0 4	0 03
Golden	24	0	9 76	3 11	0 04	17	3	0 47	0 [illegible]0	0 01
Lafayette	[illegible]	0	4 19	1 42	0 03	12	2	0 82	0 39	0 0
Louisville	[illegible]3	0	3 15	1 27	0 03	11	1	1 60	0 35	0 0
Thornton	[illegible]3	0	17 48	7 18	0 08	16	8	0 46	0 11	0 01
Westminster	[illegible]3	0	6 49	2 01	0 04	18	2	1 80	0 40	0 02
Summary	211	0	18 58			144	37	(5 03)		
Averages				3 32	0 04				0 31	0 01

(1) D[illegible] suspect data

[1] The standard for a mixture of soluble U [illegible] Pu in water is $\frac{C_U}{MPC_U} + \frac{C_{Pu}}{MPC_{Pu}} = <1$ where $MPC_U = 10\,000 \times 10^{-9}$ µCi/ml and $MPC_{Pu} = 1\,667 \times 10^{-9}$ µCi/ml

[2] The standard for soluble [illegible] in water [illegible] 1667 X 10 [illegible] µCi/ml [illegible] soluble Am (in water) standard of 1333 X 10 [illegible] µCi/ml

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Table VIII Water Surveys (continued)

(C) Semiannual Water Collection (Summary 1971)

Concentrations X 10^{-9} µCi/ml

Location	No Samples	U + Pu Concentrations Min	Max	Avg	% of Standard[1]	No Samples	Pu Concentrations Min	Max	Avg.	% of Standard[2]
<5 Miles	28	0.54	16.35	2.72	0.05	13	0.05	2.76	0.41	0.02
>5 Miles	32	0.74	39.62	6.85	0.08	16	0.08	0.92	0.25	0.01
Summary	60	0.55	39.62	4.92	0.07	29	0.05	2.76	0.32	0.02

[1] The standard for a soluble mixture of U + Pu in water is $\frac{C_U}{MPC_U} + \frac{C_{Pu}}{MPC_{Pu}} < 1$ Where MPC_U is 10 000 X 10^{-9} µCi/ml and MPC_{Pu} is 1.667 X 10^{-9} µCi/ml

[2] The standard for soluble ^{239}Pu in water is 1,677 X 10^{-9} µCi/ml

(D) Chemical Concentrations in Holding Ponds and Effluent Waste Waters

1 Pond B-4

Sample Period	Number Samples	Range of pH	Average Concentration (mg/l) NO_3^-	PO_4^{-3}	F^-	BOD_5	DO***	Total Solids	Cr^{+6}
January	20	7.2-8.1	16.7	10.9	0.5	5.4	26.3	400	<0.005
February	20	7.4-8.1	6.2	9.2	0.4	9.9	10.8	(681)	<0.005
March	22	7.2-7.9	9.4	6.3	0.4	4.5	10.8	406	<0.005
April	19	7.2-7.8	8.4	4.3	0.4	6.4	11.0	392	<0.005
May	19	7.6-8.5	5.5	12.5	0.4	5.8	9.9	456	<0.005
June	22	7.4-8.5	3.8	13.3	0.5	7.2	10.3	368	<0.005
Summary	122	7.2-8.5	8.3	9.4	0.4	6.6	13.2	450	<0.005
July	21	7.2-8.2	3.4	8.9	0.4	NA	4.4	NA	<0.005
August	22	7.1-9.6	4.1	7.[illegible]	0.4	8.2	4.4	NA	<0.005
September	21	7.2-7.9	3.6	15.4	0.4	7.9	5.3	260	<0.005
October	21	7.1-8.1	7.2	20.7	0.4	6.7	6.2	309	<0.005
November	20	7.2-7.7	7.1	22.6	0.7	4.2	8.8	393	<0.005
December	21	7.2-7.8	4.9	17.2	0.4	6.0	9.3	332	<0.005
Summary	126	7.1-9.6	5.1	15.5	0.4	6.6	6.4	324	<0.005

***Dissolved oxygen.

2 1971 Summary

			Average Concentration (mg/l)						
Jan-Jun	122	7.2-8.5	8.3	9.4	0.4	6.5	13.2	450	<0.005
Jul-Dec	126	7.1-9.6	5.1	15.4	0.4	6.6	6.4	324	<0.005
Summary	248	7.1-9.6	6.7	12.4	0.4	6.5	9.8	387	<0.005
Applicable Std	–	6.5-8.5	<45.0	–	<1.2	<30.0	>6	<500	<0.050
% of Std	–	–	14.9	–	30.0	22.0	38.8	77.4	<10

3 Elemental Analyses (Pond B-4)

Concentrations mg/l

	Number Samples	As	Ba	Be	Cd	Cu	Pb	Mn
Yearly Summary	10	0.02	0.005	0.0004	0.005	0.03	0.002	0.006
Applicable Std	(2)	0.05	1.00	–	0.01	1.00**	0.05	0.05
% Std	–	40	0.05	–	50	3.0	4.0	12

* These are not standards relating to the safety of the water but are suggested maximums relating to consumer acceptance thereof.

OTE Cyanide and selenium are not currently run by Rocky Flats Health Physics Department. Historically we have depended on the guidance of the [illegible] Health Water Pollution Control Commission for these analyses. Since [illegible] for these analyses [illegible] will be performed in the future as a means of further protection and compliance with both the spirit and the letter of the law.

* The 1962 Drinking Water Standards of the U.S. Public Health Service call for semiannual analysis of these parameters.

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Table VIII Water Surveys (continued)

(I) Chemical Concentrations in Holding Ponds and Effluent Waste Waters

1 Grab Samples Ponds A and C

Monthly Averages (mg/l)

	Pond A						Pond C					
	pH	NO_3	PO_4 [3]	F	Total Solids	Cr [6]	pH	NO_3	PO [3]	F	Total Solids	Cr [6]
January	7 8	11 1	0 6	0 4	173	<0 005	7 8	0 5	0 6	0 4	243	<0 005
February	7 6	13 7	1 1	0 4	109	<0 005	7 7	0 9	1 3	0 4	212	<0 005
March	7 5	19 6	0 6	0 4	164	<0 005	7 5	0 4	0 6	0 4	205	<0 005
April	7 8	29 7	0 7	0 4	183	<0 005	7 5	0 4	0 6	0 4	249	<0 00[illegible]
May	7 9	85 0	0 6	0 4	393	<0 005	8 0	0 3	0 6	0 4	272	<[illegible]
June	8 0	20 1	0 6	0 4	233	<0 005	7 8	0 3	0.6	0 4	188	<0 [illegible]
Summary	7 8	29 9	07	0 4	209	<0 005	7 7	0 5	0 7	0.4	228	<0 0[illegible]5
July	7 8	23 0	0 6	0 3	NA	<0 005	7 8	0 3	0.6	0.3	NA	<0 0
August	9 2	23 4	0 6	0 4	NA	<0 005	8 4	0 6	0.6	[illegible]	NA	<0 0[illegible]
September	8 5	36 3	0 6	0 [illegible]	300	<0 005	8 5	1.2	0 6	0.3	175	<0 0
October	7 6	52 9	0 4	0 4	384	<0 005	8 2	1.3	0 6	0 4	227	<0 005
November	7 8	58 9	0 6	0 5	429	<0 005	8 1	1 5	0 6	0 8	185	<0 0[illegible]5
December	7 7	78 6	0 6	0 4	488	<0 005	7 7	0 9	0 6	0 4	194	<0 0[illegible]
Average	[illegible] 1	45 5	0 6	0 4	400	<0 005	8 1	1 0	0 6	0 4	195	<0 0[illegible]

NA is no analysis

2 Yearly Summary – Pond A

Elemental Analyses	Number Samples	As	Ba	Be	Cd	Cu	Pb	Mn	Na
(Yearly Summary)	10	0 01	0 01	0 0005	0 005	0 01	0 001	0 01	1 3
Applicable Std	2	0 05	1 00	-	0 01	1 00	0 0[illegible]	0 05	–
% of Standard	–	20%	1%	–	50%	1 0%	2%	20%	–

3 Yearly Summary – Pond C

(Yearly Summary)	10	0 01	0 01	0 0002	0 006	0 01	0 01	0 002	17 6
Applicable Std	2	0 05	1 00	–	0 01	1 00 *	0 05	0 05	–
% of Standard	–	20%	1%	–	60%	1 0%	20%	4 0[illegible]	–

Run in compliance with State guidelines instead of Sodium Adsorption Ratio

These are not standards relating to the safety of the water but are suggested maximums relating to consumer compliance thereof

NOTE Cyanide and selenium are not currently run by Rocky Flats Health Physics Department Historically [illegible] guidance of the Colorado Department of Health Water Pollution Control Commission for these analyses Since [illegible] facility [illegible] for these analyses however they will be performed in the future as a means of further protection and compliance with both the spirit and the letter of the law

Table IX Sediment Samples Yearly Summary

Plutonium Concentrations (X 10^{-6} µCi/gram)

	Location	No Samples	Maximum	Average
A	Pond A	4	26 06	17 53
	Pond B-1	3	641 67	319 87
	Pond B-2	3	385 53	199 00
	Pond B 3	3	174 85	67 99
	Pond B-4	3	181 34	65 68
	Pond C	3	8 47	3 35
B	Baseline Reservoir	2	7 03	3 68
	Great Western Reservoir	2	1 87	1 08
	Ralston Reservoir	2	0 65	0 43
	Standley Reservoir	2	0 42	0 29

Sample Dry Depth 4 [illegible]

A Controlled Area B = Out of Controlled Area

NOTE For averaging purposes all samples below minimum detectable amount (MDA) were assigned a fractional value (No of samples > MDA divided by total No analyses) of the appropriate MDA

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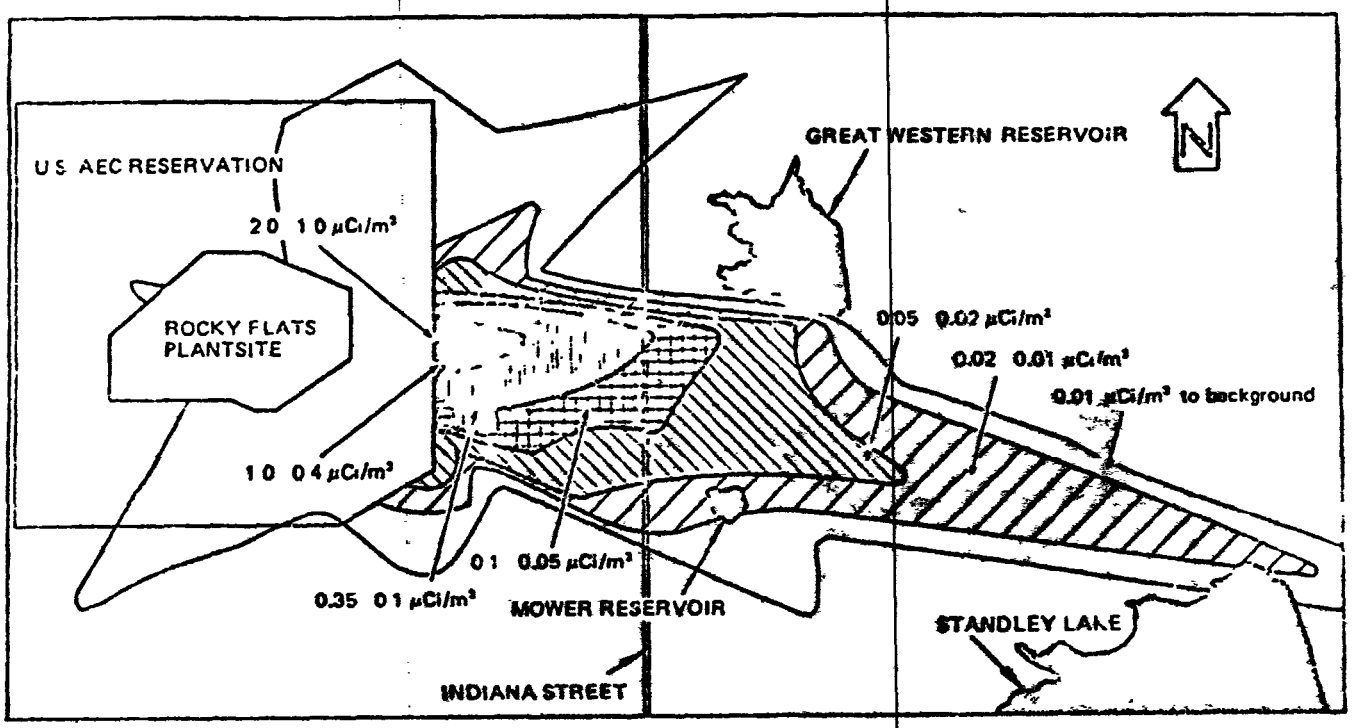

Table X Surface Soil Analysis off-site contours.

NOTE These contours were empirically derived by means of a computer curve fitting program using the method of least squares. This results in a mathematical expression for grid sectors giving the activity of the plutonium in the soil as a function of radial distance from the on site barrel storage area Three hundred forty-two soil samples were used in generating these contours. Eighteen samples were taken by the Colorado Committee on Environmental Information 18 by U.S. AEC Health and Safety Laboratory, 306 by the Rocky Flats Health Physics Department. The values assume a soil density of 1 g/cm³ at a depth of one centimeter

Table XI Vegetation Samples 1971

Plutonium Concentrations (X 10⁻⁶ μCi/gram Dry)

	June 1971				September 1971			
	No Samples		Concentrations		No Samples		Concentrations	
	Taken	<Det	Max	Avg	Taken	<Det	Max	Avg *
<1 Mile	20	5	2 5	0 29	22	8	3 0	0 18
1 5 Mile	38	7	0 79	0 12	39	11	0 39	0 054
>5 Mile	22	8	0 25	0 053	21	12	0 17	0 032
Summary	80	20	2 5		82	31	3 0	
Averages				0 14				0 082

NOTE For averaging purposes all samples below minimum detectable amounts (MDA) were assigned a fractional value (No of samples > MDA divided by total No analyses) of the appropriate MDA

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Changes in text of RFP ENV 71E corresponding to tabular corrections

Page 10 Paragraph 5

The maximum (one month average) total long lived alpha emission from all uranium operations (Table IC) was 071 x 10^{-12} μCi/ml The yearly average was 0 008 x 10^{-12} μCi/ml which is about 0 3% of the applicable (population) standard

Page 10 Paragraph 6

Maximum (one month average) beryllium emission was 1 6 x 10^{-5} mg/cubic meter (before atmospheric dilution) The 12 month average stack release for all beryllium operations was 1 4 x 10^{-6} milligrams per cubic meter or about 14% of the standard Beryllium results are tabulated in Tables IIA and IIB

Page 11 Paragraph 5

Results for the year indicated a maximum of 0 06 x 10^{-12} μCi/ml High volume grab samples were also taken to the east of an asphalt pad covering some contaminated soil (former drum storage area in the southwest corner of the plant site proper) The 189 samples taken in 1971 represent over 40 000 cubic meters of air actually filtered and were analyzed or *total plutonium content* The results varied from a single sample maximum of 0 52 x 10^{-12} μCi/ml to a yearly average of 0 01 x 10^{-12} μCi/ml (Table V)

Page 11 Paragraph 7

This complex of air samplers produces nearly 10 000 samples per year These are analyzed to make certain that effluent levels as well as any re-distribution effects are kept well below guideline concentrations Summaries of these results for 1971 are presented in Tables III IV and V

On site air samples varied from a maximum average *long lived alpha concentration* (one month average) of 0 0322 X 10^{-12} μCi/ml with a 12 month average of 0 0018 X 10^{-12} μCi/ml about 24 0% of the standard

Page 12 Paragraph 1

Low volume off site air sample results were also quite low The programmed samplers indicated a maximum *long lived alpha concentration* (one month average) of 0 01 x 10^{-12} μCi/ml with a yearly average of 0 0040 x 10^{-12} μCi/ml about 60% of the guidelines The high volume off site samplers much more indicative of chronic exposure levels revealed much lower concentrations The maximum (one month *plutonium* average) was 0 005 x 10^{-12} μCi/ml whereas the average for the year was 0 0002 x 10^{-12} μCi/ml about 1 2 of the guideline (Table IV)

Page 12 Paragraph 3

Average beryllium sample concentrations were also below guidelines Nearly 12 000 analyses of air samples indicate an off site average for the year of about 21% of the guidelines while the on site average was about 12

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Page 13 Paragraph 6

[illegible] restrictive standard that for soluble plutonium 239 is 1 67 x 10^{-6} µCi/ml in terms of yearly averages to a suitable sample of a population *Gross alpha concentrations* in samples from B 4 pond had a maximum of 36 6 x 10^{-9} µCi/ml and a yearly average of 11 79 x 10^{-9} µCi/ml These gross alpha concentration are contributions from both plutonium and uranium All other naturally occurring long lived alpha emitters are removed from the samples during the analytical procedure (Table VIII A 1 2)

Page 13 Paragraph 7

Total *maximum plutonium concentration* in Pond B 4 was 7.23 x 10^{-9} µCi/ml with a yearly average of 1 89 x 10^{-9} µCi/ml *Americium 241 maximum* was 3 07 x 10^{-9} µCi/ml with a yearly average of 1 12 x 10^{-9} µCi/ml (Table VIII A 1 A 2)

Average Gross Alpha Americium and Plutonium Concentrations Below Guidelines

Page 13 Paragraph 8

Grab samples from Pond A showed a maximum *gross alpha concentration* of 28 89 x 10^{-9} µCi/ml with a yearly average of 7 30 x 10^{-9} µCi/ml Pond C showed similar low concentrations with a yearly maximum (gross alpha) of 23 64 x 10^{-9} µCi/ml and a yearly average of 6 14 x 10^{-9} µCi/ml (Table VIII A 3)

Page 13 Paragraph 9

Those grab samples taken at the confluence of North and South Walnut Creeks showed a maximum gross alpha of 49 34 x 10^{-9} µCi/ml Maximum *plutonium* concentration found was 8 47 x 10^{-9} µCi/ml, and maximum americium was about one half that amount *Average gross alpha was 12 17, average plutonium 2.26 and average americium 0 60 all x 10^{-9} µCi/ml* (Table VIII A 4)

Page 14 Paragraph 1

Tap water results averaged 3 32 x 10^{-9} µCi/ml with a maximum of 18 56 x 10^{-9} µCi/ml *gross alpha activity* Gross alpha concentrations in the reservoirs averaged 6 76 x 10^{-9} µCi/ml with a maximum of 30 4 x 10^{-9} µCi/ml at Ralston Reservoir (Table VIII B)

Tap Water From Surrounding Communities and Reservoir Samples Below Gross Alpha (U + Pu) Guidelines

Page 14 Paragraph 4

Sediment samples from the four major reservoirs are collected semi annually and more frequent sediment samples are taken from each of the six holding ponds Additional samples are also taken from Walnut and Woman Creeks These samples are taken to a depth of 4 centimeters No specific standard now exists for plutonium in sediment samples. The results tabulated in Table IX indicate a maximum of 641 67 x 10^{-6} µCi/gram (dry) within the controlled area The maximum concentration found outside the controlled access area of the plant site was 7 x 10^{-6} µCi/gram

No Standards for Sediment Samples

Page 15 Paragraph 3

Results for 1971 (Table XI) show that plutonium levels were a maximum of 3 00 x 10^{-6} µCi/gram (dry) One notable aspect of this sampling program is that the plant is analyzed without any prior washing Thus the plant becomes a form of dustfall collector as well as a measurement of the amount of plutonium physically incorporated into the plant through normal growth activities Although no specific standard has been established for plutonium in food plants these levels are considered by most experts to be insignificant especially in light of empirically derived dilution factors [15]

No Standard for *Plutonium* In Vegetation. Levels Found Are Considered Safe

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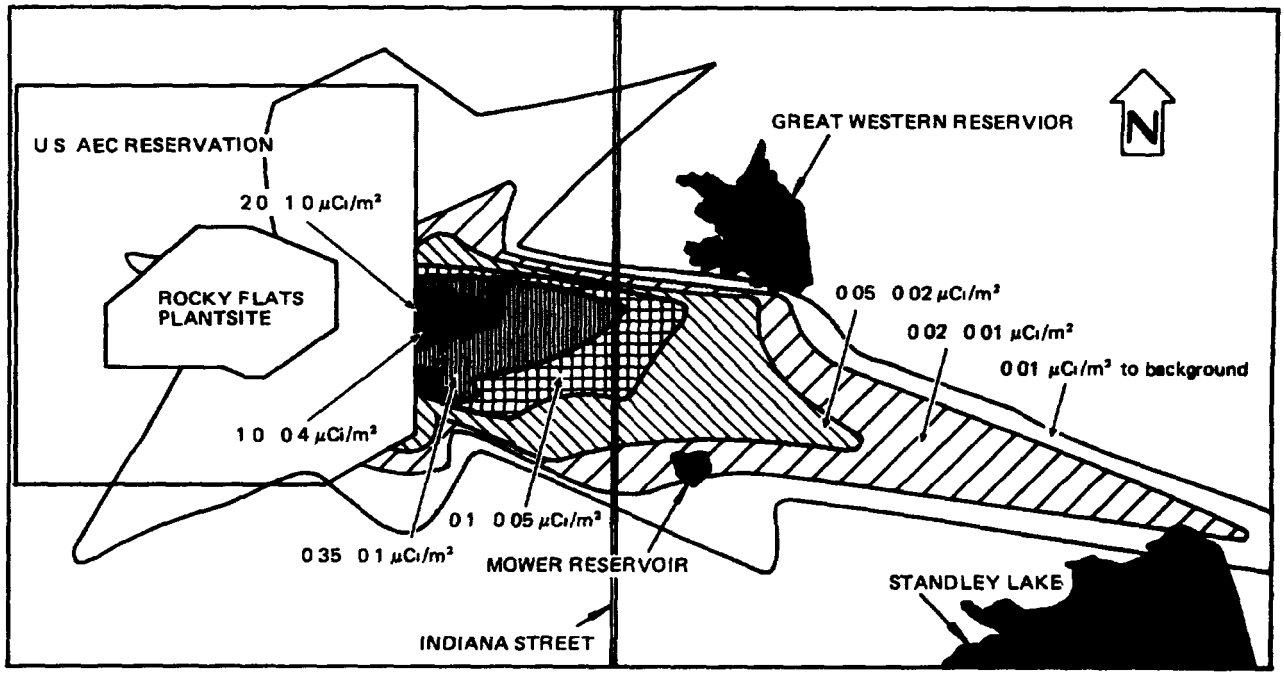

Table X *Surface Soil Analysis off-site contours.*

NOTE These contours were empirically derived by means of a computer curve fitting program using the method of least squares This results in a mathematical expression for grid sectors giving the activity of the plutonium in the soil as a function of radial distance from the on site barrel storage area Three hundred forty two soil samples were used in generating these contours Eighteen samples were taken by the Colorado Committee on Environmental Information 18 by U S AEC Health and Safety Laboratory 306 by the Rocky Flats Health Physics Department. The values assume a soil density of 1 g/cm^3 at a depth of one centimeter

Table XI Vegetation Samples 1971

Concentrations (X ~~10^{-6}~~ μCi/gram Dry)

	June 1971				September 1971			
	No Samples		Concentrations		No Samples		Concentrations	
	Taken	<Det	Max	Avg	Taken	<Det	Max	Avg
<1 Mile	~~12~~	5	~~0 00130~~	~~0.00009~~	~~14~~	4	~~0.00016~~	~~0 00003~~
1 5 Miles	~~42~~	~~3~~	~~0 00254~~	~~0.00018~~	~~44~~	11	~~0.00039~~	~~0.00004~~
>5 Miles	~~32~~	~~6~~	~~0.00025~~	~~0.00004~~	~~24~~	~~10~~	~~0.00017~~	0 00004
Summary	77	~~13~~	~~0.00254~~	~~0.00005~~	82	~~25~~	~~0 00039~~	~~0.00003~~

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* (→ NOTE ←)

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VI *Summary and Conclusions*

Environmental Protection Must Be At Source

The principal protection for our environment must be provided at the very source of potential degradation and/or potential pollution No program can replace adequate controls at the source any environmental program is after the fact

Rocky Flats Working Toward Total Containment of Radioactive Material

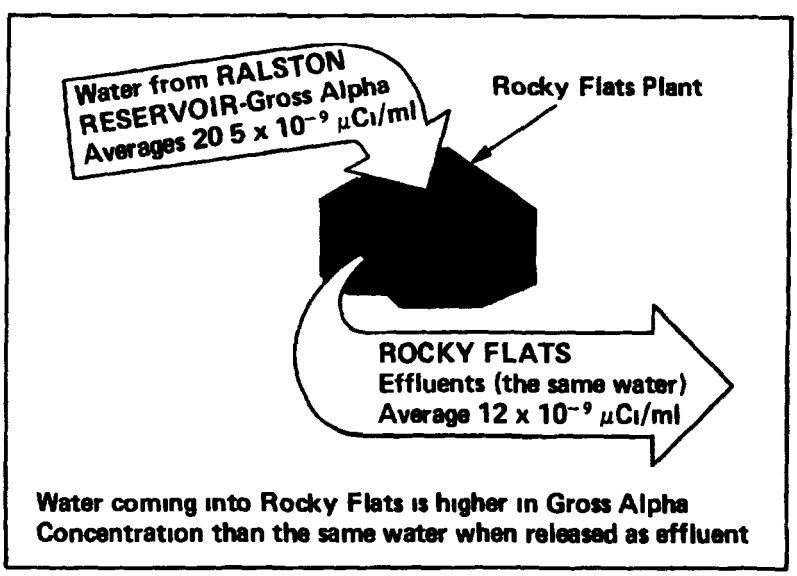
This is especially true for radioactive isotopes Rocky Flats is working toward total containment of radioactive materials The data contained in this report are the result of the controls employed at this plant site and do not in any way describe those complex controls in themselves That these controls are effective can be seen by comparing releases with those established standards over the applicable time periods

Frame of Reference for Data

Data are not meaningful without a frame of reference It is appropriate to provide some background information to better understand this report

Water From Wells Near Boulder Has 10 000 Times Natural Radioactivity as Water From Potomac Near Washington D C

The State of Colorado and the immediate environs of Rocky Flats are most interesting from a radiological point of view For example water taken from wells in Maine has about 3000 times the natural radioactivity as that taken from the Potomac River near Washington D C But even that level is low when compared with water taken from wells near Boulder (or for that matter Joachimsthal Czechoslovokia) where natural radioactivity concen trations are 10 000 times that amount [16] Rocky Flats receives its water from Ralston Reservoir near Golden Background radiation surveys indicate that this water is higher in gross alpha content when it enters the plant than when it is released as effluent after being used to process radioactive materials



Water coming into Rocky Flats is higher in Gross Alpha Concentration than the same water when released as effluent

1971 EPA Survey Shows Colorado Has Highest Natural Radiation Level in U.S

Residents of Colorado receive an annual cosmic ray dose of about 120 millirem about three times that received by the average resident of California (40 mrem) and about twice the annual gamma ray dosage from naturally occurring terrestrial radioactivity [4] In fact a 1971 survey released by the EPA showed that Colorado has the highest natural radiation levels in the U S

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Table VIII Water Surveys (continued)

(E) Chemical Concentrations in Holding Ponds and Effluent Waste Waters

1 Pond Grab Water Samples

Monthly Averages (mg/l)

	Pond A						Pond C					
	pH	NO_3	PO_4^{3}	F	Total Solids	Cr ^{6}	pH	NO_3	PO_4^{3}	F	Total Solids	Cr ^{6}
January	7 8	11 1	0 6	0 4	173	<0 005	7 8	0 5	0 6	0 4	243	<0 005
February	7 6	13 7	1 1	0 4	~~101~~ 109	<0 005	7 7	0 9	1 3	0 4	212	<0 005
March	7 5	19 6	0 6	0 4	164	<0 005	7 5	0 4	0 6	0 4	205	<0 005
April	7 8	29 7	0 7	0 4	183	<0 005	7 5	0 4	0 6	0 4	249	<0 005
May	7 9	85 0	0 6	0 4	393	<0 005	8 0	0 3	0 6	0 4	272	<0 005
June	8 0	20 1	0 6	0 4	233	<0 005	7 8	0 3	0 6	0 4	188	<0 005
Summary	7 8	29 9	0 7	0 4	~~208~~ 209	<0 005	7 7	0 5	0 7	0 4	228	<0 005
July	7 8	23 0	0 6	0 3	*NA	<0 005	7 8	0 3	0 6	0 3	NA	<0 005
August	9 2	23 4	0 6	0 4	NA	<0 005	8 4	0 6	0 6	0 4	NA	<0 005
September	8 5	36 3	0 6	0 4	300	<0 005	8 5	1 2	0 6	0 3	175	<0 005
October	7 6	52 9	0 4	0 4	384	<0 005	8 2	1 3	0 6	0 4	227	<0 005
November	7 8	58 9	0 6	0 5	429	<0 005	8 1	1 5	0 6	0 8	185	<0 005
December	7 7	78 6	0 6	0 5	488	<0 005	7 7	0 9	0 6	0 4	194	<0 005
Summary	8 1	45 5	0 6	0 4	~~267~~ 400	<0 005	8	1 0	0 6	0 4	195	<0 005

*NA is no analysis

2 Yearly Summary – Pond A

Elemental Analyses	Number Samples	As	Ba	Be	Cd	Cu	Pb	Mn	NA
(Yearly Summary)	10	0 01	0 01	0 0005	0 005	0 01	0 001	0 01	21 3
Applicable Std	(2)	05	1		0 01	1 00	0 05	0 05	–
% of Standard		20%			50%	1 0%	2%	20%	–

3 Yearly Summary – Pond C

(Yearly Summary)	10	0 01	0 01	0 0002	0 006	0 01	0 01	0 002	17 6
Applicable Std	(2)	0 05	1 00	–	0 01	1 00	0 05	0 05	–
% of Standard	–	20%	1%	–	60%	1 0%	20%	4 0%	–

*Run in compliance with State guidelines instead of Sodium Adsorption Ratio

*These are not standards relating to the safety of the water but are suggested maximums relating to consumer acceptance thereof

NOTE Cyanide and selenium are not currently run by Rocky Flats Health Physics Department Historically we have depended on the guidance of the Colorado Department of Health Water Pollution Control Commission for these analyses Since basic facilities exist for these analyses however they will be performed in the future as a means of further protection and compliance with both the spirit and the letter of the law

Table IX Sediment Samples Yearly Summary

Concentrations (X 10 ^{6} μCi/gram)

	Location	No Samples	Maximum	Average
A	Pond A	4	26 06	17 53
	Pond B-1	3	641 67	~~246.32~~ 319 87
	Pond B-2	3	385 53	199 00
	Bond B-3	3	174 85	67 99
	Pond B-4	3	181 34	65 68
	Pond C	3	8 47	~~3.30~~ 3 35
		Averages	0 ~~385 μCi/gram~~	~~0.030 μCi/gram~~
B	Baseline Reservoir	2	7 03	3 68
	Great Western Reservoir	2	1 67	1 08
	Ralston Reservoir	2	0 65	0 43
	Standley Reservoir	2	0 42	~~0.57~~ 29
		Averages	0 007 μCi/gram	~~0.0007 μCi/gram~~

Samples Dry depth 4 centimeters

A = Controlled Area B = Outside Controlled Area

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Table VIII Water Surveys (continued)

(C) Semiannual Water Collection (Summary 1971)

Concentrations X 10^{9} µCi/ml

Location	No Samples	U + Pu Concentrations Min	Max	Avg	% of Standard[1]	No Samples	Pu Concentrations Min	Max	Avg.	% of Standard[2]
<5 Miles	14	0.55	16.34	3.32	0.06	13	0 05	2 76	0 41	0 02
>5 Miles	16	1.09	34.40	5.85	0.07	16	0 08	0 92	0 25	0 01
Summary	30	0.55	34.40	4.70	0 06	29	0 05	2 76	0 32	0 02

[1] The standard for a soluble mixture of U + Pu in water is $\frac{C_U}{MPC_U} + \frac{C_{Pu}}{MPC_{Pu}} < 1$ Where MPC_U is 10 000 X 10^{9} µCi/ml and MPC_{Pu} is 1 667 X 10^{9} µCi/ml

[2] The standard for soluble ^{239}Pu in water is 1 677 X 10^{9} µCi/ml.

(D) Chemical Concentrations in Holding Ponds and Effluent Waste Waters

1 Pond B-4

Sample Period	Number Samples	Range of pH	Average Concentration (mg/1) NO_3	PO_4^{3}	F	BOD_5	DO***	Total Solids	Cr^{6}
January	20	7 2 - 8 1 7 3-8 0	16 7	10 9	0 5	5 4	26 3	400	<0 005
February	20	7 4 - 8 1 7 4-7 6	6 2	9 2	0 4	9 9	10 8	(681)	<0 005
March	22	7 2 - 1 7 2 7 9	9 4	6 3	0 4	4 5	10 8	406	<0 005
April	19	7 - 7 2 7 8	8 4	4 3	0 4	6 4	11 0	392	<0 005
May	19	- 7 6 8 4	5 5	12 5	0 4	5 8	9 9	456	<0 005
June	22	7 4 - 8 7 7 8 5	3 8	13 3	0 5	7 3	10 3	368	<0 005
Summary	122	7 2 - 8 7 2 8 4	8 3	9 4	0 4	6 6	13 2	450	<0 005
July	21	7 2 8 4	3 4	8 9	0 4	NA	4 4	NA	<0 005
August	22	1 - 7 1 9 6	4 1	7 9	0 4	8 2	4 4	NA	<0 005
September	21	2 - 7 7 2 7 9	3 6	15 4	0 4	7 9	5 3	260	<0 005
October	21	1 - 1 7 1 8 1	7 2	20 7	0 4	6 7	6 2	309	<0 005
November	20	7 - 1 7 7 2 7 7	7 1	22 6	0 7	4 2	8 8	393	<0 005
December	21	1 - 1 7 2 7 8	4 9	17 2	0 4	6 0	9 2	332	<0 005
Summary	126	7 1 - 1 6 7 1 9 6	5	~~15 4~~ 15 5	0 4	6 6	6 4	324	<0 005

**Dissolved oxygen

1971 Summary

			Average Concentration (mg/l)						
Jan Jun	122	7 2 - 8 7 2 8 5	8 3	9 4	0 4	6 6	13 2	450	<0 005
Jul Dec	126	7 1 9 6	5 1	15 4	0 4	6 6	6 4	324	<0 005
Summary	248	7 1 9 6	6 7	12 4	0 4	6 6	9 8	~~392~~ 387	<0 005
Applicable Std	–	6 5 8 5	<45 0	–	<1 2	<30 0	>6	<500	<0 050
% of Std	–	–	14 9	–	~~38.6~~ 30	22 0	38 8	~~76.4~~ 77 4	<10

2 Elemental Analyses (Pond B-4)

Concentrations mg/l

	Number Samples	As	Ba	Be	Cd	Cu	Pb	Mn
Yearly Summary	10	0 02	0 005	0 0004	0 005	0 03	0 002	0 006
Applicable Std	(2)	0 05	1 00	–	0 01	1 00	0 05	0 05 *
% Std	–	40	0 05	–	50	3 0	4 0	12

Run in compliance with State guidelines in lieu of Sodium Adsorption Ratio

**These are not standard relating to the safety of the water but are suggested maximums relating to consumer acceptance thereof

NOTE Cyanide and selenium are not currently run by Rocky Flats Health Physics Department Historically we have depended on the guidance of the Colorado Department of Health Water Pollution Control Commission for these analyses Since basic facilities exist for these analyses however they will be performed in the future as a means of further protection and compliance with both the spirit and the letter of the law

* The 1962 Drinking Water Standards of the U S Public Health Service call for semiannual analysis of these parameters

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Table VIII Water Surveys (continued)

2 Community Tap Water Samples

January – June 1971

Concentrations (X 10 ⁻⁹ μCi/ml)

	U + Pu				Pu					
	Number Samples		Concentrations		Number Samples		Concentrations			
	Taken	<Det	Max	Avg	Taken	<Det	Max	Avg		
Arvada	12	0	16 20	7 64	~~2~~ 9	~~0~~ 7	0 77	0 [illegible]	10	10
Boulder	12	0	6 93	~~3.34~~ 2 32	~~10~~ 9	~~2~~ 0	0 97	0 [illegible]3	32	32
Broomfield	12	0	18 58	2 54	6	0	(5 03)	0 [illegible]8	78	94
Denver	12	0	17 19	5 73	11	2	2 79	0 [illegible]6	44	44
Golden	12	0	8 79	3 40	~~11~~ 10	~~4~~ 2	0 45	0 [illegible]9	1[illegible]	16
Lafayette	12	0	3 23	1 40	~~6~~ 5	~~1~~ 0	0 77	0 [illegible]2	2[illegible]	33
Louisville	12	0	2 45	~~1.24~~ 1.25	~~3~~ 4	~~1~~ 0	0 52	0 [illegible]	28	2
Thornton	12	0	17 48	9 29	~~3~~ 10	~~0~~ 9	0 30	0 [illegible]	06	03
Westminster	12	0	6 49	2 26	~~9~~ 11	~~0~~ 1	~~0.60~~ 1.80	0 [illegible]	38	38

0.0389 X 10⁻⁹ = 1

AVG ① AVG ②

★1 SUB [illegible] fo the [illegible] Liquet

Ø2 [illegible] f(0.0[illegible]) fo the [illegible] Liquet

(B) Radioactivity in Reservoirs and Tap Water Samples (continued)

July – December 1971

	U + Pu				Pu					
	Number Samples		Concentrations		Number Samples		Concentrations			
	Taken	<Det	Max	Avg	Taken	<Det	Max	Avg		
[illegible]	~~11~~ 12	0	7 02	~~4.04~~ [illegible]	7	~~2~~ 1	~~0.45~~ 78	[illegible]	[illegible]	[illegible]
[illegible]	~~11~~ 12	0	8 62	~~1.02~~ [illegible]	10	5	0 03	[illegible]	18	17
Broomfield	~~11~~ 12	0	9 00	~~1.97~~ 2 84	~~9~~ 9	3	~~0.59~~ 82	[illegible]	26	[illegible]
Denver	~~11~~ 12	0	5 77	~~3.86~~ 2 [illegible]	9	~~5~~ 3	0 46 2 03	[illegible]	3	43
Golden	~~11~~ 12	0	9 76	~~2.01~~ 2 82	7	~~2~~ 1	0 47	[illegible]	[illegible]	
Lafayette	~~9~~ 10	0	4 19	~~1.35~~ 1 [illegible]	7	~~2~~ 2	0 82	[illegible]	[illegible]	
Louisville	~~10~~ 11	0	~~4.88~~ 3.15	~~1.64~~ 1.31	~~6~~ 7	1	~~0.20~~ 1 60	[illegible]	[illegible]	[illegible]
Thornton	~~10~~ 11	0	~~8.31~~ 8 60	~~6.12~~ 4 8[illegible]	~~7~~ 6	~~2~~ 1	0 46	[illegible]	21	21
Westminster	~~10~~ 11	0	4 95	1 74	~~6~~ 7	1	~~0.63~~ 1.41	[illegible]	[illegible]	13

1971 Summary

	U + Pu					Pu						
	No Samples		Concentrations		% of	No Samples		Concentration		% of	AVG ①	AVG ②
	Taken	<Det	Max	Avg	Standard[1]	Taken	<Det	Max	Avg	Standard[2]		
Arvada	~~33~~ 24	0	16 20	~~6.03~~ 5 86	0 0	~~9~~ 16	~~9~~ 8	~~0.77~~ 78	0 [illegible]	0 01	16	16
Boulder	~~33~~ 24	0	8 62	~~2.02~~ 1 9	0 03	~~20~~ 19	~~7~~ 5	0 97	0 [illegible]	0 01	24	24
Broomfield	~~33~~ 24	0	18 58	~~2.27~~ 2 69	~~0.04~~ 05	~~13~~ 15	3	(5 03)	0 [illegible]	0 03	[illegible]	[illegible]
Denver	~~33~~ 24	0	17 19	~~4.36~~ 4 31	~~0.05~~ 06	20	~~7~~ 5	2 79	0 [illegible]	~~0.01~~ 03	4	44
Golden	~~33~~ 24	0	9 76	~~3.19~~ 3 11	0 04	~~8~~ 17	~~6~~ 3	~~0.46~~ 47	0 [illegible]	0 01		5
Lafayette	~~21~~ 22	0	4 19	~~1.38~~ 1 42	0 03	~~13~~ 12	~~4~~ 2	0 82	0 [illegible]	0 02		
Louisville	~~22~~ 23	0	~~4.82~~ 3 15	~~1.43~~ 1 27	~~0.02~~ 03	~~9~~ 11	~~3~~ 1	~~0.62~~ 1 60	0 [illegible]	~~0.01~~ 02	[illegible]	[illegible]
Thornton	~~33~~ 23	0	17 48	~~7.39~~ 7 18	0 08	~~10~~ 16	~~5~~ 0	0 46	0 [illegible]	0 01		1
Westminster	~~33~~ 23	0	6 49	~~3.02~~ 2 01	~~0.03~~ 04	~~15~~ 18	~~1~~ 2	~~0.60~~ 1 80	0 [illegible]	0 02		
Summary	202 211	0	18 58	~~3.33~~ 3 32	0 04	~~127~~ 144	~~36~~ 37	(5 03)	0 19	0 01	3[illegible]	.3

( ) Denotes suspect data

[1] The standard for a mixture of soluble U + Pu in water is $\frac{C_U}{MPC_U} + \frac{C_{Pu}}{MPC_{Pu}} = <1$ where $MPC_U = 10\,000 \times 10^{-9}$ μCi/ml and $MPC_{Pu} = 1\,667 \times 10^{-9}$ μCi/ml

The standard for soluble ^{239}Pu in water is 1667 X 10⁻⁹ μCi/ml

[2] Based on soluble ^{241}Am (in water) standard of 1333 X 10⁻⁹ μCi/ml

Table VIII Water Surveys (continued)

(A) Radioactivity in Holding Ponds and Effluent Waste Waters (continued)

4 Walnut Creek at Indiana Water Samples (Rocky Flats Effluent Water Course) (continued)

Yearly Summation

Concentrations (X 10^{9} μCi/ml)

U + Pu			Pu				Am			
Concentrations		% of	Concentrations			% of	Concentrations			% of
Max	Avg	Standard[1]	Min	Max	Avg	Standard[2]	Min	Max	Avg.	Standard[3]
49 34	~~11 55~~ 12 17	~~0.24~~ 23	0 41	8 47	~~2.56~~ 2 26	~~0.15~~ 14	0 01	~~4.39~~ 1 67	~~0.80~~ 60	~~0.06~~ 05

[1] $\frac{C_U}{MPC_U} + \frac{C_{Pu}}{MPC_{Pu}} \leq 1$ where $MPC_U = 10\,000 \times 10^{9}$ μCi/ml and $MPC_{Pu} = 1\,667 \times 10^{9}$ μCi/ml

[2] Based on the soluble ^{239}Pu in water standard of 1667×10^{9} μCi/ml

[3] Based on the soluble ^{241}Am in water standard of 1333×10^{9} μCi/ml

(B) Radioactivity in Reservoirs and Tap Water Samples

1 Reservoir Water Samples

Concentrations (X 10^{9} μCi/ml)

January – June 1971

	U + Pu			Pu				Am		
	Number Samples	Concentrations		Number Samples		Concentrations		Number Samples	Concentrations	
Location	Taken	Max	Avg.	Taken	<Det	Max	Avg.	Taken	Max	Avg
Baseline Reservoir	12	6.06	3 25	11	0	1 68	0 33	–	–	–
Great Western Reservoir	12	6 29	3 12	~~10~~ 12	2	0 64	0 14	4	1 13	0 60
Ralston Reservoir	12	~~28.79~~ 3 40	20 50	10	9	~~0.04~~ 2 53	~~UD~~ 26	–	–	–
Standley Reservoir	~~12~~ 11	17 44	~~5.22~~ 5 23	~~8~~ 10	0	~~0.95~~ 4 93	~~0.30~~ 6	1	0 10	0 10

July – December 1971

	U + Pu			Pu				Am		
	Number Samples			Number Samples				Number Samples		
Location	Taken	Max	Avg.	Taken	<Det	Max	Avg	Taken	Max	Avg.
Baseline Reservoir	~~7~~ 8	6 92	~~3.63~~ 3 27	~~7~~ 8	~~2~~ 3	0 46	~~0.11~~ 13	–	–	–
Great Western Reservoir	~~9~~ 12	16 06	~~2.97~~ 3 70	~~10~~ 12	1	0 82	~~0.37~~ 26	~~8~~ 8	~~0.46~~ 47	0 13
Ralston Reservoir	~~11~~ 12	22 04	~~10.29~~ 10 12	~~8~~ 9	~~8~~ 3	~~0.34~~ 96	~~0.03~~ 20	–	–	–
Standley Reservoir	~~10~~ 11	~~5.16~~ 6 05	~~3.22~~ 3 17	~~10~~ 11	~~0~~ 6	0 24	~~0.06~~ 09	~~8~~ 4	0 12	~~0.16~~ 06

Summation 1971

Concentrations (X 10^{9} μCi/ml)

	U + Pu					Pu					Am			
	No Samples				% of	No Samples				% of	Number			% of
Reservoir	Taken	<Det	Max	Avg.	Std[1]	Taken	<Det	Max	Avg.	Std[2]	Samples	Max	Avg.	Std[3]
Baseline	~~19~~ 20	0	6.92	~~3.39~~ 3 27	0 05	~~18~~ 19	~~2~~ 3	1 68	0 25	0 02	–	–	–	–
Great Western	~~21~~ 24	~~8~~ 1	16 06	~~3.05~~ 3 41	0 04	~~20~~ 24	3	0 82	~~0.34~~ 20	0 01	~~8~~ 12	1 13	~~0.32~~ 29	0 02
Ralston	~~23~~ 24	0	~~28.79~~ 30 40	~~15.62~~ 3 ~~0.15~~ 17		~~18~~ 19	~~15~~ 12	~~0.24~~ 2 53	~~0.04~~ 3	~~0.002~~ 01	–	–	–	–
Standley	22	0	17 44	~~3.45~~ 4 20	~~0.04~~ 06	19	4	~~0.95~~ 4 93	~~0.16~~ 37	~~0.01~~ 02	~~8~~ 5	0 12	~~0.06~~ 07	0 01
Summary	~~85~~ 90	~~8~~ 1	~~28.79~~ 30 40	~~6.38~~ 6 76	~~0.06~~ 08	~~65~~ 81	~~24~~ 22	~~1.68~~ 4 93	~~0.11~~ 26	~~0.01~~ 02	~~15~~ 17	1 13	22	02

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Table VIII Water Surveys (continued)

(A) Radioactivity in Holding Ponds and Effluent Waste Waters

3. Grab Water Samples – Ponds A and C (Holding Ponds)

	Pond (A) X 10^{-9} µCi/ml				Pond (C) X 10^{-9} µCi/ml			
	No Samples		Concentrations		No Samples		Concentrations	
	Taken	<Det	U+Pu	Pu	Taken	<Det	U+Pu	Pu
Jan	4	0	~~7.00~~ 9 07	0 51	4	0	6 98	0 26
Feb	4	0	8 88	0 42	4	0	10 98	0 72
Mar	4	0	7 09	0 31	4	0	5 66	0 25
Apr	5	0	6.62	1 12	5	0	6 44	1 13
May	4	0	6.23	0 85	4	0	6 73	0 31
Jun	5	0	4 63	1 21	5	0	4 52	0 94
Jul	4	0	3 93	0 97	4	0	4 19	0 47
Aug	4	0	7 27	0 66	4	0	8 63	0 50
Sep	5	0	6 13	~~0.68~~ 51	5	0	6 90	0 52
Oct	4	0	6 85	0 32	4	0	4 32	0 48
Nov	~~4~~ 3	0	9 04	~~0.40~~ 38	4	0	3 80	0 79
Dec	5	0	13 75	0 79	5	0	4 47	0 41

1971 Summary

	U + Pu X 10^{-9} µCi/ml						Plutonium X 10^{-9} µCi/ml					
	No Samples		Concentrations			Percent of	No. Samples		Concentrations			Percent of
	Taken	<Det	Min.	Max.	Avg.	Standard[1]	Taken	<Det	Min	Max	Avg	Standard[2]
Pond A	~~26~~ 51	0	1 33	~~17.62~~ (29 97)	~~7.38~~ 9 30	0 11	~~26~~ 49	0	0 04	2 76	0 68	0 04
Pond C	~~26~~ 51	0	~~1.06~~ 82	23 64	6 14	0 09	~~26~~ 52	0	0 06	~~2.40~~ 3.84	~~0.69~~ 58	0 03

[1] Gross alpha standard is $\frac{C_U}{MPC_U} + \frac{CPu}{MPC_{Pu}} < 1$ Where $MPC_U = 10\,000 \times 10^{-9}$ µCi/ml, $MPC_{Pu} = 1667 \times 10^{-9}$ µCi/ml

[2] The plutonium standard is 1667 X 10^{-9} µCi/ml.

(A) Radioactivity in Holding Ponds and Effluent Waste Waters

4. Walnut Creek at Indiana Water Samples (Rocky Flats Effluent Water Course)

Concentrations (X 10^{-9} µCi/ml)

	U + Pu				Pu				Am			
Sample Period	Number Samples	Concentrations Min	Max	Avg.	Number Samples	Concentrations Min	Max	Avg	Number Samples	Concentrations Min	Max	Avg.
January	~~3~~ 2	2 85	19 71	~~11.93~~ 11 29	~~3~~ 2	~~1.10~~ 1 26	2 68	~~1.69~~ 1 98	1	0 73	0 73	0 73
February	4	13 69	30 06	19 30	4	0 86	8 47	4 36	3	0 68	~~1.40~~ 1 62	1 25
March	5	4.76	11 53	~~8.74~~ 5 91	5	1 36	3 33	2 52	~~3~~ 2	~~0.18~~ 20	~~4.39~~ 1 62	~~1.91~~ 1 15
April	4	6.32	13 68	11 18	4	1 14	3 10	2 09	~~4~~ 3	~~0.01~~ 49	~~2.68~~ 93	~~0.93~~ [illegible]
May	4	7 15	12.43	9 91	4	0 67	6 59	2 68	2	0 40	0 47	0 44
June	~~4~~ 5	6.40	11.43	~~9.12~~ 1 03	~~4~~ 5	1 28	~~2.37~~ 3 21	~~2.04~~ 2 06	~~2~~ 5	0 30	1 25	~~0.67~~ 53
July	4	3 87	29 54	11 67	4	1 54	3 61	2 56	2	0 41	0 80	~~0.60~~ 41
August	4	3 73	36.58	13 16	5	1 03	3 14	1 65	5	0 30	0 68	0 49
September	4	2.18	22 10	9 07	4	0 08	7 99	2 41	4	0 01	0 29	~~0.14~~ 19
October	4	3 12	49 34	16 87	4	0 41	2 84	1 96	~~3~~ 2	0 21	0 77	0 49
November	5	3 97	~~6.87~~ 5 35	~~5.85~~ 15.89	5	0 67	3 80	1 64	~~0~~ 5	–	–1 03	– 46
December	3	5 77	12 81	8 96	3	0 83	1 33	1 03	0	–	–	–

Yearly Summary

	U + Pu				Pu				Am			
Sample Period	Number Samples	Concentrations Min	Max	Avg.	Number Samples	Concentrations Min	Max	Avg	Number Samples	Concentrations Min	Max	Avg.
Jan-Jun	24	2.85	30 06	~~12.23~~ 11 41	24	0 67	8 47	~~2.56~~ 64	~~18~~ 16	~~0.01~~ 30	~~4.39~~ 1 62	~~1.11~~ 79
Jul-Dec	25	2.18	49 34	~~10.90~~ 12.90	25	0 41	7 99	~~0.96~~ 1 89	~~14~~ 18	0 01	~~0.80~~ 1 05	~~0.42~~ 43
Summary	49 (0)	2.18	49.34	~~11.55~~ 12 17	49 (0)	0 41	8 47	~~2.56~~ 6	~~33 (2)~~ 34 (1)	0 01	~~4.39~~ 1 62	~~0.80~~ 60

( ) Denotes less than detection limits

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Table VII Dustfall Samples, 1971 Yearly Summary

(Plutonium)

	No Samples Taken	No Samples Less Than Detection Limit	Sample Days	1971 Maximum (Single Sample) Concentration (pCi/M²)	Total Deposition (pCi/M²)	Deposition Rate (pCi/M²/month)
Arvada	23	4	362	16 11	77 44	5.30
Broomfield	22	11	348	28 88	74 48	3 21
Boulder	18	14	334	28 59	85 69	1 71
Coal Creek	19	11	292	21 66	50 76	2 20
Denver	22	11	341	53 87	118 27	5 20
Eastlake	23	11	362	6 00	49 84	2 15
Golden	*22 (21)	8	*348 (334)	*(174 16)	*219 55 (45 39)	12 04 (2 65)
Lafayette	22	13	348	11 77	46 26	1 63
Marshall	23	10	362	67 70	149 04	6 98
Superior	21	8	334	16 11	74 20	4 13
Wagner	20	6	292	13 17	9 61	0 69
Westminster	22	7	341	17 30	41 36	2 48
Summary	*257 (256)	114	*4064 (4050)	*(174 16) (67 70)	*996 50 (822 34)	4 09 (3 38)
Berthoud	7	2	310	5 58	12 98	0 90
Castle Rock	9	7	358	2 46	7 73	0 14
Summary	16	9	668	5 28	20 73	0 41

*Based on highly suspect data The removal of one single aliquot sample reduces the total deposition at Golden to 45 39 pCi/M² and the total (summary) deposition rate to 3 38 pCi/M²/month

Table VIII Water Surveys.

(A) Radioactivity in Holding Ponds and Effluent Waste Water

1 Pond B-4 (Effluent Waste Water)

Concentrations (X 10⁹ μCi/ml)

Sample Period	No Samples	Effluent Volume (million liters)	U + Pu Concentrations Max	U + Pu Concentrations Avg	U + Pu Release (mCi)	Pu Concentrations Max	Pu Concentrations Avg	Pu Release (mCi)	Am Concentrations Avg	Am Concentrations Max	Am Release (mCi)
January	4	36 01	36 64	14 33	0 516	4 01	2 29	0 082	3 07	~~1.09~~	~~0.112~~ 111
February	4	34 85	27 73	24 74	0 862	7 23	2 92	0 101	1 20	1 36	0 042
March	4	49 18	~~19 19~~ 19 29	13 15	0 647	4 32	2 86	0 141	1 89	2 67	0 093
April	5	41 21	~~19.29~~ 19 /5	14 75	0 608	5 23	2 99	0 123	~~1.31~~ 1 61	2 39	~~0.063~~ 066
May	4	32 36	~~19 98~~ 19 06	12 54	0 406	4 59	2 63	0 085	0 94	2 26	0 030
June	5	28 15	10 30	8 33	0 234	2 61	1 60	0 045	1 37	2 18	0 039
July	~~8~~ 4	23 95	8 95	~~6.14~~ 5 79	~~0.147~~ 137	6 09	~~2.98~~ 3 70	~~0.070~~ 096	1 03	1 29	0 025
August	4	30 47	18 75	11 34	0 346	2 77	1 05	0 032	0 42	0 52	0 013
September	5	33 69	11 19	~~7.14~~ 6 73	~~0.241~~ 233	~~2.04~~ 4	~~2.72~~ 1 29	~~0.092~~ 043	0 65	1 08	0 022
October	4	42 64	5 75	5 61	0 239	1 59	1 01	0 043	0 06	~~0.16~~ 14	0 003
November	4	47 61	(15 08)	10 67	0 508	0 98	0 59	0 028	~~NA~~ 76	~~NA~~ 1 30	~~NA~~ 036
December	5	53 79	~~(28.89)~~ 18 59	11 48	0 618	1 56	1 09	0 059	NA	NA	NA

( ) denotes suspect data NA – No Analysis

2. Yearly Summation Pond B-4 (Effluent Waste Water Total Volume 1971 = ~~232,150 000~~ 152 112 000 Liters)

Concentrations (X 10⁹ μCi/ml)

Sample Period	U + Pu Number Samples Taken	U + Pu Concentrations Max	U + Pu Concentrations Avg.	U + Pu Release (mCi)	Pu Number Samples Taken	Pu Concentrations Max	Pu Concentrations Avg	Pu Release (mCi)	Am (1) Concentrations Max	Am (1) Concentrations Avg	Am (1) Release (mCi)
Jan Jun	26	36 64	~~14 64~~ 14 76	3 273	26	7 23	~~2.55~~ 61	~~0.577~~ 578	3 07	~~1.60~~ 1 72	~~0.378~~ 381
Jul Dec	~~27~~ 26	~~(28 89)~~ 18 59	~~8.73~~ 8 15	~~2.098~~ 2 082	~~27~~ 26	6 09	~~1.56~~ 1 21	~~0.324~~ 282	1 29	~~0.53~~ 55	~~0.063~~ 129
Summary	~~53~~ 52	36 64	~~11 69~~ 11 99	~~5.371~~ 5 355	~~53~~ 52	7 23	~~2.06~~ 1 87	~~0.981~~ 860	3 07	~~1.00~~ 1 12	~~0.441~~ 508

(1) Jul DEC Am Avg (calculated from Five Month Data

Jul DEC Release AV X Jul Dec Effluent summary AV. = 508 – Total Effluent

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Table VII Dustfall Samples, 1971 Yearly Summary

(Plutonium)

	No Samples Taken	No Samples Less Than Detection Limit	Sample Days	1971 Maximum (Single Sample) Concentration (pCi/M²)	Total Deposition (pCi/M²)	Deposition Rate (pCi/M²/month)
Arvada	23	4	362	16 11	77 44	5 30
Broomfield	22	11	348	28 88	74 48	3 21
Boulder	18	14	334	28 59	85 69	1 71
Coal Creek	19	11	292	21 66	50 76	2 20
Denver	22	11	341	53 87	118 27	5 20
Eastlake	23	11	362	6 00	49 84	2 15
Golden	*22 (21)	8	*348 (334)	(174 16)	*219 55 (45 39)	*12 04 (2 65)
Lafavette	22	13	348	11 77	46 26	1 63
Marshall	23	10	362	67 70	149 04	6 98
Superior	21	8	334	16 11	74 20	4 13
Wagner	20	6	292	13 17	9 61	0 69
Westminster	22	7	341	17 30	41 36	2 48
Summary	*257 (256)	114	*4064 (4050)	(174 16) (67 70)	*996 50 (822 34)	*4 09 (3 38)
Berthoud	7	2	310	5 58	12 98	0 90
Castle Rock	9	7	358	2 46	7 73	0 14
Summary	16	9	668	5 28	20 73	0 41

Based on highly suspect data The removal of one single aliquot sample reduces the total deposition at Golden to 45 39 pCi/M² and the total (summary) deposition rate to 3 38 pCi/M²/month

Table VIII Water Surveys.

(A) Radioactivity in Holding Ponds and Effluent Waste Water

1 Pond B 4 (Effluent Waste Water)

Concentrations (X 10 μCi/ml)

Sample Period	No Samples	Effluent Volume (million liters)	U + Pu Concentrations Max	U + Pu Concentrations Avg	U + Pu Release (mCi)	Pu Concentrations Max	Pu Concentrations Avg	Pu Release (mCi)	Am Concentrations Avg.	Am Concentrations Max	Am Release (mCi)
January	4	36 01	36 64	14 33	0 516	4 01	2 29	0 082	3 07	–	0 112
February	4	34 85	27 73	24 74	0 862	7 23	2 92	0 101	1 20	1 36	0 042
March	4	49 18	19 19	13 15	0 647	4 32	2 86	0 141	1 89	2 67	0 093
April	5	41 21	19 29	14 75	0 608	5 23	2 99	0 123	1 51	2 39	0 062
May	4	32 36	19 98	12 54	0 406	4 59	2 63	0 085	0 94	2 26	0 030
June	5	28 15	10 30	8 33	0 234	2 61	1 60	0 045	1 37	2 18	0 039
July	5	23 95	8 95	6 14	0 147	6 09	2 92	0 070	1 03	1 29	0 025
August	4	30 47	18 75	11 34	0 346	2 77	1 05	0 032	0 42	0 52	0 013
September	5	33 69	11 19	7 14	0 241	7 04	2 72	0 092	0 65	1 08	0 022
October	4	42 64	5 75	5 61	0 239	1 59	1 01	0 043	0 06	0 16	0 003
November	4	47 61	(15 08)	10 67	0 508	0 98	0 59	0 028	NA	NA	NA
December	5	53 79	(28 89)	11 48	0 618	1 56	1 09	0 059	NA	NA	NA

( ) denotes suspect data NA – No Analysis

2 Yearly Summation Pond B 4 (Effluent Waste Water Total Volume 1971 = 232 150 000 Liters)

Concentrations (X 10 ⁹ μCi/ml)

Sample Period	Number Samples Taken	U + Pu Concentrations Max	U + Pu Concentrations Avg	U + Pu Release (mCi)	Number Samples Taken	Pu Concentrations Max	Pu Concentrations Avg	Pu Release (mCi)	Am Concentrations Max	Am Concentrations Avg	Am Release (mCi)
Jan Jun	26	36 64	14 64	3 273	26	7 23	2 55	0 577	3 07	1 50	0 378
Jul Dec	27	(28 89)	8 73	2 098	27	6 09	1 56	0 324	1 29	0 53	0 063
Summary	53	36 64	11 69	5 371	53	7 23	2 06	0 901	3 07	1 00	0 441

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Table VIII Water Surveys (continued)

(A) Radioactivity in Holding Ponds and Effluent Waste Waters

3. Grab Water Samples – Ponds A and C (Holding Ponds)

	Pond (A) X 10 ⁹ μCi/ml				Pond (C) X 10 ⁹ μCi/ml			
	No Samples		Concentrations		No Samples		Concentrations	
	Taken	<Det	U+Pu	Pu	Taken	<Det	U+Pu	Pu
Jan	4	0	7 00	0 51	4	0	6 98	0 26
Feb	4	0	8 88	0 42	4	0	10 98	0 72
Mar	4	0	7 09	0 31	4	0	5 66	0 25
Apr	5	0	6 62	1 12	5	0	6 44	1 13
May	4	0	6 23	0 85	4	0	6 73	0 31
Jun	5	0	4 63	1 21	5	0	4 52	0 94
Jul	4	0	3 93	0 97	4	0	4 19	0 47
Aug	4	0	7 27	0 66	4	0	8 63	0 50
Sep	5	0	6 13	0 58	5	0	6 90	0 52
Oct	4	0	6 85	0 32	4	0	4 32	0 48
Nov	4	0	9 04	0 40	4	0	3 80	0 79
Dec	5	0	13 75	0 79	5	0	4 47	0 41

1971 Summary

	U + Pu X 10 ⁹ μCi/ml						Plutonium X 10 ⁹ μCi/ml					
	No Samples		Concentrations			Percent of	No Samples		Concentrations			Percent of
	Taken	<Det	Min	Max	Avg	Standard[1]	Taken	<Det	Min	Max	Avg	Standard[2]
Pond A	26	0	1 33	17 62	7 28	0 11	26	0	0 04	2 76	0 68	0 04
Pond C	26	0	1 06	23 64	6 14	0 09	26	0	0 06	2 40	0 57	0 03

[1] Gross alpha standard is $\frac{C_U}{MPC_U} + \frac{CPu}{MPC_{Pu}} \leq 1$ Where $MPC_U = 10\,000 \times 10^{9}$ μCi/ml, $MPC_{Pu} = 1667 \times 10^{9}$ μCi/ml

[2] The plutonium standard is 1667 X 10 ⁹ μCi/ml

(A) Radioactivity in Holding Ponds and Effluent Waste Waters

4 Walnut Creek at Indiana Water Samples (Rocky Flats Effluent Water Course)

Concentrations (X 10 ⁹ μCi/ml)

	U + Pu				Pu				Am			
Sample	Number	Concentrations			Number	Concentrations			Number	Concentrations		
Period	Samples	Min	Max	Avg	Samples	Min	Max	Avg	Samples	Min	Max	Avg.
January	3	2 85	19 71	11 93	3	1 10	2 68	1 69	1	0 73	0 73	0 73
February	4	13 69	30 06	19 30	4	0 86	8 47	4 36	3	0 68	1 40	1 25
March	5	4 76	11 53	8 74	5	1 36	3 33	2 52	5	0 18	4 39	1 91
April	4	6 32	13 68	11 18	4	1 14	3 10	2 09	4	0 01	2 68	0 93
May	4	7 15	12 43	9 91	4	0 67	6 59	2 68	2	0 40	0 47	0 44
June	4	6 40	11 43	9 12	4	1 28	2 37	2 04	2	0 30	1 25	0 57
July	4	3 87	29 54	11 67	4	1 54	3 61	2 56	2	0 41	0 80	0 60
August	5	3 73	36 58	13 16	5	1 03	3 14	1 65	5	0 30	0 68	0 49
September	4	2 18	22 10	9 07	4	0 08	7 99	2 41	4	0 01	0 29	0 14
October	4	3 12	49 34	16 87	4	0 41	2 84	1 96	3	0 21	0 77	0 49
November	5	3 97	6 87	5 85	5	0 67	3 80	1 64	0	–	–	–
December	3	5 77	12 81	8 96	3	0 83	1 33	1 03	0	–	–	–

Yearly Summary

	U + Pu				Pu				Am			
Sample	Number	Concentrations			Number	Concentrations			Number	Concentrations		
Period	Samples	Min	Max	Avg.	Samples	Min	Max	Avg	Samples	Min	Max	Avg
Jan Jun	24	2 85	30 06	12 23	24	0 67	8 47	2 56	19	0 01	4 39	1 11
Jul Dec	25	2 18	49 34	10 90	25	0 41	7 99	0 96	14	0 01	0 80	0 42
Summary	49 (0)	2 18	49 34	11 55	49 (0)	0 41	8 47	2 56	33 (2)	0 01	4 39	0 80

( ) Denotes less than detection limits

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On Site Be for table VI

	$\sum_{days} C_o$	N_{days}	av C_o	$N_{samples}$	$\sum C_i - C_o$	av C	⇓
Jan	240	29	8 276	240	0	8.276	0008
Feb	228	28	8 143	228	692	11 178	0011
Mar	276	33	8 364	275	133	8.847	0009
Apr	252	30	84	251	0	8.4	.0008
May	216	24	9	213	2197	19.315	0019
Jun	264	33	8.	264	4	8.015	0008
6 month	1476	177	8 339	1471	3026	10.396	0010
Jul	252	30	8 4	250	834	11.736	0012
Aug	264	32	825	264	0	825	.0008
Sep	240	28	8 571	240	3882	24.746	.0025
Oct	240	28	8 571	240	1375	14 301	.0014
Nov	240	28	8 571	240	0	8.571	0009
Dec	228	27	8 444	228	0	8 444	.0008
6 month	1464	173	8.462	1462	6091	12.627	0013
year	2940	350	8.4	2933	9117	11.508	.0012
							av conc
							$\mu g/m^3$

standard = $.01 \mu g/m^3$

Off site Be for table VI

	Σvol_i	$\Sigma(c_i - c_o) vol_i$		c_o	c	⇓
Jan	352285	43612		00105	01343	0134
Feb				.00085	00085	0009
Mar				00115	00115	0012
Apr				0012	0012	0012
May	333616	2.884		0012	00021	0.0021
Jun				001175	00118	.0012
6 month	2187037	46.496	$\frac{0277}{25} =$	001108	00323	.0032
Jul	400111	2.993		0011	00185	.0019
Aug				.0011	0011	0011
Sep				00077	00077 ~~00077~~	0008
Oct	459729	4896		0011	.00216	.0022
Nov				0011	0011	0011
Dec				0010	0010	0010
6 month	204659	7.889	$\frac{0246}{24} =$	001025	00141	0014
year	422896	54385			00235	0024

av conc $\mu g/M^3$

Table IV(B) page 23

1 Pu Conc

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
S 26	— **	0.00014	0.00020	0.00012	0.00024	0.00019	0.00007	0.00023	0.00012	0.00022	0.00017	0.00053	
S 27	—	0.00008	0.00022	0.00012	0.00025	0.00027	0.00015	0.00031	0.00014	0.00046	—***	0.00047	
S 28	—	0.00017	0.00019	0.00012	0.00020	0.00027	0.00013	0.00029	0.00033	0.00012	—***	—***	
S 29	—	0.00019	0.00016	0.00011	0.00023	0.00041	0.00028	0.00083	0.00022	0.00019	0.00017	0.00024	
S 30	—	0.00011	0.00016	0.00010	0.00026	0.00030	0.00019	0.00024	0.00012	—***	—***	—***	
S 31	—	0.00009	0.00015	0.00022	0.00053	0.00028	0.00019	0.00050	0.00023	0.00014	0.00020	0.00030	
S 32	—	0.00019	0.00033	0.00016	0.00028	0.00124	0.00011	0.00028	0.00026	0.00193	—***	[redacted]*	— 0.00005
S 33	—	0.00025	0.00030	0.00020	0.00033	0.00030	0.00018	0.00026	0.00021	0.00009	0.00013	0.00022	
S 34	—	0.00020	0.00[illegible]	0.00014	0.00031	0.00009	0.00012	0.00022	UD*	—***	—***	[redacted]*	— 0.00017
S 35	—	0.00016	0.00021	0.00016	0.00027	0.00021	0.00016	0.00022	0.00016	0.00031	UD*	0.00039	
S 36	—	0.00011	0.00035	0.00021	0.00025	0.00026	0.00012	0.00029	0.00022	0.00020	0.00017	0.00016	
S 37	—	0.00016	0.00092	0.00030	0.00027	0.00028	0.00011	0.00032	0.00029	0.00460	UD*	—***	

2 Yearly Summary

	Mean Conc. ± Sigma ± mpc	Ave. ±	Mean Conc. ± Sigma ± mpc	[illegible]	[illegible]	% Std	Total N Samples	No Reliable Detect. Limit
S 26	0.00041	0.00021	0.00041	0.00013	0.00017	0.89	41	11
S 27	0.00044	0.00020	0.00013	0.00029	0.00021	1.07	35	5
S 28	0.00044	0.00019	0.00073	0.00025	0.00021	1.06	33	2
S 29	0.00068	0.00022	0.00132	0.00029	0.00026	1.30	44	5
S 30	0.00056	0.00019	0.00043	0.00020	0.00019	0.97	30	3
S 31	0.00064	0.00023	0.00053	0.00024	0.00029	1.18	43	2
S 32	0.00428	0.00046	0.00193	0.00022	0.00034	1.30	34	4
S 33	0.00063	0.00028	0.00083	0.00019	0.00023	1.16	44	4
S 34	0.00092	0.00026	0.00028	0.00016	0.00023	1.14	28	4
S 35	0.00043	0.00022	0.00066	0.00021	0.00022	1.08	37	5
S 36	0.00070	0.00025	0.00087	0.00018	0.00021	1.05	43	6
S 37	0.00222	0.00041	0.00464	0.00023	0.00039	1.70	32	6
	Yearly Summation, Total Averages						444	57

Table III Average Monthly Air Sample Concentrations On-Site Radioactive

(A) Total Long Lived Alpha Concentrations (U Pu and naturally occurring alpha emitters)

Monthly Average Concentrations (X 10^{12} μCi/ml)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S 1	0 0044	0 0033	0 0046	0 0036	0 0057	0 0052	0 0034	0 0040	0 0045	0 0049	0 0035	0 0038
S 2	0 0045	0 0044	0 0039	0 0046	0 0060	0 0027	0 0025	0 0056	0 0029	0 0044	0 0040	0 0047
S-3	0 0033	0 0028	0 0033	0 0059	0 0052	0 0048	0 0054	0 0066	0 0057	0 0052	0 0046	0 0043
S-4	0 0021	0 0044	0 0047	0 0067	0 0042	0 0040	0 0046	0 0041	0 0035	0 0034	0 0034	0 0034
S-5	0.0017	0.0040	0 0032	0 0036	0.0047	0 0060	0 0053	0 0026	0 0034	0 0058	0 0069	0 0034
S-6	0.0031	0 0030	0 0028	0 0037	0 0052	0 0034	0 0145	0 0020	0 0032	0 0021	0 0068	0 0030
S-7	0 0082	0 0066	0 0054	0 0082	0 0043	0 0047	0 0026	0 0034	0 0022	0 0034	0 0012	0 0045
S-8	0 0058	0 0069	0 0078	0 0324	0 0090	0 0103	0 0096	0 0110	0 0056	0 0128	0 0114	0 0071
S 9	0 0043	0 0040	0 0041	0 0039	0 0036	0 0042	0 0043	0 0036	0 0026	0 0028	0 0013	0 0049
S-10	0 0046	0 0052	0 0041	0 0092	0 0047	0 0073	0 0029	0 0030	0 0040	0 0062	0 0040	0 0038
S-50	0 0042	0 0026	0 0045	0 0085	0 0048	0 0078	0 0052	0 0086	0 0059	0 0076	0 0064	0 0036
S-51	0 0044	0 0051	0 0036	0 0067	0 0046	0 0037	0 0024	0 0020	0 0041	0 0054	0 0044	0 0056

Applicable Standard (Soluble Plutonium 239) = 0 02 X 10^{-12} μCi/ml

(B) Summary Total Long Lived Alpha On-Site 1971

Concentration (X 10^{12} μCi/ml)

Location	No of Samples	<Det	C_{Max}	C_{Avg}	% of Std
S-1	243	125	0 0218	0 0043	21 6
S-2	241	140	0 0420	0 0040	20 0
S-3	245	124	0 0218	0 0047	23 6
S-4	244	142	0 0333	0 0040	20 0
S-5	245	132	0 0228	0 0042	21.2
S-6	245	161	0 2723	0 0043	21 5
S-7	245	136	0 0822	0 0046	22 8
S-8	245	81	0 1884	0 0104	52.0
S-9	244	146	0 0368	0 0036	17 9
S-10	237	112	0 0228	0 0047	23.4
S-50	244	120	0 1436	0 0058	28 8
S-51	244	135	0 0341	0 0043	21 5
Yearly Summation Total Averages	2922	1554	0 2723	0 0049	24 5

This sampler (S-8) is located within the strongest most frequent wind vector and is adjacent to the asphalt pad covering some contaminated soil The large volumes of dirt thus seen by this sampler may be indicative of resuspension mechanisms It is worthy of note that this the highest concentration-location is still less than 40% of the applicable standard when stated in terms of yearly averages

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Table IV Average Monthly Air Sample Concentrations Off-Site Radioactive

(A) Low-Volume Programmed Samplers

1 Total Long Lived Alpha Concentrations 1971 (U Pu and naturally occurring alpha emitters)

Monthly Average Concentrations (X 10^{12} μCi/ml)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boulder (S-15)	0 0036	0 0039	UD	0 0049	0 0074	0 0061	0 0044	0 0056	0 0077	0 0078	0 0036	0 0034
Broomfield (S-17)	0 0041	0 0060	0 0066	0 0056	0 0026	0 0031	UD	0 0044	0 0046	UD	0.0031	0 0035
Coal Creek (S-11)	0 0031	0 0041	0 0022	0 0062	0 0022	0 0036	UD	UD	UD	0 0027	0 0029	0 0023
Denver (S-23)	0 0022	0 0014	0 0085	0 0068	0 0029	0 0055	0 0024	0 0069	0 0059	0 0032	0 0030	0 0024
Golden (S-20)	0 0039	0 0047	0 0061	0 0062	0 0052	UD	UD	UD	0 0040	0 0118	UD	0 0037
Lafayette (S-16)	0 0063	0 0079	0 0055	0 0068	0 0078	0 0065	0 0034	0 0033	0 0073	0 0031	0 0025	0 0083
Marshall (S-13)	0 0042	0 0024	UD	UD	0 0023	UD	0 0023	0 0022	0 0036	0 0021	UD	UD
Wagner (S-18)	0 0053	UD	UD	0 0105	0 0080	0 0130	0 0083	0 0033	0 0082	0 0032	0 0029	0 0050
Westminster (S-25)	0 0050	UD	0 0026	0 0085	UD	0 0137	0 0052	0 0063	UD	0 0060	0 0024	0 0038

Applicable Standard (unidentified alpha emitters) = 0 0067 X 10^{-2} μCi/ml

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Table I Radioactive Stack Effluent Release 1971 (continued)

(D) Yearly Summary – Uranium (continued)

Concentrations (X 10^{12} μCi/ml)

Building	January – June Maximum Concentration ~~(one month average)~~	January – June (Monthly) Average Concentration	July – December Maximum Concentration (one month average)	July – December (Monthly) Average Concentration	Total Year Concentration Max (Bldg)	Total Year Concentration Av (Bldg)	Total Year % Std (Av Conc)	Total Year Total Release (μCi)
~~895~~	~~0.004~~	0 002	~~0 001~~	0 001	~~0.004~~	0 002	~~0 1~~	~~0 803~~
991 T	~~0.007~~	0 002	~~0 007~~	0 001	~~0 007~~	0 002	~~0 1~~	~~0 033~~
Total Uranium Operations Yearly Summation					~~0 077~~	0 008	0 3	~~98 690~~

Maximum monthly average emission 0 071 X 10^{12} μCi/ml (Building 447 January)

*Maximum single sample concentration Both maximums associated with filter changes in the plenums of this building

** Although Rocky Flats effluents would include several isotopes of uranium the guideline for soluble 238 is the most restrictive in air It must be noted that this standard applies at the plant boundary and is in terms of yearly averages to an individual in the general population The values here all well below that standard are taken at the stack before any atmospheric dilution

Table II Non-Radioactive Stack Effluent Releases 1971

(A) Beryllium

Monthly Average Concentrations (X 10^{6} mg/M^3)

Building	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
444 447	2 2	5 1	3 0	2 2	1 8	0 7	15 0	2 0	2 8	1 2	0 2	~~1 1~~ 157
883A	1 0	3 2	0 5	0 2	0 2	0 2	0 3	0 2	~~1 1~~	0 2	0 2	0 2
779	0 3	0 7	0 3	0 3	0 3	0 3	0 3	0 5	0 2	0 6	3 6	0 6
774	0 8	0 6	0 3	0 5	0 5	0 5	0 3	0 3	0 2	0 2	0.5	0 5
865	0 5	2 0	0 4	0 2	0 5	0 5	0 2	0 2	0 2	1 0	0 2	0 2
Total Monthly Release (grams)	~~0.8226~~	2 0923	1 2391	0 6988	0.6192	0 3700	4 4909	0.8021	0 8809	~~0.5191~~	0 0940	~~4.2010~~

(B) Annual Summary

Beryllium Stack Effluent Releases (X 10^{6} mg/M^3)

Building	January – June Maximum Single-Sample Concentration	January – June Average Concentration	July – December Maximum Single Sample Concentration	July – December Average Concentration	Totals for Year Max Conc	Totals for Year Av Conc	Totals for Year % Std	Totals for Year Total Release (g)
444-447	45 0	2 6	209 2	~~6.8~~	209 2	~~4 2~~	~~42~~	~~15.1879~~ 16
883A	25 2	0 3	1 2	~~0 5~~	25 2	0 6	6	0.0793
779	5 1	0 4	7 7	~~0 9~~	~~7 7~~	~~0.6~~	6	~~0.0262~~
774	2 4	0 3	~~0 4~~	~~0.2~~	2 4	0.5	5	~~0.8146~~
865	9 8	~~1.0~~	7 0	~~0 4~~	9 8	~~0.7~~	7	~~0 7220~~
Total Beryllium Operations Yearly Summation					209 2	1 3	~~13 0~~	Total ~~16.8301~~

Applicable Standard is 10 X 10 mg/M^3 (Division Internal Goal is 5 X 10^{6} mg/M^3)

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Table I Radioactive Stack Effluent Releases 1971

(A) Plutonium

Monthly Concentrations (X 10^{12} μCi/ml)

Building	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
771	0 005	0 005	0 005	0 015	0 007	0 012	0 007	0 006	0 015	0 012	0 004	0 006
774	0 015	0 010	0 011	0 014	0 060	0 013	0 008	0 007	0 012	0 010	0 013	0 015
776	0 004	0 095	0 033	0 006	0 018	0 011	0 003	0 003	0 002	0 009	0 002	0 002
779	0 007	0 002	0 002	0 002	0 002	0 002	0 002	0 002	0 002	0 002	0 002	0 002
559	0 003	0 002	0 002	0 002	0 003	0 003	0 003	0 002	0 002	0 002	0 002	0 002
707	0 003	0 002	0 005	0 003	0 005	0 004	0 003	0 004	0 003	0 002	0 080	0 004
Total Releases by Month (μCi)	2 852	17 240	8 017	5 989	8 286	5 838	2 671	2 680	5 096	5 270	7 884	2 546

Applicable Standard (Soluble ^{239}Pu) = 0 06 X 10^{12} μCi/ml

(B) Yearly Summary – Plutonium

Concentrations (X 10^{12} μCi/ml)

Building	January – June: Maximum Concentration (Single Sample)	January – June: (Monthly) Average Concentration	July – December: Maximum Concentration (Single Sample)	July – December: (Monthly) Average Concentration)	Total Year: Concentration Max (Bldg)	Total Year: Concentration Av (Bldg)	Total Year: % Std (Av Conc)	Total Year: Total Release (μCi)
771	0 015	0 008	0.008	0 007	0 015	0 008	13 3	26.427
774	0.109	0 021	0.013	0 011	0 109	0 016	26 7	6.034
776	0 087	0 028	0 009	0 004	0 087	0 016	26 7	33.052
779	0 006	0 003	0 002	0 002	0 006	0 002	3 3	0 344
559	0 004	0 003	0 004	0 002	0 004	0 002	3 3	0 766
707	0 004	0 004	0 080	0 016	0 080	0 010	16 7	7 726
Total Plutonium Operations Yearly Summation					0.109	0 009	15%	74 349

The maximum monthly average emission (which occurred during filter changing operations in Building 776 in February) was 0 095 X 10^{12} μCi/ml The maximum single sample emission (0.10 X 10^{-12} μCi/ml) was from Building 776 It must be noted that these values are taken at the stack BEFORE appropriate atmospheric dilution The standards apply at the plant perimeter and are in terms of averages of up to one year The annual average Pu emission from ALL Pu operations was 0 009 X 10^{12} μCi/ml about 15% of the applicable standard (0 06 X 10^{12} μCi/ml)

Filter changing operations

Effluents leaking around one stage of filter plenum Discovered and corrected

(C) Uranium

Monthly Average Concentrations (X 10^{12} μCi/ml)

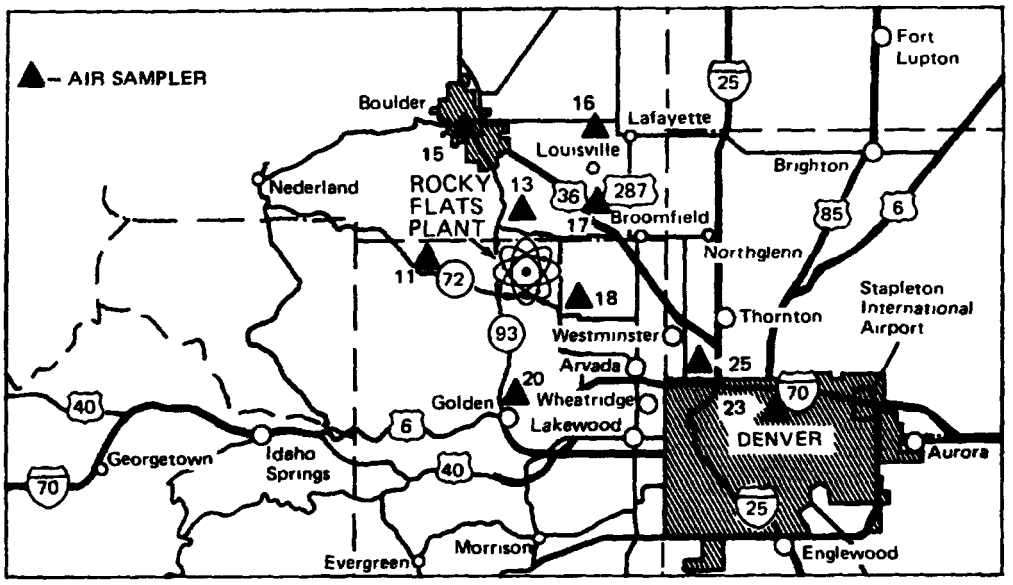
Building	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
444	0 009	0 005	0 002	0 002	0 002	0 002	0 002	0 002	0 001	0 001	0 017	0 002
447	0 071	0 070	0 029	0 033	0 040	0 023	0 002	0 017	0 030	0 018	0 007	0 021
881	0 004	0 017	0 018	0 049	0 005	0 005	0 005	0 006	0 002	0 002	0 003	0 002
883 (A)	0 010	0 008	0 010	0 012	0 041	0 034	0 008	0 013	0 013	0 010	0 015	0 011
883 (B)	0 010	0 006	0 003	0 004	0 008	0 005	0 003	0 003	0 002	0 002	0 003	0 002
886	0 003	0 001	0 002	0 002	0 002	0 002	0 002	0 002	0 001	0 001	0 003	0 003
889	0 003	0 002	0 002	0 002	0 002	0 002	0 002	0 002	0 001	0 003	0 002	0 003
865	0 002	0 001	0 002	0 002	0 002	0 002	0 002	0 002	0 001	0 001	0 001	0 001
991 T	–	0 002	0 002	0 001	0 001	0 002	0 002	0 002	0 001	0 001	0 001	0 001
Total Release by Month (μCi)	11 264	12 148	8 959	21 935	10 052	7 270	2 976	6 149	4 405	3 151	6 801	3 741

Applicable Standard *** (Soluble ^{238}U) – 3 X 10^{12} μCi/ml

(D) Yearly Summary – Uranium

Concentrations (X 10^{12} μCi/ml)

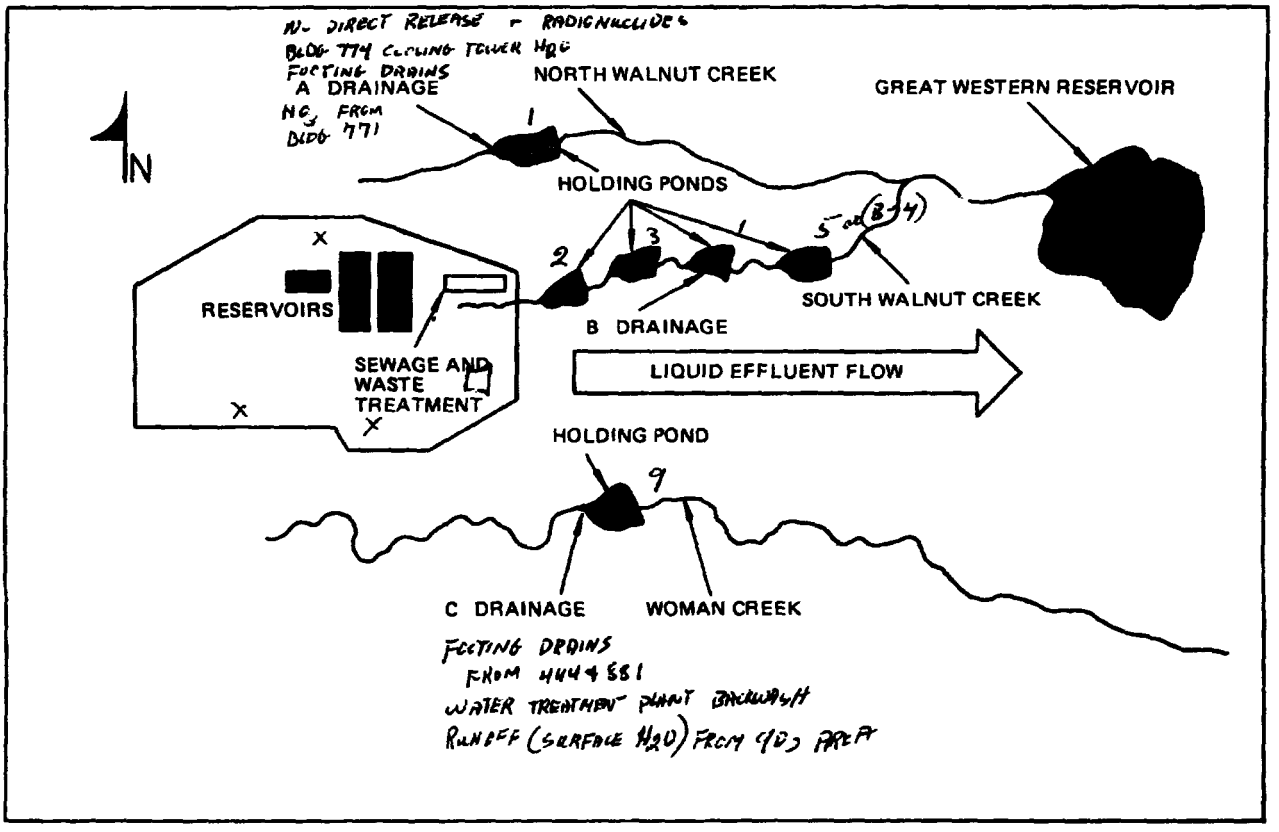
Building	January – June: Maximum Concentration (Single Sample)	January – June: (Monthly) Average Concentration	July – December: Maximum Concentration (Single Sample)	July – December: (Monthly) Average Concentration	Total Year: Concentration Max (Bldg)	Total Year: Concentration Av (Bldg)	Total Year: % Std (Av Conc)	Total Year: Total Release (μCi)
444	0.009	0 004	0.017	0 004	0 017	0 004	0 1	9.960
447	0 077	0 044	0.033	0 016	0 077	0 030	1 0	25.756
881	0 050	0 016	0 006	0 003	0.050	0 010	0 3	35.440
883A	0 040	0 019	0 014	0 012	0.040	0 016	0 5	20.680
883B	0.012	0 006	0.003	0 002	0.012	0 004	0 1	5.740
886	0 004	0 002	0.004	0 002	0 004	0 002	0 1	0.132
889	0.005	0 002	0.003	0 002	0 005	0 002	0 1	0.146



Map 3. Programmed Environmental Air Sampling Network

RF receives its water from Roleton Reservoir

Map 4 Rocky Flats Effluent Water Flow



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