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40 CFR 190 RELATED RADIOLOGICAL DOSES DUE TO THE OPERATION OF THE URAVAN URANIUM MILL

Prepared for

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1.0 INTRODUCTION

NUS Corporation was retained by the Union Carbide Corporation's Metals Division to provide radiological consulting services related to the operation of the Uravan Uranium Mill in Uravan, Colorado. The overall objective of the work, performed in two phases, was to evaluate radiological doses due to the operation of the Uravan Uranium Mill with respect to 40 CFR 190 and to identify emission sources responsible for any excess doses.

The dose limitations established by the U.S. Environmental Protection Agency contained in 40 CFR 190 that become effective December 1, 1980, are designed to assure protection of the public against radioactive emissions resulting from uranium fuel cycle operations.(1) As applied to individuals in the general public, these standards limit the annual dose equivalent to the whole body or any internal organ, except the thyroid, to 25 mrem, and the annual dose equivalent to the thyroid to 75 mrem. Doses due to Rn-222 and its short-lived daughters, as well as doses associated with uranium mining, are excluded from this regulation.

The objective of the Phase I work was to determine in a preliminary manner whether the environmental radiological doses due to the operation of the Uravan Uranium Mill were in compliance with 40 CFR 190 using available monitoring data. The results were presented in the Phase I report(2) which indicated that doses are in excess of 40 CFR 190, but that not enough information was available to identify the sources responsible with any certainty.

The objective of the Phase II work was to refine the radiological dose calculations performed as part of Phase I and identify the responsible emission sources by using supplemental environmental measurements data, analysis, and modeling. The Phase II work included 1) a correlation analysis of certain variables affecting airborne radioactive particulates in the site vicinity; 2) supplemental environmental measurements including stack emission testing performed by NUS and specific activity measurements of soils by Union Carbide; 3) a review of the on-site and off-site meteorological data with additional data reduction if required to generate the most representative joint frequency distribution (JFD) for use in modeling; and 4) modeling of the environmental radioactive concentrations and related doses due to stack and area source emissions from the Uravan Uranium Mill using the Uranium Dispersion and Dosimetry (UDAD) model developed by Argonne National Laboratory.[3]

Separate reports on the correlation analysis,[4] the stack emission testing,[5] and the meteorological data review,[6] have been prepared and should be referred to in the review of this report. This report summarizes the results of the Phase I work, the correlation analysis, stack emission testing and meteorological data review, and presents a detailed description of the UDAD modeling effort and the results. The summary and conclusions of the Phase II work are presented in Chapter 2. Chapter 3 presents a brief site and facility description to provide a basis for the information that follows. Chapter 4 reviews potential environmental radiological dose pathways in the site vicinity to establish the needs for monitoring data and modeling in support of the evaluation of 40 CFR 190 doses and to eliminate insignificant pathways. Chapter 5 reviews the environmental radiological monitoring program and associated data used in the analysis that follows. Chapte [illegible] describes the methodology used in the 40 CFR 190 dose calcula[illegible]s and related work, including the monitoring data approach and the modeling approach to such calculations. The results of the Phase II work, including the dose calculations and the emission source identification, are presented and discussed in Chapter 7.

2.0 SUMMARY AND CONCLUSIONS

An evaluation of 40 CFR 190 related radiological doses due to the operation of the Uravan Uranium Mill has been performed by the NUS Corporation for Union Carbide Corporation's Metals Division. The Uravan Uranium Mill is located adjacent to the town of Uravan, Colorado along a narrow canyon of the San Miguel River, approximately 90 miles southwest of Grand Junction. Maps showing the regional setting, site vicinity and site layout are shown in Figures 1, 2, and 3, respectively. The methodology used and the results of the study are summarized below.

The work was carried out in two phases. Phase I included a preliminary dose calculation based on measured radioactive airborne particulate concentrations in the site vicinity. The results indicated that the offsite doses were in excess of those specified in 40 CFR 190 but the emission sources responsible for the doses could not be identified with any certainty.

The Phase II work, designed to refine the dose calculations and identify the responsible emission sources, included a correlation analysis of the airborne radioactive particulate concentrations, a supplemental environmental measurements program, a review of meteorological data representative of the site vicinity, and modeling of the environmental radioactive concentrations and associated doses based on emission source terms and applicable meteorological data representative of the site vicinity. This work is described further below.

2.1 Correlation Analysis

The results of the correlation analysis were inconclusive in that, although many statistically significant correlations were identified, they were insufficient to identify emission sources primarily responsible for the doses. The correlation analysis was useful, however, in judging whether concentrations of certain radionuclides at certain locations were fugitive dust dominated or stack emission dominated. Furthermore, the results supported the conclusion in Phase I that Pb-210 concentrations were dominated by the regional background.

2.2 Supplemental Environmental Measurements Program

Monitoring data necessary to support the Phase II work were identified to include the radioactive concentrations of U-Nat, Th-230, Ra-226, and Pb-210 in ore, tailings, yellowcake, airborne particulates, and soils; and radioactive particulate emission rates. A supplemental environmental measurements program was designed to collect additional data beyond that already provided by the onsite environmental radiological monitoring program. These measurements included stack emission testing to determine the radioactive particulate emission rates, and the analysis of road dust, and soil for radionuclide content.

2.3 Meteorological Data Review

Onsite meteorological data for wind speed and wind direction collected at two locations, including one location in the valley and a second location on the mesa near the B Plant, was reviewed for use in the modeling and compared with National Weather Service data from Grand Junction. It was determined that further reduction of the onsite data to generate onsite atmospheric stability class data would not be feasible, but that such information should be extracted from the Grand Junction data. Onsite meteorological data for both the valley and the B plant were similar, with the valley data considered the better set. It was decided to use the valley and Grand Junction data sets in various combinations with the emission sources to fine tune the dose modeling as described below.

2.4 UDAD Modeling

The radioactive airborne particulate emissions due to the operation of the Uravan Uranium Mill were modeled using the UDAD model to evaluate the resulting airborne radioactive particulate concentrations and associated doses at selected receptor locations in the site vicinity. The UDAD model developed by Argonne National Laboratory differs somewhat from NRC draft guidelines.(8) Parameter changes within UDAD were made and supplemental hand calculations were performed to make the methodology as consistent as possible with the NRC draft guidelines for such calculations. Additional changes were made in the inhalation dose rate conversion factors to reflect revised solubility classifications of the inhaled particulate compounds of interest.

The UDAD model inputs emission source terms for an array of point and area sources, meterological data, and selected receptor locations. Dose pathways evaluated in the model include the direct inhalation of particulates from the direct plume and those resuspended from prior deposition cloud immersion, ground plane radiation, and ingestion of contaminated vegetables, meat and milk. The output includes airborne radioactive concentrations and associated doses at each receptor location.

The radioactive emission sources considered in the analysis included the mill stack emissions, road fugitive dust, and windblown tailings. The principal stack emissions include those from the yellowcake, Aerofall (dry grinding), acid-kill (AK) leach, leach and fine ore bin stacks.

UDAD model screening runs were made using the Grand Junction and onsite valley meteorological data with various combinations of point and area sources to optimize the comparison between predicted and measured airborne concentrations monitoring locations 1, 2, and 3 shown in Figure 3. The results indicated that the concentrations predicted without resuspension (that is, the resuspension of previously deposited airborne material such as stack and road emissions and windblown tailings) were in better agreement with the measured concentrations than when resuspension was included. The best agreement with the measured concentrations occurred when the valley station JFD was used with the A plant and valley sources, and the Grand Junction JFD was used with the B plant, tailings, and other mesa sources. In general, the concentrations predicted without resuspension agreed surprisingly well with the measured concentrations, especially when the complex terrain and uncertainties associated with the spectrum of input parameters are considered.

Final UDAD production runs were made using the optimized combination of emission sources and meteorological data without resuspension, except that windblown tailings as calculated by UDAD was included. An integration period of 18 years of equivalent 1979 full capacity operation was used that included both the commercial and non-commercial milling periods at the site.

The radiological doses at selected locations were then calculated assuming five alternative emission control scenarios, including 1) currently installed emission controls, 2) reductions of 67% and 99% in the yellowcake and AK leach emissions, respectively, 3) reductions of 83% and 99% in the yellowcake and AK leach emissions, respectively, 4) a reduction of 83% in the yellowcake emissions and process changes designed to eliminate Aerofall, fine ore bin, AK leach and leach emissions entirely, and 5) the same as Scenario 3 but with vegetable gardens in the town of Uravan eliminated.

2.5 Conclusions

The objectives of this study, to 1) evaluate 40 CFR 190 doses due to mill operation and 2) identify the emission sources responsible for the doses, were satisfied.

A comparison of predicted and measured radioactive concentrations in airborne particulates and soils was made. The predicted and measured airborne concentrations at selected locations were in good agreement. However, the measured concentrations in soils were higher than predicted by one to two orders of magnitude, not accounting for natural background. The soils data supported the conclusion that this was due to radioactive contamination of the soil within the town of Uravan by milling operations that took place onsite prior to the establishment of the present Union Carbide commercial uranium milling operations.

The results of the dose calculations indicated that with presently installed emission controls the doses due to the operation of the Uravan Uranium Mill are in excess of those specified by 40 CFR 190 at selected receptor locations in the town of Uravan. The highest doses at locations where people lived were in Block B (Figure 3) where the doses were 100, 156, and 47 mrem/yr to the lung, bone and kidney, respectively. Higher doses occurred at monitoring location 3 and Block C, but nobody lives at these locations. The principal dose pathway is inhalation, followed by vegetable ingestion.

Assuming currently installed emission controls, the results of the calculation of airborne concentrations at locations within Uravan indicated that over 90% of the U-238 and U-234 was due to the yellowcake stack emissions. The AK leach stack and Aerofall stacks account for approximately 50% and 20%, respectively, of the Th-230, Ra-226, and Pb-210 concentrations, with the other stacks accounting for most of the remainder. Fugitive radioactive dust emissions from site roads account for up to 25% of the Ra-226 and less than 10% of the Th-230 and Pb-210. Tailings emissions generally accounted for less than 5% of the Th-230, Ra-226 and Pb-210, primarily because low annual average wind speeds at the site do not result in much wind erosion of the tailings. This is consistent with the previous conclusion that resuspension is not an important mechanism in the site vicinity.

The results indicated that the application of Emission Control Scenario 4 (a reduction of 83% in the yellowcake emissions and process changes designed to eliminate the Aerofall, fine ore bin, AK leach and leach emissions) would reduce the predicted doses within the residential portions of Uravan to a maximum of 20.5 mrem to the bone. Therefore, Union Carbide would be able to meet the 40 CFR 190 limits according to this analysis by implementing an emission and/or process control strategy which lies between Scenario 3 and Scenario 4.

3.0 SITE AND FACILITY DESCRIPTION

To provide a basis for the work presented in this report, a brief site and facility description is presented below which has been summarized from the Uravan Project Environmental Report (ER).[7]

3.1 Site and Regional Setting

The town of Uravan and the mill are located in Montrose County, Colorado approximately 90 miles southwest of Grand Junction, Colorado on Route 141. Maps showing the site in relation to the regional setting and the local site vicinity are shown in Figures 1 and 2, respectively.

The site is located in the Dolores River Basin within the Canyonlands section of the Colorado Plateau which includes portions of western Colorado, eastern Utah, northern Arizona, and northwestern New Mexico. The Uravan site is along a narrow canyon cut through the Uncompahgre uplift by the San Miguel River, a tributary of the Dolores River. The geology and surface features of the site vicinity are dominated by eroded Mesozoic sandstones and shales gently dipping to the northeast. The vegetation in the region is generally sparse, dominated mainly by pinyon-juniper associations.

The climate is generally dry with mild winters and warm summers. The annual average temperature and precipitation at Uravan are 52°F and 10 inches equivalent rainfall, respectively. Local winds are strongly influenced by the San Miguel River valley with the highest frequency (59%) wind directions from the east-southeast through south-southeast, corresponding primarily to cold air drainage down the valley during the night and early morning hours. The annual mean wind speed is low in the valley, about 4-5 mph. Regional winds across the higher elevations above the valley are generally from the southwest with higher average wind speeds.

3.2 Site Description

A layout of the site and the town of Uravan is presented in Figure 3. The town of Uravan with a population of approximately 800 is spread out along the canyon floor on a southeast to northwest axis that roughly parallels the San Miguel River. It includes housing for mining and milling employees and their families plus basic services structures.

The milling facility is divided by topography into two areas. The B Plant area encompasses the operations of ore receiving, crushing, grinding, leaching and washing out of the mineral values and is sited on the southwest rim of the canyon cut by the San Miguel River. The tailings disposal area, consisting of two tailings ponds and a raffinate spray evaporation area are located back from the rim on the plateau. The remaining processing facilities, denoted as the A Plant, are located along the canyon floor. These operations include separations of the uranium from the vanadium by fixed bed ion exchange, precipitation of the uranium values as ammonium diuranate, filtration, and calcination of the wet cake to U_3O_8.

3.3 Process Description

The Uravan Uranium Mill has an ore processing capacity of 1500 tons per day, 365 days per year. Ore containing about 0.17 percent U_3O_8 and one percent V_2O_5 is hauled to the mill from up to thirty underground mines in the Uravan Mineral Belt, with most located within a 40 mile radius of Uravan.

In the B Plant area, incoming ore is received, stockpiled, crushed, sampled and then ground in two autogeneous dry-grinding mills. The uranium and vanadium values are then extracted from the ground ore by a hot sulfuric acid leach in a two-stage circuit followed by separation of the pregnant liquor and tailings through a counter-current decantation circuit. Uranium is recovered and isolated from the pregnant solution containing vanadium by ion exchange. The yellowcake product is then precipitated out as ammonium diuranate with a solution of anhydrous ammonia and sodium chlorate or hydrogen peroxide. The ammonium diuranate is then calcined to U_3O_8, dried and packaged in 55-gallon drums for shipment. The pregnant vanadium solution progresses through a solvent extraction circuit, producing a concentrated vanadium solution, which is shipped to the Union Carbide plant at Rifle, Colorado for further processing.

The principal airborne radioactive emission sources are stack emissions, windblown tailings, and vehicular fugitive dust along site roads. The radioactive stack emission sources include those from the yellowcake stack, Aerofall (dry grinding) stacks, acid-kill (AK) leach stack, leach stack, and fine ore bin stacks. These emission sources are described in further detail in Sections 5.3.2 and 6.3.3.

4.0 ENVIRONMENTAL RADIOLOGICAL DOSE PATHWAYS

The calculation of offsite population doses due to the radioactive effluents from the Uranium Uranium Mill requires an identification of environmental radiological dose pathways that are likely to occur in the site vicinity. The identification of probable dose pathways in turn establishes the need for radiological monitoring and modeling requirements in support of such calculations.

The evaluation of 40 CFR 190 doses can be performed using either a modeling or monitoring data approach. In the modeling approach, emissions source terms are quantified, environmental dispersion modeling performed to determine concentrations in various environmental media, and the population exposure and subsequent radiological doses calculated. The monitoring data approach bypasses the need to quantify emission source terms and to perform dispersion analyses by going directly to measured environmental media concentrations. Subsequent calculation of population exposure and resulting radiological doses are similar to that in the modeling approach.

Potential environmenal radiological dose pathways that should be considered in either approach to the calculation of 40 CFR 190 doses are shown in Figure 4.[4]

NRC draft guidelines on the evaluation of radiological doses due to uranium milling place primary emphasis on environmental radiological dose pathways associated with airborne effluents.[8] Liquid pathways are not treated although NRC indicates such pathways should be considered if they are determined to be important.

The significance of the pathways shown in Figure 4 in the site vicinity have been evaluated to some extent in Section 5.1 of the ER.[7] In evaluating the signficance of these pathways for liquid and airborne effluents from the operations of the Uravan Uranium

Mill, careful consideration must be given to background environmental levels of radioactivity in the site vicinity, since the radiological doses associated with background are not included in 40 CFR 190 dose calculations. Background levels in the site vicinity are especially difficult to establish because of the complicated prior history of radium, vanadium, and uranium recovery at the site prior to the establishment of the current Union Carbide operation. Furthermore, if they were considered as background, such levels may not be easily separated from those due to the current milling operations.

The principal exposure pathway in the immediate site vicinity is considered to be inhalation of radioactive airborne particulates from the milling operation.

Potential contamination of drinking water in the site vicinity is not considered here. Domestic water for the Town of Uravan is obtained from a well 2 miles ESE of the site which taps an aquifer 150 to 200 feet below the surface. This aquifer does not surface in the site vicinity. Although levels of Ra-226 in the drinking water were previously in excess of the EPA guideline of 5 pCi/l, this was due to natural sources and for this reason was not considered in the dose analysis.(7) Ion exchange is bringing this source in line with the EPA guideline.

Vegetable gardens maintained by residents within the town of Uravan could be a significant exposure pathway that should be considered.

Ingestion of contaminated meat from beef, cattle, mule deer, and elk is a possible exposure pathway. Mule deer, elk and cattle are rather wide ranging in their foraging activities implying they would spend but a small part of the time in areas that may be contaminated. There is no commercial milk production within 15 miles of the site. Most meat consumed within Uravan comes from commercial meat packaging operations located in Grand Junction.

In any case, the meat pathway cannot be evaluated due to the lack of data, using the monitoring approach. Since meat and milk production and consumption is a regional activity, beyond that covered by the monitoring program, this pathway could only be evaluated by a modeling effort.

The ingestion of contaminated fish was discounted as a likely pathway in Section 5.1 of the ER.[7]

External doses due to cloud immersion and ground plane radiation should be considered, although it may be difficult to separate background doses, especially in the case of ground plane doses.

5.0 ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM REVIEW

5.1 Scope of the Review

An environmental radiological monitoring program is being conducted by Union Carbide in the Uravan Uranium Mill site vicinity. It is designed to characterize concentrations of radioactivity in the environment due to the milling operations. The design of the program has been described in Section 6.2 of the ER with results during the period 1973-1977 reported in Section 2.9 of the ER.[7] Supplemental environmental measurements have been made by Union Carbide following this period, including those in support of the current Phase II work. The principal monitoring locations and parameters monitored are shown in Figure 5. The environmental radiological monitoring program at the site has been reviewed with respect to NRC guidance on such monitoring and to summarize data needed in support of the Phase II work. The results of this review are presented below.

5.2 Comparison of Program With Regulatory Guidelines

The environmental radiological monitoring program was compared with guidelines for radioactive effluent monitoring at operating uranium mills contained in NRC Regulatory Guide 4.14 dated June 1977.[9] The proposed operational monitoring program outlined in Section 6.2 of the ER is consistent with that recommended by the NRC in Reference 9. However, the implementation of the proposed operational monitoring program is such that the current monitoring program differs in some aspects from NRC recommendations.

The monitoring of radioactive airborne particulates at the site exceeds NRC recommendations. NRC recommends continuous low volume air sampling at a minimum of three locations with composite samples analyzed quarterly. The current monitoring program at the site includes continuous low volume air sampling at five locations with samples analyzed weekly for U-Nat, Th-230, Ra-226, and Pb-210.

Previously, continuous high volume air sampling was performed at three locations and samples analyzed weekly.

The proposed operational monitoring program includes semi-annual stack emission testing, consistent with NRC recommendations. Although such testing has not been implemented on a semi-annual basis, a comprehensive stack testing program was conducted in March 1980 as part of the Phase II work.[5]

The proposed operational monitoring program included continuous radon monitoring one week per month, consistent with NRC recommendations. Although some radon monitoring has been performed over 48-hour periods, as described in Section 2.9 of the ER, the radon monitoring outlined in the proposed operational monitoring program has not yet been implemented. NUS understands that periodic radon gas monitoring at various locations has been performed since June 1979. This information is on record at Uravan but is not part of the 40 CFR 190 evaluation. Future radon gas monitoring at Uravan will consist of passive environmental monitors (PERMs) utilizing TLD chips. Union Carbide is currently developing a TLD program with the recent acquisition of a TLD reader.

The liquid sampling program being conducted at the site is considered adequate relative to NRC recommendations in that liquid discharges to unrestricted areas are sampled continuously with composite samples analyzed monthly, and surface seepage sampled and analyzed quarterly.

Additional environmental measurements beyond those recommended in NRC Regulatory Guide 4.14 dated June 1977 include meteorological monitoring at two locations, gamma dose rate measurements, and measurement of radioactive concentrations in soils at several locations.

5.3 Environmental Radiological Monitoring Data Summary

A summary of data collected as part of the onsite environmental radiological monitoring program needed in support of the 40 CFR 190 dose calculations and emission sources identification is presented below. These data include radioactive concentrations of U-Nat, Th-230, Ra-226, and Pb-210 in ore, tailings, yellowcake, airborne particulates, and soils; and radioactive stack particulate emission rates.

5.3.1 Source Material Radioactive Concentrations

Monthly composite samples of ore, tailings and yellowcake were obtained during February 1980 to determine the specific activity and specific activity ratios of each radionuclide of interest. The results are summarized in Table 1 which indicate that 90.5% of the Th-230, 97.4% of the Ra-226 and 100% of the Pb-210 in the ore leave the circuit in the tailings.[10]

5.3.2 Radioactive Stack Particulate Emissions

NUS Corporation conducted a stack emission testing program at the Uravan Uranium Mill March 4-7, 1980 that is described in Reference 5. Seven stacks were sampled, including the four Aerofall stacks associated with the grinding circuit, fine ore bin stack, acid-kill (AK) leach stack, leach stack, and yellowcake drier stack. The testing program included triplicate particulate mass emission tests, duplicate particle size tests, and supporting measurements on each stack. Union Carbide performed radiochemical analyses on the samples to determine the specific activities. The results of the testing program are summarized in Table 2 which presents for each stack the annual average radioactive emission rate of each radionuclide based on the average of the triplicate particulate tests and an annual plant capacity factor of 1.0.

5.3.3 Radioactive Airborne Particulate Concentrations

Annual average concentrations and specific activities of radioactive airborne particulates at locations 1, 2, and 3 shown in Figure 5, based on samples collected over weekly periods using high volume air samplers, are summarized in Table 3 for the period May 1978 through April 1979.[4] Additionally, data for June and July 1979 for location 4 is presented. Locations 1 and 2 characterize concentrations at the nearby offsite residences, location 3 characterizes concentrations at the edge of tailings pile No. 2, and location 4 characterizes "background" concentrations. In February 1980 two new background monitoring locations were established, including one approximately 2 miles southeast of Uravan near the domestic water supply (denoted as location 5) and one in Block C within Uravan, but the associated data is not yet available for incorporation into this report.

Airborne radioactive particulate data considered representative of background for the Disappointment Valley in San Miguel County, Colorado;[11] Tallahassee Creek region of Fremont, County Colorado;[11] the State of Utah;[12] and nationwide[13] are summarized in Table 4. The results indicate that airborne concentrations of U-Nat, Th-230 and Ra-226 in the site vicinity are two orders of magnitude higher than typical regional background concentrations. Pb-210 onsite is similar to regional levels, indicating regional sources (decay of airborne radon from uranium deposits and natural sources) may be controlling such concentrations.

5.3.4 Soils

Soils were sampled initially in support of the ER with the results reported therein.[7] The supplemental environmental measurements program conducted by Union Carbide provided additional data related directly to the Phase II work.[10]

Road dust samples were collected and analyzed for silt content (finer than 200 Mesh) and specific activity to provide input to road fugitive dust calculations described in Section 6.3.3. Samples were collected at the locations shown in Figure 5 with the results summarized in Table 5. Selected soil samples were obtained, for both the top 5 cm and 1 ft. layer at the locations shown in Figure 5 with the results of the analyses presented in Table 6.

6.0 40 CFR 190 RADIOLOGICAL DOSE CALCULATION METHODOLOGY

The methodology used in the evaluation 40 CFR 190 related environmental radiological doses due to the operation of the Uravan Uranium Mill and the identification of mill emission sources responsible for such doses is described in this section. The work leading up to the final Phase II effort is also described. This included the Phase I work to use the monitoring data existing at the time to calculate 40 CFR 190 doses and identify responsible emission sources, and a correlation analysis of available monitoring data in an effort to identify responsible emission sources. This is followed by a description of the methodology used to model environmental radioactive concentrations and associated doses based on emission source terms and applicable meteorology. The monitoring data approach and the modeling data approach to the calculation of 40 CFR 190 doses have already been discussed in an introductory manner in Chapter 4.

6.1 Monitoring Data Approach to the Dose Calculations

In Phase I preliminary 40 CFR 190 related radiological dose calculations were made using available monitoring data as described in Reference 2. Radioactive airborne particulate concentrations at locations 1 and 2 were used to calculate inhalation doses in accordance with draft NRC draft guidelines on such calculations(8) with modified dose rate conversion factors described in Section 6.3.1. External dose rates were determined based primarily on gamma dose rate measurements at these locations as reported the ER.(7) The results indicated that based on available data inhalation and external doses at locations 1 and 2 were individually in excess of 40 CFR 190. However, it was not possible to separate doses due to prior and present milling operations on site, especially in the case of external doses, which would require a modeling effort. Furthermore, an evaluation of the particulate concentrations and specific activities indicated that the data was insufficient to identify the emission sources responsible for the excess doses with any certainty. Recommendations were then made for the Phase II work. A supplemental environmental measurements program was designed to support the Phase II work to include stack emission testing and soil sampling.

6.2 Correlation Analysis

As part of the initial Phase II work, a correlation analysis of certain variables affecting airborne radioactive particulate concentrations in the site vicinity was performed in an attempt to better identify the emission sources responsible for the excess doses, as described in Reference 4. The results of the correlation analysis were inconclusive, in that, although many statistically significant correlations were identified, they were insufficient to identify emission sources primarily responsible for the radioactive airborne concentrations. Since the original results were inconclusive, additional computer runs were made to try to clarify the correlations by analyzing wind directions in a different manner and forming new variables from combinations of old variables. Although specific emission sources could not be identified as being responsible for the measured concentrations, the correlation analysis was useful in judging whether the concentrations of certain radionuclides at certain locations were fugitive dust dominated or stack dominated. Furthermore, the results supported the conclusion of the Phase I work that Pb-210 concentrations were dominated by regional background.

6.3 Modeling Approach to Dose Calculations

The airborne radioactive particulate emissions associated with the operation of the Uravan Uranium Mill were modeled to evaluate the resulting airborne radioactive particulate concentrations and associated radiological doses at selected receptor locations within the site vicinity. Such modeling was designed to 1) more carefully evaluate contributions of emission sources to environmental concentrations and doses in both the site vicinity and the region,

2) evaluate effects of added emission source controls, and 3) separate environmental concentrations and related doses due to prior milling operations from those due to current milling operations. However, the complex terrain in the site vicinity makes such modeling difficult, and the limitations inherent in such modeling are recognized. A description of the modeling methodology is presented below.

6.3.1 UDAD Model Description

The NRC has established draft guidelines on the calculation of radiological doses from uranium milling operations.[8] These calculations are summarized in Figure 6. In the modeling of the radiological doses due to the Uravan Uranium Mill operations, the Uranium Dispersion and Dosimetry (UDAD) model, Version 9, developed by Argonne National Laboratory[3] has been used. This was the only publicly available model that approximated the calculational procedure contained in the NRC draft guidelines.

The Argonne-developed UDAD model, used in this analysis, inputs a user specified array of point and area sources of airborne radioactive emissions; an annual meteorological joint frequency distribution (JFD) of wind speed, wind direction, and atmospheric stability class; a population distribution and selected receptor locations out to 80 km; and information on the agricultural productivity in both the region and at selected receptor locations for vegetables, milk, and meat. Radiological dose pathways evaluated in the model include the direct inhalation of particulates, cloud immersion, exposure due to ground deposited activity, and ingestion of contaminated vegetation, milk, and meat. The UDAD model also considers the contributions to airborne concentrations of dusts resuspended by wind action. The resulting environmental concentrations of radioactivity and related doses are calculated in terms of the contribution of each source, as well as total contribution from all sources.

The Argonne version of UDAD has been undergoing revision by the NRC for over a year in order to make the code more efficient, and to update environmental transfer factors and dose rate conversion factors that reflect new information. These changes are contained, in part, in the draft NRC Regulatory Guide on radiological dose calculations for airborne emissions from operating uranium mills.[8] The final NRC version of UDAD, called MILDOS, is expected to be publicly available within the next several months, however the target date has been continually slipping over the past year. Therefore, the currently available Argonne version of UDAD has been used in the present analysis with certain parameters changed to reflect those contained in the draft NRC Regulatory Guide to the extent possible.

The first step in the dose calculation is to evaluate inhalation doses due to radioactive airborne particulates. Inhalation dose rate conversion factors as a function of isotope, particle size, and chemical composition are presented in Table 7, based on the draft NRC Regulatory Guide[8] and NUREG-0511.[14] These dose rate conversion factors are calculated with an internal dosimetry subroutine within the UDAD model. The calculation of dose conversion factors by UDAD requires information of the solubility classification of the particulates which governs internal transport within the body. Solubility classifications are denoted by Y (years; for slowly soluble or unsoluble compounds), W (weeks; for moderately soluble compounds), or D (days; quite soluble). The inhalation dose conversion factors in Table 7 assume a Y solubility classification for uranium and thorium and a W solubility classification for radium and lead. However, new experimental data has become available which indicates that other solubility classifications, or split solubility classifications, may be more appropriate.[14, 15] NUREG-0511 used these revised solubility classifications for occupational doses, but, due to lack of time were unable to revise the environmental inhalation dose factors. NRC is currently in the process of revising the dose rate conversion factors in MILDOS to reflect the revised solubility classification. NUREG-0511 and

Reference 15 indicate that ore and tailings dust should be classified as follows: U-235 and U-238, class W; Th-230, class Y; Ra-226, 10% D and 90% Y; and Pb-210, class Y. Yellowcake should be classified as 60% D and 40% W for uranium. NUS used the internal dosimetry subroutine of the Argonne version of UDAD to revise the inhalation dose rate conversion factors based on the revised solubility classification. The results are summarized in Table 8. The characteristics and solubility classification of the particulates of interest are summarized in Table 9.

The dose calculations performed in both the Phase I and Phase II work used the revised set of dose rate conversion factors presented in Table 8. In order to accommodate the split solubility classification scheme, dual UDAD runs had to be made, since a given radionuclide can have only a single solubility in each UDAD run. In accomplishing this, the source terms were split in accordance with the above percentages in the respective UDAD runs and then the outputs were manually added.

The inputs for UDAD, including the meteorological data, source terms, and receptor locations are described in the following sections.

6.3.2 Meteorological Data

Wind speed and wind direction data were collected by Union Carbide within the valley and at the B-plant site, respectively. NUS examined the coded hourly averages of each parameter for the one year of data (July 1, 1976 - June 30, 1977) that had been reported in the Uravan ER to determine if the data should be further analyzed to obtain a complete joint frequency distribution of wind speed by wind direction and stability class for use in the UDAD modeling analysis. Although only Trailer (valley) site wind speed/wind direction data were reported in the ER, the data from the B-plant site were also evaluated to determine whether B-plant site sources were subject to the same meteorological conditions as sources within the valley.

NUS estimated the recovery rates at each site for each parameter (78% and 62% for the Trailer and B-plant sites, respectively) based only on the times when the data were not obviously suspect. NUS compared the data from the two sites to determine qualitatively whether the two sites were similar. NUS also compared the Trailer site data as summarized in the ER to that from the NWS station at Grand Junction and from the San Miguel mill site in another, broader valley near Uravan. The average wind speed at the Trailer site was only 4-5 mph while that at the B-plant site was 6-7 mph. Both sets of data had wind speeds lower than were observed at the Grand Junction station. While the B-plant site wind direction data were frequently aligned with that from the Trailer site, there were many times when this was not the case. Frequently, the wind speeds at the B-plant were higher than those of the Trailer site. There had been no routine preventative maintenance on the equipment at either the Trailer or B-plant sites. Therefore, it could not be determined if the low wind speeds were actually as frequent as recorded at both sites or whether the threshold wind speed of the sensors at either or both sites might have deteriorated thus resulting in a larger number of "low" wind speeds being recorded. Both sites had been in operation for over two years by July 1, 1976. The Trailer site data showed a predominant up-valley/down-valley effect. Otherwise the data was similar to that of the Grand Junction Station. The similarity of the Trailer and B-plant data could have been influenced by the presence of the tailings piles which effectively act to extend the valley walls on one side of the B-plant site. Therefore, the stack emissions from the B-plant could be influenced by winds similar to the sources within the valley. The tailings piles, however, would be influenced by the general flow as shown in the Grand Junction data.

Since no stability data were available for the Uravan sites and the wind speed data were suspect, it was decided to apply the Grand Junction stability data as described in the ER. Although it was concluded that this stability distribution should not really apply for the unstable to neutral cases, the comparison of the Grand Junction and San Miguel data implied that the occurrence of the more stable conditions would be similar at all sites.

Because of the uncertainty of the meteorological data set to be applied to the B-plant stack emissions, as described in Section 6.3.5, both Grand Junction and Trailer site data were used in the UDAD model for these sources for the screening runs (Scenarios 3 and 4) and the results compared to observed monitoring data to determine the correct data set to use in predicting dose estimates for the Uravan sources. The meteorological joint frequency distributions for the Valley Trailer site and Grand Junction used in the UDAD modeling are presented in Appendices A and B, respectively. A more detailed discussion of the meteorological evaluation is found in Reference 6.

6.3.3 Source Term Evaluation

The radioactive emission sources considered in this analysis consist of stack emissions, road fugitive dust, wind blown tailings, and ore handling. The evaluation of these emissions sources are described below.

The radioactive stack particulate emissions include those from the yellowcake stack, Aerofall stacks, AK leach stack, leach stack, and fine ore bin stack. The radioactive particulate emission rates for these stacks have been discussed in Section 5.3.2 and presented in Table 2.

Wind blown tailings emissons are calculated with an internal subroutine of UDAD using a theoretical model with experimental input parameters described in Reference 3 that indicate emissions increase as the cube of the wind speed and inversely as the square of the moisture content. Tailings ponds Nos. 2 and 3 were represented by a series of square area sources. The ponds were assumed to be 50% dry on the average. The specific activity of the tailings emissions was assumed to be that presented in Table 1 with a bimodal particle size distribution consisting of 30% with an activity median diameter of 5 μm and 70% with an activity median diameter of 35 μm based on References 8 and 14.

The radioactive emissions due to road fugitive dust were based on a very comprehensive evaluation by Union Carbide of traffic patterns in the site vicinity coupled with analyses of selected road dust samples, including silt content (smaller than 200 Mesh) and the specific activities of U-Nat, Th-230, Ra-226, and Ph-210.(10) This information was used by NUS to calculate radioactive emission rates using the following procedure. Road fugitive dust emissions were calculated using EPA emission factors that are a function of road silt content, vehicular speed, number of tires, tire width, and the number of wet days per year.(16) The emission factors were initially developed for unpaved roads, but were applied to paved roads, as required, using an EPA recommended paving control efficiency of 85%. No dust control measures were assumed for unpaved roads, although Union Carbide indicated such roads are watered approximately once per week. After calculating the fugitive dust emission rates, the appropriate specific activities were applied to determine the radioactivity emission rates. These emissions were treated as area sources by assigning the emissions to one of 27 square road emission areas, shown in Figure 7.

Fugitive radioactive emissions due to the ore handling activities of the stockpile loading, wind erosion, and loadout were based on EPA emission factors for such emissions.(16) No emission controls such as watering were assumed in these activities.

The emission sources considered in the analysis and their associated UDAD input parameters are presented in Table 10. The locations of the point and area sources are shown in Figure 7.

6.3.4 Receptor Locations

Environmental concentrations and associated doses were calculated at an array of receptor locations including: 1) standard UDAD receptor locations in 16 wind directions and 15 downwind distances out to 80 km, and, 2) 42 special receptor locations in the site vicinity. The special receptor locations considered in the analysis are presented in Table 11 and shown in Figures 3 and 8. Ingestion pathways considered at the special receptor locations are also shown in Table 11.

6.3.5 UDAD Model Screening Runs

UDAD model screening runs were made using Grand Junction and on-site valley meteorological data with various combinations of point and area sources to optimize the comparison of predicted and measured concentrations. An integration period of 18 years of equivalent 1979 full capacity operation was used that includes both the commercial and noncommercial milling periods at the site.

A set of two UDAD runs were made in this optimization procedure. Since only concentrations were being evaluated at this point, dual split solubility runs were not necessary. The two runs included:

- UDAD Run 1 - All point and area sources (Grand Junction JFD)

- UDAD Run 2 - All point and area sources (Valley Station JFD)

Using these runs individual source contributions to the concentrations at locations 1, 2, and 3 were manually summed to develop predicted concentrations for four scenarios, including:

- Scenario 1 - All point and area sources (Valley Station JFD)

- Scenario 2 - All point and area sources (Grand Junction JFD)

- Scenario 3 - A Plant and Valley sources (Valley Station JFD)
  B Plant and tailings (Grand Junction JFD)

- Scenario 4 - A and B Plant (Valley Station JFD) Tailings (Grand Junction JFD)

The results of the screening runs are summarized in Table 12 which presents the ratios of the predicted cor ntrations, with and without background, to the measured concentrations. Predicted concentrations without contribution from resuspended dust but with windblown tailings were in better agreement with the measured concentrations than when resuspension was included. The best agreement with the measured concentrations occurred in Scenario 3 where the Valley Station JFD was used with the A Plant and valley sources, and the Grand Junction JFD used with the B Plant, tailings, and other mesa sources. This is consistent with the conclusion of the meteorological data review that either Scenario 3 or 4 were expected to fit with the physics of the problem, based on the evaluation of the terrain and the two onsite meteorological data sets. The use of the Valley Station JFD with B Plant sources in Scenarios 1 and 4 resulted in an overestimate of the concentrations at location 3 and an underestimate of the concentrations at location 1, probably due to the high frequency of down valley flows associated with the Valley Station JFD. When applied to the B Plant stacks, the down-valley flow component directs emissions towards location 3 and away from location 1. The use of the Grand Junction JFD for the B plant stacks resulted in a much better agreement with the measured concentrations, probably because of a cross valley wind component that decreases location 3 concentrations and increases location 1 concentrations.

In general the predicted concentrations using Scenario 3 agree suprisingly well with the measured concentrations, especially when the complex terrain and uncertainties associated with the spectrum of input parameters are considered.

The predicted concentrations without resuspension of previously deposited airborne material but including windblown tailings were in much better agreement with the measured concentrations than when resuspension was included. Resuspension associated with wind erosion usually occurs with a threshold wind speed of approximately 12 mph. The low tailings particulate emissions, generally contributing less than 5% to the concentrations, reflect the low annual average wind speed at the site using the higher average wind speed Grand Junction data for tailings emissions. Even if the tailings emissions model used in UDAD were off by an order of magnitude, the tailings would still not contribute much to the concentrations. It should be further noted, that for a given emission rate, concentrations predicted by a Gaussian model are inversely proportional to the wind speed, so that even if wind erosion emissions increase with wind speed, this is counteracted somewhat by increased dispersion. The low predicted tailings emissions indicate that resuspension is not an important mechanism at the site.

It is important at this point to understand how UDAD calculates resuspension. UDAD calculates tailings emissions assuming that emissions increase as the cube of the wind speed as discussed previously. At a given receptor location, however, the resuspended air concentration (that due to the resuspension of previously deposited material including stack and road dust emissions and windblown tailings) is calculated in a manner completely independent of wind speed, based on resuspension factors derived from field studies of resuspended plutonium at the Nevada Test Site where wind speeds are higher and there is little topography or vegetation. For the integration period considered in the analysis, UDAD calculates that the total air concentration including resuspension is 1.626 times the direct air concentration. Since the use of the added factor of 0.626 due to resuspension results in large overprediction of the concentrations and since the low tailings emissions reflect that resuspension is not an important mechanism at the site, all subsequent dose calculations in the analysis were based on direct airborne concentrations without resuspension, but included windblown tailings.

6.3.6 UDAD Model Production Runs

A set of final UDAD model runs were made based on Scenario 3 of the UDAD screening runs described in Section 6.3.6. The final UDAD model production runs consisted of four runs, including dual split solubility runs using the Valley Station JFD for the A Plant complex and other valley sources, and dual split solubility runs using the Grand Junction JFD for the B Plant complex, tailings and roads on the mesa above the valley.

The outputs of the four runs were combined and additional hand calculations were applied so that the methodology would be consistent with that in the draft NRC draft regulatory guide for such calculations as described below.

The UDAD model calculates doses to the upper respiratory system in terms of those to the nasopharyngeal, tracheobronchial, pulmonary, and lymph nodes individually. The draft NRC regulatory guide and MILDOS calculates a mass average lung dose by weighting doses to the individual regions of the respiratory system by their masses, which are 1.4 g for the nasopharyngeal, 400 g for the tracheobronchial, 600 g for the pulmonary, and 15 g for the lymph nodes. The mass average lung doses were hand calculated in this manner using the combined doses from the four UDAD runs for the individual compartments.

The dose conversion factors in UDAD and the associated computational methodology for the ground plane doses also differs from that in the draft NRC regulatory guide. Ground concentrations calculated by UDAD were used as input to a hand calculation based on the draft regulatory guide. Dose rates due to decay products of Ra-226, including Rn-222 and its short-lived daughters, were deleted from the calculation for two reasons. First, 40 CFR 190 doses limits do not include Rn-222 and its short-lived daughters. Second, it seems reasonable that any Rn-222 due to dispersed Ra-226 in a ground deposit would off-gas and be dispersed from the deposition site anyway, and its inclusion in the calculation would be unrealistic.

The ingestion doses and associated calculation methodology in UDAD differ markedly from those in the draft regulatory guide, primarily in terms of the dose conversion factors, the environmental transfer factors from soil to vegetation, and the manner in which vegetation types are treated. The ingestion doses were therefore hand calculated using the methodology in the draft regulatory guide with inputs consisting of the direct airborne and ground concentrations of each radionuclide as calculated by UDAD.

The radiological doses at selected receptor locations were calculated assuming alternative emission control scenarios.

These scenarios as specified by Union Carbide included the following:

<u>Scenario 1</u> - Presently installed emission controls as reflected in the source emission rates presented in Table 10.

Scenario 2 - 67% reduction in yellowcake emissions and a 99% reduction in AK leach emissions

Scenario 3 - 83% reduction in yellowcake emissions and 99% reduction in AK leach emissions

Scenario 4 - 83% reduction in yellowcake emissions and process changes designed to eliminate the Aerofall, fine ore bin, AK leach, and leach stack emissions.

Scenario 5 - 83% reduction in yellowcake emissions, 99% reduction in AK leach emissions, and elimination of vegetable gardens from the town of Uravan.

The results of the dose calculations and the effect of alternative emission controls scenarios are presented in the following chapter.

7.0 RESULTS AND DISCUSSION

7.1 Environmental Radioactive Concentrations

The direct airborne and ground concentrations for each radionuclide of interest predicted by UDAD at the selected receptor locations are summarized in Table 13. These concentrations are based on 18 years of equivalent 1979 full capacity operation without resuspension. Airborne concentrations would be increased by a factor of 1.626 if resuspension were included. Since 40 CFR 190 dose limits are applicable to commercial uranium fuel cycle operations only, the analysis is somewhat conservative in that the 18 years of operation considered includes only 10 years of commercial operation. The ground concentrations reported in Table 13 should be multiplied by 0.59, 0.85, 1.1 and 1.33 to obtain ground concentrations for 10, 15, 20, and 25 years of commercial operation, respectively.

The highest concentrations are predicted to occur in a WNW direction from the yellowcake building as a reference point. Of the selected receptor locations, Block C had the highest airborne concentration of U-238 and U-234, and location 3 had the highest airborne concentrations of Th-230, Ra-226, and Pb-210.

A comparison of the predicted direct airborne concentrations with the measured concentrations at monitoring locations 1, 2, and 3 has already been made as part of the UDAD screening runs with the results presented as Scenario 3 of Table 12. Although there are some variations, the predicted and measured airborne concentrations are considered to be in reasonably good agreement. This is rather surprising, especially when the complex terrain and variability in the spectrum of input parameters are considered.

A comparison was made of predicted and measured radioactivity concentrations in soil at selected locations within Uravan. The results indicate the measured concentrations are higher than the predicted concentrations by one to two orders of magnitude. The measured soil concentrations presented in Table 7 indicate there is no significant decrease in concentrations in going from the top 5-cm soil layer to the top 1-foot soil layer, with concentrations actually increasing in many cases. This tends to indicate the concentrations in the soil are due to below ground contamination, instead of due to the deposition of airborne activity. Soil concentrations would be expected to decrease rapidly with depth if they were airborne derived. This situation is considered to reflect the radioactive contamination of the soil within the town of Uravan due to radium, vanadium, and uranium milling that took place onsite prior to the establishment of the present Union Carbide commercial uranium milling operations.

The relative contribution to the direct airborne concentration at selected receptor locations is shown in Table 14. These results indicate that over 90% of the U-238 and U-234 is due to the yellowcake stack emissions, and the AK leach stack and Aerofall stacks account for approximately 50% and 20%, respectively, of the Th-230, Ra-226, and Pb-210 concentrations, with the other stacks accounting for most of the remainder. Fugitive radioactive dust from site roads account for up to 25% of the Ra-226 and less than 10% of the Th-230 and Pb-210. Tailings emissions generally account for less than 5% of the Th-230, Ra-226 and Pb-210, primarily because low annual average wind speeds at the site do not result in much wind erosion of the tailings.

7.2 40 CFR 190 Radiological Doses

The 40 CFR 190 radiological doses by dose pathway (inhalation, ingestion, cloud immersion, and ground plane radiation) and radionuclide (U-238, U-234, Th-230, Ra-226, and Ph-210) are presented in Table 15 for eight selected receptor locations in the site vicinity having the highest predicted dose rates. The calculations assumed emission scenario 1 in which presently installed emission controls are in effect. The calculation of ingestion doses conservatively assumed that each receptor obtained their entire annual vegetable requirement from a vegetable garden located at the receptor location. The dose rates are reported for the skin, whole body, lung, bone, kidney, and liver in terms of mrem/yr which represents the integrated 50-year dose due to a one year exposure.

The results indicate that with the presently installed emission controls the doses due to the operation of the Uravan Uranium Mill are in excess of 40 CFR 190 at selected receptor locations in the town of Uravan occur in Block C with doses of 158, 283, and 79 mrem/yr to the lung, bone, and kidney, respectively; the remaining organ doses are within the limits of 40 CFR 190. These doses are followed in order of magnitude by those in Block B, Block D, Block A, and Block E. Location 3 had higher predicted doses than those of Block C but location 3 is well within the site boundary and not near any residential location. Furthermore, Union Carbide indicates there are no residences presently in Block C, so that Block B would have the highest doses where residents live, these being 100, 156, and 47 mrem/yr to the lung, bone, and kidney, respectively.

The effect of additional alternative emission controls on the doses presented above was evaluated based on the emission control scenarios described in Section 6.3.6. The fractional contributions to the radioactive airborne concentrations with the presently installed emission controls (Scenario 1) by each emission source have been summarized previously in Table 14. The additional reductions indicated by Emission Control Scenarios 2, 3, 4, and 5 were applied to determine the resulting fractional contribution of each emission source to the airborne concentrations. The indicated reductions from this analysis were applied to the 40 CFR 190 doses summarized in Table 15 by dose pathway and radionuclide. The inhalation and cloud immersion doses are directly proportional to the airborne concentrations, so they scale directly. The ground plane doses, due to prior deposition, are unaffected by the emission reductions. The ingestion doses were further evaluated to determine what portion of the ingested activity comes from airborne activity deposited on the vegetation, and what portion comes from root uptake due to the ground plane deposits. The results as summarized in Table 16 indicated the airborne contribution to the ingestion doses were more than an order of magnitude higher than the ground plane contribution. Hence, the reduction in ingestion doses resulting from each emission scenario essentially scales directly according to the reduction in emissions.

The results of the evaluation of the effect of additional alternative emission controls on the doses at the eight selected receptor points with the highest doses are summarized in Table 17 by dose pathway and radionuclide for Emission Control Scenarios 2, 3, and 4. The results indicate that the application of Emission Control Scenario 4, consisting of an 83% reduction in yellowcake emissions and process changes designed to eliminate the Aerofall, fine ore bin, AK leach, and leach stack emissions, would reduce predicted radiological doses within the residential portions of Uravan to a maximum of 20.5 mrem to the bone. Therefore, Union Carbide would be able to meet the 40 CFR 190 limits according to this analysis by implementing an emission and/or process control strategy which lies between Scenario 3 and Scenario 4.

Similar analyses were performed at other selected receptor locations in the site vicinity. The results are summarized in Table 18 which presents the total doses to the whole body, lung, bone, kidney, and liver resulting from all dose pathways and radionuclides for each emission control scenario. Since the bone is the critical organ with respect to 40 CFR 190 doses, the results for the grid receptor locations were used to generate 25 mrem/yr bone dose isopleths for each emission scenario which are presented on a site map in Figure 11.

8.0 REFERENCES

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Table 1

Specific Activities of Ore, Tailings, and Yellowcake

Source Material	Concentrations[a]					Specific Activity Ratios Relative to U-Nat			
	U-Nat[b]	Th-230[b]	Ra-226[b]	Pb-210[b]	V_2O_5[c]	U-Nat	Th-230	Ra-226	Pb-210
Yellowcake	521,583	2,503	21	309	1,800	1	0.010	0.001	0.001
Ore	1,125	542	595	617	15,530	1	0.964	1.058	1.097
Tailings	166	485	573	666	4,730	1	5.850	6.907	8.028

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a. 90.5% of Th-230, 97.4% of Ra-226, and 100% of Pb-210 (± analytical error) in ore reports to tailings.
b. pCi/g
c. mg/g

Table 2

Radioactive Stack Particulate Emissions

Stack	Radioactive Emission Rate, Ci/yr				
	U-238	U-234	Th-230	Ra-226	Pb-210
Yellowcake	5.36E-01	5.36E-01	8.51E-03	3.45E-04	4.00E-03
Ak Leach	4.79E-02	4.79E-02	1.94E-01	7.09E-02	3.23E-01
Leach	6.26E-04	6.26E-04	6.39E-04	2.39E-04	1.56E-03
Aerofall #1	4.74E-03	4.74E-03	5.57E-03	1.93E-03	9.92E-03
Aerofall #2	9.16E-03	9.16E-03	2.88E-02	3.36E-03	1.58E-02
Aerofall #3	3.14E-02	3.14E-02	3.20E-02	2.10E-02	3.24E-02
Aerofall #4	4.04E-03	4.04E-03	9.37E-03	4.44E-03	6.14E-03
Fine Ore Bin	5.34E-03	5.34E-03	8.45E-03	1.83E-02	1.27E-02

Table 3

Summary of Annual Average Airborne Concentrations
at Uravan Uranium Mill Site (May 1978 - April 1979)

Component	Airborne Concentration at Indicated Monitoring Locations[a]				Specific Activity of Airborne Particulates at Indicated Monitoring Locations, pCi/g			
	1	2	3	4[b]	1	2	3	4
U-238	4.34E - 02	1.07E - 01	7.20E - 02	2.46E - 02	8.32E + 02	2.00E + 03	8.94E + 02	-
U-234	4.34E - 02	1.07E - 01	7.20E - 02	2.46E - 02	8.32E + 02	2.00E + 03	8.94E + 02	-
Th-230	1.66E - 02	1.38E - 02	4.00E - 02	7.60E - 03	3.18E + 02	2.58E + 02	4.96E + 02	-
Ra-226	6.40E - 03	6.22E - 03	2.81E - 02	1.00E - 04	1.23E + 02	1.09E + 02	3.49E + 02	-
Pb-210	3.69E - 02	4.44E - 02	7.51E - 02	-	7.07E + 02	8.28E + 02	9.32E + 02	-
V_2O_5	3.20E + 01	3.48E - 01	9.27E - 01	2.82E - 01	-	-	-	-
Particulates	5.22E + 01	5.36E + 01	8.06E + 01	-	-	-	-	-

a. Units are as follows: U-238, U-234, Th-230, Ra-226 and Pb-210 reported as pCi/m^3, and V_2O_5 and particulates reported as g/m^3

b. Data for monitoring location 4 is available for June and July 1979 only.

Table 4

Summary of Regional Background Concentrations
of Airborne Radioactive Particulates

Reference	Location	Background Air Concentration, pCi/m^3				
		U-238	U-234	Th-230	Ra-226	Pb-210
15	Disappointment Valley, Colorado	4.00E - 04	4.00E - 04	1.62E - 04	2.03E - 04	3.32E - 02
15	Tallahassee Creek, Colorado	3.38E - 05	3.38E - 05	1.07E - 05	9.22E - 04	2.68E - 02
16	State of Utah	-	-	2.5 E - 05	2.5 E - 05	-
17	State of Utah	-	-	-	-	2.00E - 02
17	Denver, Colorado	2.08E - 05	8.20E - 05	-	-	-
17	State of Colorado	-	-	-	-	2.10E - 02

Table 5

Specific Activity and Silt Content of Road Dust Samples

Sample	Location[a]	Silt Content, %[d]	Concentration[c] U-Nat[d]	Th-230[d]	Ra-226[d]	Pb-210[d]	V_2O_5[e]
D1	Block B	22.69	63.2	40.1	36.0	43.8	0.95
D2	Iron Steps	16.72	45.4	57.3	24.4	44.8	0.71
D3	B Plant (Maintenance Shop)	21.79	321.5	177.5	168.7	172.2	6.25
D4	County Road by SX	12.26	155.0	75.1	71.9	62.2	2.73
D5	Hier. Canyon Road	18.41	56.8	32.6	35.8	29.3	1.11
D6	B Plant (Leach)	11.90	223.9	156.7	15.8	19.9	5.3
D7	B Plant (Ore Haul Road)	13.45	160.7	133.4	108.4	110.3	3.45
D8	School	11.50	80.4	52.0	48.1	12.0	1.43
D9	Block H	5.73	23.0	23.3	27.8	12.7	1.0
D10	B Plant (Service Road)	7.34	80.4	64.3	26.4	154.1	1.95

a. See Figure 5 for sampling point locations
b. Defined as finer than 200 Mesh
c. Concentration in silt content of dust
d. pCi/g
e. mg/g

TABLE 6

Specific Activity of Soil Samples

Location	Specific Activity, pCi/g (5 cm Layer) U-Nat	Th-230	Ra-226	V_2O_5	Specific Activity, pCi/g (1 foot Depth) U-Nat	Th-230	Ra-226	V_2O_5
S1	15.80	21.16	8.58	0.37	13.82	13.18	2.57	0.21
S2	-	-	-	-	-	-	-	-
S3	-	-	13.47	-	-	-	23.42	-
S4	-	-	28.04	-	-	-	5.95	-
S5	-	-	9.84	-	-	-	4.49	-
S6	16.79	14.52	8.21	0.43	25.42	22.22	9.43	0.43
S7	-	-	33.79	-	-	-	8.24	-
S8	28.24	22.07	16.29	0.54	15.54	5.99	3.27	0.23
S9	-	-	44.82	-	-	-	25.68	-
S10	27.77	7.01	7.51	0.32	24.95	13.47	6.55	0.34
S11	39.54	20.67	20.68	0.68	19.77	14.87	6.24	0.25
S12	-	-	2.32	-	-	-	3.12	-
S13	-	-	9.26	-	-	-	5.67	-
S14	-	-	8.67	-	-	-	3.63	-
S15	-	-	23.37	-	-	-	6.49	-
S16	21.66	8.23	7.66	0.46	19.77	6.17	7.99	0.32
S17	49.16	40.49	24.34	0.71	31.28	27.12	20.19	0.64
S18	21.85	17.21	14.94	0.55	44.70	50.97	33.63	0.75
S19	-	-	117.14	-	-	-	30.36	-
S20	-	-	32.97	-	-	-	42.02	-
S21	20.36	20.67	15.69	0.41	33.27	12.63	11.53	0.30
S22	-	-	9.54	-	-	-	7.39	-
S23	175.55	168.91	103.26	2.14	66.16	53.67	37.83	0.86
S24	-	-	18.99	-	-	-	2.53	-
S25	50.65	54.43	42.27	0.62	56.61	61.63	29.66	0.71
S26	47.94	179.29	26.09	0.98	86.29	410.92	85.99	2.25
S27	-	-	5.29	-	-	-	248.05	-
S28	-	-	28.26	-	-	-	89.06	-
S29	-	-	13.68	-	-	-	8.72	-
S30	-	-	13.94	-	-	-	18.08	-
S31	-	-	22.18	-	-	-	7.29	-
S32	23.01	8.56	2.98	0.18	12.46	6.44	2.75	0.14
S33	-	-	4.56	-	-	-	1.24	-
S34	-	-	4.46	-	-	-	4.34	-
S35	-	-	3.05	-	-	-	4.70	-
S36	-	-	5.89	-	-	-	4.72	-
S37	12.46	9.72	3.65	0.29	11.50	3.08	1.56	0.14
S38	8.62	3.17	1.25	0.11	15.80	7.59	4.62	0.12
S39	16.79	7.50	5.84	0.25	-	-	-	-
S40	24.19	196.22	4.58	0.36	14.81	5.48	1.06	0.14
S41	32.58	24.91	24.36	0.61	16.79	6.44	4.73	0.83

Table 7

Inhalation Dose Rate Conversion Factors Based on Draft NRC Regulatory Guide and NUREG-0511[a]

Inhalation Dose Conversion Factors, mrem/yr per pCi/m^{3}[b]

Organ	U-238	U-234	Th-230	Ra-226	Pb-210
Particle Group 1[c]					
W. Body	1.44E + 00	1.64E + 00	1.37E + 02	3.97E + 01	9.42E + 00
Bone	2.42E + 01	2.64E + 01	4.90E + 03	3.97E + 02	2.87E + 02
Lung	2.13E + 03	2.42E + 03	2.37E + 03	3.04E + 02	2.49E + 01
Liver	0.	0.	2.82E + 02	4.94E - 02	7.32E + 01
Kidney	5.53E + 00	6.30E + 00	1.37E + 03	1.40E + 00	2.39E + 02
Particle Group 2[c]					
W. Body	1.65E + 00	1.87E + 00	1.66E + 02	3.40E + 01	8.24E + 00
Bone	2.78E + 01	3.03F + 01	5.95E + 03	3.40E + 02	2.56E + 02
Lung	2.88E + 03	3.28E + 03	3.22E + 03	4.04E + 02	2.13E + 02
Liver	0.	0.	3.43E + 02	4.22E - 02	6.53E + 01
Kidney	6.33E + 00	7.22E + 00	1.67E + 03	1.20E + 00	3.38E + 01
Particle Group 3[c]					
W. Body	1.16E + 00	1.32E + 00	1.01E + 02	4.47E + 01	1.00E + 01
Bone	1.96E + 01	2.14E + 01	3.60E + 03	4.47E + 02	3.11E + 02
Lung	1.24E + 03	1.42E + 03	1.38E + 03	1.87E + 02	1.45E + 01
Liver	0.	0.	2.07E + 02	5.55E - 02	7.93E + 01
Kidney	4.47E + 00	5.10E + 00	1.00E + 03	1.57E + 00	2.59E + 02
Particle Group 4[c]					
W. Body	7.92E -01	9.02E - 01	5.77E + 01	4.40E + 01	9.66E + 00
Bone	1.34E + 01	1.46E + 01	2.07E + 03	4.40E + 02	3.00E + 02
Lung	3.33E + 02	3.80E + 02	3.71E + 02	6.38E + 01	3.91E + 00
Liver	0.	0.	1.19E + 02	5.47E - 02	7.65E + 01
Kidney	3.05E + 00	3.47E + 00	5.73E + 02	1.55E + 00	2.50E + 02

a. Standard computer notation is used in this table: 1.28E + 01 = 1.28 x 10^{1}

b. 50 year integrated dose due to a 1 year exposure

c. See Table 10

Table 8

Inhalation Dose Rate Conversion Factors
With Revised Solubility Classification[a]

Inhalation Dose Conversion Factors, mrem/yr per pCi/m^3 [b]

Organ	U-238	U-234	Th-230	Ra-226	Pb-210
Particle Group 1[c]					
W. Body	1.28E + 01	1.46E + 01	1.37E + 02	3.58E + 01	4.66E + 00
Bone	2.16E + 02	2.35E + 02	4.90E + 03	3.58E + 02	1.45E + 02
Lung	4.90E + 01	5.56E + 01	2.37E + 03	4.87E + 03	5.69E + 02
Liver	0.	0.	2.82E + 02	4.47E - 02	3.69E + 01
Kidney	4.92E + 01	5.60E + 01	1.37E + 03	1.26E + 00	1.21E + 02
Particle Group 2[c]					
W. Body	4.32E + 00	4.92E + 00	1.66E + 02	3.09E + 01	4.36E + 00
Bone	7.29E + 01	7.95E + 01	5.95E + 03	3.09E + 02	1.35E + 02
Lung	1.58E + 02	1.80E + 02	3.22E + 03	6.61E + 03	7.72E + 02
Liver	0.	0.	3.43E + 02	3.86E - 02	3.45E + 01
Kidney	1.66E + 01	1.89E + 01	1.67E + 03	1.09E + 00	1.13E + 02
Particle Group 3[c]					
W. Body	4.91E + 00	5.60E + 00	1.01E + 02	4.00E + 01	4.84E + 00
Bone	8.30E + 01	9.05E + 01	3.60E + 03	4.00E + 02	1.50E + 02
Lung	7.32E + 01	8.32E + 01	1.38E + 03	2.85E + 03	3.30E + 02
Liver	0.	0.	2.07E + 02	4.97E - 02	3.83E + 01
Kidney	1.89E + 01	2.16E + 01	1.00E + 03	1.41E + 00	1.25E + 02
Particle Group 4[c]					
W. Body	4.64E + 00	5.29E + 00	5.77E + 01	3.90E + 01	4.43E + 00
Bone	7.84E + 01	8.55E + 01	2.07E + 03	3.90E + 02	1.38E + 02
Lung	2.50E + 01	2.85E + 01	3.71E + 02	7.64E + 02	8.70E + 01
Liver	0.	0.	1.19E + 02	4.85E - 02	3.51E + 01
Kidney	1.[illegible]9E + 01	2.04E + 01	5.73E + 02	1.38E + 00	1.15E + 02

a. Standard computer notation is used in this table: $1.28E + 01 = 1.28 \times 10^1$

b. 50 year integrated dose due to a 1 year exposure

c. See Table 10

Table 9

Particle Size and Solubility Classifications for Inhalation Dose Rate Conversion Factors

Particle Group	Size mm	Density g/cm³	Material	U-238/U-234 D	U-238/U-234 W	U-238/U-234 Y	Th-230 D	Th-230 W	Th-230 Y	Ra-226 D	Ra-226 W	Ra-226 Y	Pb-210 D	Pb-210 W	Pb-210 Y
				Solubility Classification, Fraction[a]											
				Set 1 (Draft NRC Regulatory Guide and NUREG-0511)											
1	1.0	8.90	Yellowcake	0.0	0.0	1.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0
2	1.0	2.40	Fine ore dust	0.0	0.0	1.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0
3	5.0	2.40	Ore and tailings, 30%	0.0	0.0	1.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0
4	35.0	2.40	Ore and tailings, 70%	0.0	0.0	1.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0
				Set 2 (Revised Solubility Classification)											
1	1.0	8.90	Yellowcake	0.6	0.4	0.0	0.0	0.0	1.0	0.1	0.0	0.9	0.0	0.0	1.0
2	1.0	2.40	Fine ore dust	0.0	1.0	0.0	0.0	0.0	1.0	0.1	0.0	0.9	0.0	0.0	1.0
3	5.0	2.40	Ore and tailings, 30%	0.0	1.0	0.0	0.0	0.0	1.0	0.1	0.0	0.9	0.0	0.0	1.0
4	35.0	2.40	Ore and tailings, 70%	0.0	1.0	0.0	0.0	0.0	1.0	0.1	0.0	0.9	0.0	0.0	1.0

a. The letters D, W, and Y represent the pulmonary clearance half-time on the order of days, weeks, and years, respectively.

Table 10

Emission Sources Considered in the

UDAD Modeling

#	KM X	KM Y	M Z	KM2 AREA	238U	230TH	CI/YEAR 226RA	210PB	222RN	ID	PDEN SET	MSEC EXIT VEL	SOURCE TYPE
1	0.04	-0.00	21.3	1.00E-06	5.36E-01	8.51E-03	3.45E-04	4.00E-03	0.0	1101	1	3.25E+00	YELLOWCAKE
2	-0.23	-0.05	11.6	1.00E-06	4.93E-02	7.58E-02	3.07E-02	6.42E-02	0.0	2201	3	1.10E+01	AEROFALL
3	-0.29	-0.13	16.4	1.00E-06	4.79E-02	1.94E-01	7.09E-02	3.23E-01	0.0	2301	3	6.30E+00	AK LEACH
4	-0.30	-0.16	13.3	1.00E-06	6.26E-04	6.39E-04	2.39E-03	1.56E-03	0.0	2401	3	1.94E+00	LEACH
5	-0.29	-0.11	13.4	1.00E-06	5.33E-03	8.45E-03	1.64E-02	1.27E-02	0.0	2501	3	1.59E+01	FINE ORE BIN
6	-1.83	1.83	0.0	3.72E-01	6.12E-04	8.02E-04	7.29E-04	1.97E-04	0.0	3601	2	0.0	ROADS
7	-1.22	1.83	0.0	3.72E-01	9.99E-04	1.30E-03	1.20E-03	3.06E-04	0.0	3602	2	0.0	ROADS
8	-0.91	1.22	0.0	3.72E-01	6.21E-04	8.18E-04	7.47E-04	2.04E-04	0.0	3603	2	0.0	ROADS
9	-0.46	1.07	0.0	9.29E-02	5.59E-04	7.28E-04	6.74E-04	1.68E-04	0.0	4601	2	0.0	ROADS
10	-0.76	0.76	0.0	9.29E-02	4.46E-06	1.03E-05	4.79E-06	8.66E-06	0.0	4602	2	0.0	ROADS
11	-0.46	0.76	0.0	9.29E-02	1.15E-04	1.[illegible]E-04	1.37E-04	3.42E-05	0.0	4603	2	0.0	ROADS
12	-0.15	0.76	0.0	9.29E-02	4.42E-03	5.42E-04	5.00E-04	1.36E-04	0.0	4604	2	0.0	ROADS
13	-0.46	0.46	0.0	9.29E-02	5.29E-06	1.20E-05	5.69E-06	1.03E-05	0.0	4605	2	0.0	ROADS
14	-0.15	0.46	0.0	9.29E-02	5.60E-04	7.24E-04	6.67E-04	1.88E-04	0.0	6601	2	0.0	ROADS
15	-0.76	0.15	0.0	9.29E-02	7.15E-05	4.18E-04	4.95E-04	5.75E-04	0.0	5601	2	0.0	ROADS
16	-0.46	0.15	0.0	9.29E-02	2.03E-04	6.34E-04	5.84E-04	1.09E-03	0.0	5602	2	0.0	ROADS
17	-0.15	0.15	0.0	9.29E-02	4.24E-05	6.61E-05	3.38E-04	1.30E-04	0.0	6602	2	0.0	ROADS
18	0.15	0.15	0.0	9.29E-02	6.56E-04	9.97E-04	7.85E-04	1.95E-04	0.0	6603	2	0.0	ROADS
19	-1.22	-0.30	0.0	3.72E-01	1.13E-05	1.82E-04	1.37E-04	1.50E-04	0.0	5603	2	0.0	ROADS
20	-0.76	-0.15	0.0	9.29E-02	7.15E-05	4.18E-04	4.95E-04	5.75E-04	0.0	5604	2	0.0	ROADS
21	-0.46	-0.15	0.0	9.29E-02	2.98E-04	7.39E-04	6.84E-04	8.18E-04	0.0	5605	2	0.0	ROADS
22	-0.15	-0.15	0.0	9.29E-02	2.32E-04	3.11E-04	1.99E-04	4.06E-04	0.0	5606	2	0.0	ROADS
23	0.15	-0.15	0.0	9.29E-02	5.50E-04	6.18E-04	5.46E-04	7.56E-04	0.0	6604	2	0.0	ROADS
24	0.46	-0.15	0.0	9.29E-02	1.06E-03	1.38E-03	1.27E-03	3.23E-04	0.0	6605	2	0.0	ROADS
25	-0.76	-0.46	0.0	9.29E-02	1.82E-05	1.06E-04	1.25E-04	1.46E-04	0.0	5607	2	0.0	ROADS
26	-0.46	-0.46	0.0	9.29E-02	4.35E-04	6.23E-03	4.67E-03	5.13E-03	0.0	5608	2	0.0	ROADS
27	-0.15	-0.46	0.0	9.29E-02	1.46E-04	6.88E-04	5.57E-04	5.74E-04	0.0	5609	2	0.0	ROADS
28	0.15	-0.46	0.0	9.29E-02	6.59E-05	7.58E-05	8.34E-05	6.81E-05	0.0	6606	2	0.0	ROADS
29	0.46	-0.46	0.0	9.29E-02	1.53E-05	3.53E-05	1.65E-05	2.98E-05	0.0	6607	2	0.0	ROADS
30	0.76	-0.46	0.0	9.29E-02	1.38E-03	1.78E-03	1.65E-03	4.11E-04	0.0	6608	2	0.0	ROADS
31	-1.22	-0.91	0.0	3.72E-01	5.05E-04	6.09E-03	4.66E-03	5.10E-03	0.0	5610	2	0.0	ROADS
32	-0.76	-0.76	0.0	9.29E-02	5.54E-04	7.26E-03	5.52E-03	6.06E-03	0.0	5611	2	0.0	ROADS
33	-0.46	-0.76	0.0	9.29E-02	1.14E-04	5.78E-04	4.67E-04	4.85E-04	0.0	5612	2	0.0	ROADS
34	-0.69	0.08	0.0	2.51E-02	3.08E-04	1.80E-03	2.13E-03	2.47E-03	0.0	8701	2	0.0	TAILINGS
35	-0.53	0.08	0.0	2.51E-02	3.08E-04	1.80E-03	2.13E-03	2.47E-03	0.0	8702	2	0.0	TAILINGS
36	-0.69	-0.08	0.0	2.51E-02	3.08E-04	1.80E-03	2.13E-03	2.47E-03	0.0	8703	2	0.0	TAILINGS
37	-0.53	-0.08	0.0	2.51E-02	3.08E-04	1.80E-03	2.13E-03	2.47E-03	0.0	8704	2	0.0	TAILINGS
38	-0.69	-0.23	0.0	2.51E-02	3.08E-04	1.80E-03	2.13E-03	2.47E-03	0.0	8705	2	0.0	TAILINGS
39	-0.53	-0.23	0.0	2.51E-02	3.08E-04	1.80E-03	2.13E-03	2.47E-03	0.0	8706	2	0.0	TAILINGS
40	-0.84	-0.53	0.0	2.60E-02	3.19E-04	1.87E-03	2.20E-03	2.56E-03	0.0	9701	2	0.0	TAILINGS
41	-0.69	-0.53	0.0	2.60E-02	3.19E-04	1.87E-03	2.20E-03	2.56E-03	0.0	9702	2	0.0	TAILINGS
42	-0.84	-0.69	0.0	2.60E-02	3.19E-04	1.87E-03	2.20E-03	2.56E-03	0.0	9703	2	0.0	TAILINGS
43	-0.29	-0.29	0.0	1.42E-02	1.59E-02	1.54E-02	1.69E-02	1.75E-02	0.0	7801	2	0.0	ORE HANDLING

Table 11

Receptor Locations and Receptors Considered in the Analysis[a]

#	IDENTIFICATION	X(KM)	Y(KM)	Z(M)
1	MONITORING LOCATION 1	0.02	0.22	0.0
2	MONITORING LOCATION 2	-0.55	0.76	0.0
3	MONITORING LOCATION 3	-0.59	0.26	0.0
4	MONITORING LOCATION 4	-1.47	-0.82	0.0
5	MONITORING LOCATION 5	4.27	-1.01	0.0
6	BLOCK A	-0.10	0.30	0.0
7	BLOCK B	-0.24	0.51	0.0
8	BLOCK C	-0.30	0.40	0.0
9	BLOCK D	0.16	-0.05	0.0
10	BLOCK E	0.42	-0.17	0.0
11	BLOCK F	0.64	-0.36	0.0
12	BLOCK G	-0.20	0.64	0.0
13	BLOCK H	-0.59	1.01	0.0
14	BLOCK J	-0.6[illegible]	0.97	0.0
15	TRAILER COURT	-0.65	1.16	0.0
16	MINING CAMP 1	1.16	-2.31	0.0
17	MINING CAMP 2	-1.51	-0.80	0.0
18	WINTER RANGE 1 (MEAT)	0.80	0.50	0.0
19	WINTER RANGE 1 (MILK)	0.80	0.50	0.0
20	WINTER RANGE 2 (MEAT)	2.11	2.41	0.0
21	WINTER RANGE 2 (MILK)	2.11	2.41	0.0
22	WINTER RANGE 3 (MEAT)	-4.63	-2.21	0.0
23	WINTER RANGE 3 (MILK)	-4.63	-2.21	0.0
24	SUMMER RANGE (MEAT)	0.50	-4.93	0.0
25	SUMMER RANGE (MILK)	0.50	-4.93	0.0
26	RANCH 1 (VEGETATION)	10.06	-11.87	0.0
27	RANCH 1 (MEAT)	10.06	-11.87	0.0
28	RANCH 1 (MILK)	10.06	-11.87	0.0
29	RANCH 2 (VEGETATION)	12.37	-0.60	0.0
30	RANCH 2 (MEAT)	12.37	-0.60	0.0
31	RANCH 2 (MILK)	12.37	-0.60	0.0
32	RANCH 3 (VEGETATION)	-8.45	8.15	0.0
33	RANCH 3 (MEAT)	-8.45	8.15	0.0
34	RANCH 3 (MILK)	-8.45	8.15	0.0
35	RANCH 4 (VEGETATION)	-11.87	9.61	0.0
36	RANCH 4 (MEAT)	-11.87	9.61	0.0
37	RANCH 4 (MILK)	-11.87	9.61	0.0
38	NUCLA	17.07	-10.72	0.0
39	WEST VANCORIUM	12.70	-14.88	0.0
40	PARADOX	-19.65	-0.50	0.0
41	BEDROCK	-13.30	-6.15	0.0
42	GATEWAY	-21.03	34.33	0.0

a. See Figures 8 and 9 for locations of receptors.

Table 12

Alternative Scenarios Considered in the UDAD Screening Runs

Scenario	Met JFD	Source Group	Monitoring Location	Ratio of Predicted to Measured Airborne Concentrations[a]: Without Background U-238	Th-230	Ra-226	Pb-210	Average	With Background[b] U-238	Th-230	Ra-226	Pb-210	Average
1	Valley	All Sources	1	0.99	0.32	0.38	0.05		1.00	0.33	0.41	0.59	
			2	0.97	1.11	0.97	0.48	1.13	0.97	1.12	1.00	0.93	1.24
			3	1.51	2.58	1.55	2.64		1.52	2.58	1.56	2.91	
2	Grand	All Sources	1	1.60	0.77	0.89	0.44		1.61	0.78	0.92	0.98	
	Junction		2	0.27	0.82	0.82	0.35	0.77	0.27	0.83	0.85	0.80	0.88
			3	0.90	1.01	0.64	0.76		0.91	1.01	0.65	1.03	
3	Valley	A Plant	1	1.06	0.77	0.91	0.44		1.07	0.78	0.94	0.98	
	Grand	B Plant and	2	0.97	0.91	0.84	0.36	0.82	0.97	0.92	0.87	0.81	0.94
	Junction	Tailings	3	1.21	1.02	0.64	0.76		1.21	1.02	0.65	1.03	
4	Valley	A & B Plants	1	0.99	0.33	0.42	0.06		1.00	0.34	0.45	0.60	
	Grand	Tailings	2	0.97	1.12	1.00	0.45	1.14	0.97	1.13	1.03	0.90	1.25
	Junction		3	1.51	2.58	1.57	2.64		1.52	2.58	1.58	2.91	

a. Predicted concentrations do not include resuspension. Concentration ratios with resuspension are higher by a factor of 1.626.

b. Background concentrations taken to be 4.00E-04 pCi/m^3 for U-238, 1.64E-04 pCi/m^3 for Th-230, and 2.03E-04 pCi/m^3 for Ra-226 from Disappointment Valley, Colorado and 2.00E-04 pCi/m^3 for Pb-210 for the State of Colorado (from Table 4).

TABLE 13

Radioactive Airborne and Ground Concentrations at Selected Receptor Locations[(a)]

Receptor	Radioactive Airborne Concentrations Without Resuspension (pCi/m^3)				Radioactive Ground Concentrations After 18 Years of Operation (pCi/m^2)				
	U-238	Th-230	Ra 226	Pb-210	U-238	Th-230	Ra-226	Pb-210	Po-210
Monitoring Location 1	4.58E-02	1.26E-02	5.60E-03	1.61E-02	2.42E+05	7.94E+04	4.91E+04	8.16E+04	8.23E+04
Monitoring Location 2	1.04E-01	1.25E-02	5.13E-03	1.61E-02	5.30E+05	7.43E+04	4.30E+04	7.83E+04	7.91E+04
Monitoring Location 3	8.65E-02	3.93E-02	1.72E-02	5.64E-02	4.54E+05	2.46E+05	1.68E+05	2.89E+05	2.92E+05
Monitoring Location 4	4.89E-03	8.67E-03	3.58E-03	1.25E-02	2.61E+04	5.51E+04	2.42E+04	6.13E+03	6.20E+04
Monitoring Location 5	1.84E-03	9.66E-04	4.35E-04	1.34E-03	9.40E+03	5.26E+03	3.31E+03	6.05E+03	6.11E+03
Block A	7.63E-02	1.17E-02	5.07E-03	1.44E-02	3.94E+05	7.59E+04	5.02E+04	7.74E+04	7.81E+04
Block B	9.68E-02	1.39E-02	6.05E-03	1.76E-02	3.98E+05	8.66E+04	5.43E+04	8.9[illegible]E+04	8.98E+04
Block C	1.72E-01	2.09E-02	8.45E-03	2.63E-02	8.78E+05	1.25E+05	7.37E+04	1.31E+05	1.32E+05
Block D	2.90E-02	1.69E-02	7.63E-03	2.27E-02	1.60E+05	1.06E+05	6.37E+04	1.15E+05	1.16E+05
Block E	3.44E-02	1.38E-02	6.57E-03	1.68E-02	1.88E+05	9.05E+04	6.30E+03	5.72E+04	8.54E+04
Block F	4.07E-02	1.35E-02	6.14E-03	1.75E-02	2.15E+05	8.21E+04	4.80E+04	8.40E+04	8.43E+04
Block G	3.12E-02	1.03E-02	4.98E-03	1.32E-02	1.18E+05	6.50E+04	4.23E+04	6.64E+04	6.70E+04
Block H	6.33E-02	9.41E-03	4.21E-03	1.19E-02	3.29E+05	5.72E+04	3.41E+04	5.81E+04	5.86E+04
Block J	8.36E-02	9.84E-03	4.18E-03	1.27E-02	4.26E+05	5.76E+04	3.25E+04	6.06E+04	6.13E+04
Trailer Court	5.36E-02	8.12E-03	3.60E-03	1.04E-02	2.77E+05	4.89E+04	2.88E+04	4.99E+05	5.04E+04
Mining Camp 1	6.27E-03	2.40E-02	1.11E-03	3.51E-03	3.22E+04	1.41E+04	7.76E+03	1.64E+04	1.66E+04
Mining Camp 2	4.90E-03	8.61E-03	3.59E-03	1.25E-02	2.58E+04	5.24E+04	2.37E+04	5.97E+04	6.04E+04
Winter Range 1	3.59E-03	2.97E-03	1.34E-03	4.24E-03	1.94E+04	1.68E+04	9.63E+03	1.97E+04	1.99E+04
Winter Range 2	1.01E-03	6.21E-04	2.84E-04	8.73E-04	5.17E+03	3.47E+03	2.05E+03	4.06E+03	4.10E+03
Winter Range 3	8.86E-04	1.36E-03	5.95E-04	1.93E-03	4.48E+03	6.97E+03	3.18E+03	8.17E+03	8.27E+03
Summer Range	8.36E-04	7.26E-04	3.24E-04	1.01E-03	4.27E+03	3.86E+03	1.96E+03	4.49E+03	4.54E+03
Ranch 1	3.24E-04	1.03E-04	4.85E-05	1.40E-04	1.65E+03	5.64E+02	3.11E+02	6.34E+02	6.41E+02
Ranch 2	1.48E-04	8.73E-05	4.16E-05	1.19E-04	7.62E+02	4.77E+02	2.76E+02	5.46E+02	5.52E+02
Ranch 3	1.89E-03	4.49E-04	2.01E-04	5.95E-04	9.59E+03	2.36E+03	1.17E+03	2.61E+03	2.64E+03
Ranch 4	9.16E-04	2.95E-04	1.35E-04	3.97E-04	4.63E+03	1.55E+03	7.74E+02	1.73E+03	1.75E+03
Nucla	1.48E-04	7.69E-05	3.65E-05	1.06E-04	7.56E+02	4.18E+02	2.32E+02	4.80E+02	4.85E+02
West Vancorium	2.10E-04	6.83E-05	3.19E-05	9.23E-05	1.07E+03	3.69E+02	2.02E+02	4.16E+02	4.21E+02
Paradox	8.73E-05	6.46E-05	3.01E-05	1.40E-04	4.40E+02	3.27F+02	1.58E+02	3.75E+02	3.79E+02
Bedrock	7.26E-05	1.26E-04	5.95E-05	1.74E-04	3.69E+02	6.42E+02	3.16E+02	7.43E+02	7.52E+02
Gateway	7.07E-05	2.68E-05	1.24E-05	3.65E-05	3.59E+02	1.40E+02	7.08E+01	1.60E-02	1.61E+02

(a) Concentrations with resuspension approximately 1.626 times higher than values reported in table.

Table 14

Fractional Emission Sou ce Contributions to Direct Airborne
Radioactive Concentrations at Selected Receptor Locations

Receptor	Radionuclide	Percent Contribution						
		Yellowcake	Aerofall	Ak Leach	Leach	Fine Ore Bin	Roads	Tailings
Location 1	U-238	8.93E-01	4.52E-02	3.89E-02	4.24E-04	3.03E-03	1.19E-02	5.74E-04
	Th-230	5.14E-02	2.52E-01	5.73E-01	1.57E-03	1.75E-02	8.97E-02	1.21E-02
	Ra-226	4.68E-03	2.30E-01	4.71E-01	1.32E-02	7.66E-02	1.72E-01	3.21E-02
	Pb-210	1.89E-02	1.67E-01	7.45E-01	3.00E-03	2.06E-02	3.03E-02	1.30E-02
Location 2	U-238	9.53E-01	1.57E-02	1.75E-02	2.10E-04	1.33E-03	8.61E-03	2.82E-04
	Th-230	1.26E-01	2.01E-01	5.91E-01	1.78E-03	1.74E-02	4.90E-02	1.37E-02
	Ra-226	1.24E-02	1.99E-01	5.26E-01	1.62E-02	8.28E-02	1.24E-01	3.93E-02
	Pb-210	4.58E-02	1.32E-01	7.64E-01	3.37E-03	2.04E-02	1.87E-02	1.46E-02
Location 3	U-238	8.38E-01	7.48E-02	7.54E-02	6.74E-04	5.35E-03	3.64E-03	1.90E-03
	Th-230	2.93E-02	2.53E-01	6.72E-01	1.51E-03	1.86E-02	1.95E-02	2.43E-02
	Ra-226	2.71E-03	2.34E-01	5.62E-01	1.29E-02	8.26E-02	4.01E-02	6.57E-02
	Pb-210	9.57E-03	1.49E-01	7.80E-01	2.57E-03	1.95E-02	1.45E-02	2.34E-02
Block A	U-238	9.42E-01	2.56E-01	2.01E-02	2.16E-04	1.60E-03	9.69E-03	4.36E-04
	Th-230	9.74E-02	2.56E-01	5.31E-01	1.44E-03	1.65E-02	7.83E-02	1.67E-0[illegible]
	Ra-226	9.09E-03	2.39E-01	4.48E-01	1.23E-02	7.40E-02	1.72E-01	4.54E-0[illegible]
	Pb-210	3.72E-05	1.76E-01	7.15E-01	2.85E-03	2.01E-02	3.26E-02	1.85E-02
Block B	U-238	9.46E-01	2.29E-02	1.99E-02	2.25E-04	1.69E-03	8.67E-03	3.49E-04
	Th-230	7.91E-02	2.45E-01	5.64E-01	1.60E-03	1.87E-02	7.27E-02	1.42E-02
	Ra-226	7.59E-03	2.28E-01	4.74E-01	1.37E-02	8.35E-02	1.54E-01	3.85E-02
	Pb-210	3.03E-02	1.64E-01	7.39E-01	3.09E-03	2.22E-02	2.41E-02	1.54E-02
Block C	U-238	9.59E-01	2.03E-02	1.63E-02	1.85E-04	1.36E-03	3.60E-03	2.[illegible]-04
	Th-230	1.25E-01	2.57E-01	5.45E-01	1.55E-03	1.78E-02	4.08E-02	1.3[illegible]E-02
	Ra-226	1.25E-02	2.58E-01	4.93E-01	1.43E-02	8.54E-02	9.60E-02	4.02E-02
	Pb-210	4.68E-02	1.73E-01	7.22E-01	3.01E-03	2.12E-02	1.84E-02	1.50E-02
Block D	U-238	7.66E-01	1.04E-01	8.69E-02	9.10E-04	6.69E-03	3.31E-02	9.51E-04
	Th-230	2.08E-02	2.76E-01	6.04E-01	1.60E-03	1.82E-02	7.28E-02	9.59E-03
	Ra-226	1.86E-03	2.49E-01	4.89E-01	1.31E-02	7.84E-02	1.44E-01	2.50E-02
	Pb-210	7.14E-03	1.74E-01	7.49E-01	2.90E-03	2.03E-02	3.76E-02	9.78E-03
Block E	U-238	8.28E-01	7.15E-02	5.26E-02	5.41E-04	4.56E-03	4.04E-02	5.55E-04
	Th-230	3.28E-02	2.74E-01	5.30E-01	1.38E-03	1.80E-02	1.33E-01	8.12E-03
	Ra-226	2.77E-03	2.31E-01	4.08E-01	1.08E-02	7.37E-02	2.53E-01	2.01E-02
	Pb-210	1.26E-02	1.90E-01	7.26E-01	2.76E-03	2.23E-02	3.51E-02	9.17E-03

Table 15

40 CFR 190 Doses of Selected Receptor Locations by Dose Pathway and Radionuclide (Emission Control Scenario 1)

Pathway	Organ	Location 1 Organ Doses (mrem/yr)					
		U-238	U-234	Th-230	Ra-226	Pb-210	Total
Inhalation	W. Body	5.44E-01	6.20E-01	1.99	2.04E-01	7.12E-02	3.43
	Lung	2.70	3.08	3.74E+01	3.26E+01	1.20E+01	8.78E+01
	Bone	9.18	1.00E+01	7.10+01	2.04	2.22	9.45E+01
	Kidney	2.10	2.39	1.99	7.20E-03	1.85	2.63E+01
	Liver	--	--	4.10	2.54E-01	5.66E-01	4.67
Cloud Immersion	Skin	3.17E-04	3.17E-06	1.54E-06	1.21E-04	5.32E-05	4.98E-04
	W. Body	6.68E-06	9.45E-08	3.35E-07	6.58E-05	1.92E-07	7.31E-05
Ground Plane	Skin	1.17	5.18E-01	1.44E-01	4.70E-02	4.48E-01	2.33
	W. Body	6.42E-01	9.54E-02	4.01E-02	3.84E-02	1.53E-01	9.69E-01
Ingestion	W. Body	1.24E-01	1.42E-01	3.05E-02	1.4[illegible]	4.97E-01	2.21
	Bone	2.07	2.26	1.10	1.32E+01	1.26E+01	3.12E+01
	Kidney	4.12E-01	4.69E-01	1.45E-01	6.08E-02	1.03E+01	1.14E+01
	Liver	--	--	6.06E-02	2.26E-03	3.49	3.55
Total	Skin	1.17	5.18E-01	1.44E-01	4.71E-02	4.48E-01	2.33
	W. Body	1.31	8.47E-01	2.06	1.66	7.21E-01	6.61
	Lung	3.34	3.18	3.74E+01	3.26E+01	1.22E+01	8.88E+01
	Bone	1.19E+01	1.24E+01	7.21E+01	1.53E+01	1.50E+01	1.27E+02
	Kidney	3.15	2.95	2.18	1.06E-01	1.23E+01	3.87E+01
	Liver	6.42E-01	9.53E-02	4.20	4.10E-02	4.21	9.19
		Location 2 Organ Doses (mrem/yr)					
Inhalation	W. Body	1.29	1.47	1.98	1.83E-01	7.12E-02	4.99
	Lung	5.48	6.24	3.74E+01	3.03E+01	1.20E+01	9.14E+01
	Bone	2.17E+01	2.37E+01	7.08E+01	1.83	2.21	1.20E+02
	Kidney	4.95	5.64	1.99E+01	6.47E-03	1.84	3.23E+01
	Liver	--	--	4.08	2.28E-04	5.63E-01	4.65
Cloud Immersion	Skin	7.15E-04	1.16E-05	1.52E-06	1.09E-04	5.29E-05	8.91E-04
	W. Body	1.51E-05	2.13E-07	3.75E-08	5.93E-05	1.91E-07	7.48E-05
Ground Plane	Skin	2.56	1.14	1.35E-01	4.12E-02	4.13E-01	4.31
	W. Body	[illegible].41	2.09E-01	3.75E-02	3.36E-02	1.47E-01	1.84
Ingestion	W. Body	2.92E-01	3.21E-01	3.00E-02	1.28	4.96E-01	2.41
	Bone	4.6[illegible]	5.12	1.08	1.19E+01	1.25E+01	3.53E+01
	Kidney	9.34E-01	1.06	1.43E-01	5.49E-02	1.02E+01	2.38E+01
	Liver			5.97E-02	2.04E-03	3.47	3.53
Total	Skin	2.56	1.14	1.35E-01	4.13E-02	4.31E-01	4.31
	W. Body	2.98	2.00	2.05	1.50	7.14E-01	9.24
	Lung	6.89	6.45	3.74E+01	3.03E+01	1.21E+01	9.32E+01
	Bone	2.78E+01	2.90E+01	7.19E+01	1.38E+01	1.49E+01	1.57E+02
	Kidney	7.29	6.91	2.01E+01	9.50E-02	1.22E+01	5.79E+01
	Liver	1.41	2.09E-01	4.18	3.59E-02	4.18	1.00E+01

Table 15 (Continued)

40 CFR 190 Doses of Selected Receptor Locations by Dose Pathway and Radionuclide (Emission Control Scenario 1)

Pathway	Organ	U-238	U-234	Th-230	Ra-226	Pb-210	Total
		Location 3 Organ Doses (mrem/yr)					
Inhalation	W. Body	9.87E-01	1.1[illegible]	6.57	6.57E-01	2.55E-01	9.60
	Lung	5.76	6.56	1.25E+02	1.07E+02	4.23E+02	2.86E+01
	Bone	1.65E+01	1.83E+01	2.35E+02	6.57	7.78	2.85E+02
	Kidney	3.82	4.35	6.57E+01	2.33E-02	6.47	8.04E+01
	Liver	--	--	1.35E+01	8.19E-04	1.98	1.55E+01
Cloud Immersion	Skin	6.02E-04	9.80E-06	4.91E-06	3.87E-04	1.86E-04	1.19E-03
	W. Body	1.27E-05	1.79E-07	1.21E-07	2.10E-04	6.7[illegible]E-07	2.24E-04
Ground Plane	Skin	2.19	9.75E-01	4.46E-01	1.61E-01	1.52	5.29
	W. Body	1.20	1.79E-01	1.24E-01	1.31E-01	5.42E-01	2.18
Ingestion	W. Body	2.36E-01	2.69E-01	9.48E-02	4.48	1.74	6.82
	Bone	3.92	4.28	3.42	4.17E+01	4.40E+01	9.73E+01
	Kidney	7.80E-01	8.88E-01	4.51-01	1.92E-01	3.60E+01	3.83E+01
	Liver	--	--	1.89E-01	7.16E-03	1.22E+01	1.24E+01
Total	Skin	2.19	9.75E-01	4.46E-01	1.61E-01	1.52	5.29
	W. Body	2.42	1.55	6.70	5.27	2.54	1.86E+01
	Lung	6.96	6.74	1.25E+02	1.07E+02	4.28E+01	2.88E+02
	Bone	2.16E+01	2.28E+01	2.39E+02	4.84E+01	5.23E+01	3.84E+02
	Kidney	5.80	5.42	6.63E+01	1.94E+01	4.30E+01	1.21E+02
	Liver	1.20	1.79E-01	1.38E+0	1.39E-01	1.47E+01	3.01E+01
		Block A Organ Doses (mrem/yr)					
Inhalation	W. Body	9.36E-01	1.07	1.84	1.93E-01	6.48E-02	4.11
	Lung	4.17	4.74	3.45E+01	2.92E+01	1.07E+01	8.34E+01
	Bone	1.58E+01	1.73E+01	6.60E+01	1.93	2.01	1.03E+02
	Kidney	3.61	4.11	.85E+01	6.81E-03	1.73	2.80E+01
	Liver	--	--	3.80	2.40E-04	5.13E-01	4.31
Cloud Immersion	Skin	5.27E-04	8.59E-06	1.44E-06	1.13E-04	4.81E-05	6.98E-04
	W. Body	1.11E-05	1.57E-07	3.53E-08	6.11E-05	1.74E-07	7.26E-05
Ground Plane	Skin	1.91	8.48E-01	1.37E-01	4.80E-02	3.88E-01	3.33
	W. Body	1.05	1.56E-01	3.83E-02	3.92E-02	1.45E-01	1.43
Ingestion	W. Body	2.07E-01	2.36E-01	2.84E-02	1.32	4.48E-01	2.24
	Bone	3.45	3.76	1.02	1.23E+01	1.13E+01	3.78E+01
	Kidney	6.86E-01	7.81E-01	1.35E-01	5.69E-02	9.26	1.09E+01
	Liver	--	--	5.64E-02	2.12E-03	3.14	3.20
Total	Skin	1.91	8.48E-01	1.37E-01	4.81E-02	3.88E-01	3.33
	W. Body	2.19	1.46	1.91	1.55	6.58E-01	7.78
	Lung	5.22	4.90	3.45E+01	2.92E+01	1.08E+01	8.48E+01
	Bone	2.03E+01	2.12E+01	6.71E+01	1.43E+01	1.35E+01	1.36E+02
	Kidney	5.35	5.05	1.87E+01	1.03E-01	1.11E+01	4.03E+01
	Liver	1.05	1.56E-01	3.89	4.16E-02	3.80	8.94

Table 15 (Continued)

40 CFR 190 Doses of Selected Receptor Locations by Dose Pathway and Radionuclide (Emission Control Scenario 1)

Pathway	Organ	Block B Organ Doses (mrem/yr)					
		U-238	U-234	Th-230	Ra-226	Pb-210	Total
Inhalation	W. Body	9.39E-01	1.07	2.20	1.39E-01	7.82E-02	4.43
	Lung	4.25	4.85	4.14E+01	3.53E+01	1.31E+01	9.85E+01
	Bone	1.58E+01	1.73E+01	7.85E+01	2.22	2.42	1.16E+02
	Kidney	3.61	4.11	2.20E+01	7.84E-03	2.02	3.18E+01
	Liver	--	--	4.70	2.77E-04	6.18E-01	5.32
Cloud Immersion	Skin	5.31E-04	8.64E-06	1.70E-06	1.31E-04	5.82E-05	7.31E-04
	W. Body	1.15E-05	1.63E-07	5.93E-08	9.75E-05	3.06E-07	1.10E-04
Ground Plane	Skin	1.92	8.52E-01	1.57E-01	5.20E-02	8.35E-02	3.06
	W. Body	1.06	1.57E-01	4.01E-02	4.24E-02	1.67E-01	1.47
Ingestion	W. Body	2.59E-01	2.95E-01	3.36E-02	1.53	5.44E-01	2.66
	Bone	4.31	4.70	1.21	1.43E+01	1.38E+01	3.83E+01
	Kidney	8.59E-01	9.77E-01	1.60E-01	6.59E-02	1.12E+01	1.33E+01
	Liver	--	--	6.67E-02	2.45E-03	3.81	3.88
Total	Skin	1.92	8.52E-01	1.57E-01	5.21E-02	8.35E-02	3.06
	W. Body	2.26	1.52	2.27	1.71	7.89E-01	8.56
	Lung	5.31	5.01	4.14E+01	3.53E+01	1.33E+01	1.00E+02
	Bone	2.12E+01	2.22E+01	7.98E+01	1.66E+01	1.64E+01	1.56E+02
	Kidney	5.53	5.24	2.22E+01	1.16E-01	1.34E+01	4.66E+01
	Liver	1.06	1.57E-01	4.81	4.52E-02	4.60	1.07E+01

Pathway	Organ	Block C Organ Doses (mrem/yr)					
		U-238	U-234	Th-230	Ra-226	Pb-210	Total
Inhalation	W. Body	2.13	2.44	3.35	3.09E-01	1.17E-01	8.35
	Lung	9.12	1.03E+01	6.31E+01	5.14E+01	1.96E+01	1.53E+02
	Bone	5.45E+01	3.94E+01	1.20E+02	3.03	3.62	2.20E+02
	Kidney	8.21	9.37	3.35E+01	1.09E-02	3.02	5.41E+01
	Liver	--	--	6.89	3.85E-04	9.22E-01	7.82
Cloud Immersion	Skin	1.19E-03	1.93E-05	2.56E-06	1.85E-04	8.66E-05	1.43E-03
	W. Body	2.50E-05	3.54E-07	6.30E-08	1.00E-04	3.14E-07	1.26E-04
Ground Plane	Skin	4.23	1.89	2.27E-01	7.05E-02	7.20E-01	7.14
	W. Body	2.33	3.46E-01	6.34E-02	5.76E-02	2.45E-01	4.51
Ingestion	W. Body	4.67E-01	5.33E-01	5.02E-02	2.13	[illegible].11E-01	3.99
	Bone	7.77	8.48	1.81	1.98E+01	[illegible]	5.84E+01
	Kidney	1.55	1.76	2.39E-01	9.14E-02	1.67E+01	2.03E+01
	Liver	--	--	9.98E-02	3.40E-03	5.68	5.78
Total	Skin	4.23	1.89	2.27E-01	7.07E-02	7.20E-01	7.14
	W. Body	4.93	3.32	3.46	2.50	1.17	1.69E+01
	Lung	1.15E+01	1.06E+01	6.32E+01	5.15E+01	1.98E+01	1.58E+02
	Bone	6.46E+01	4.82E+01	1.22E+02	2.29E+01	2.44E+01	2.83E+02
	Kidney	1.21E+01	1.15E+01	3.38E+01	1.60E-01	2.00E+01	7.89E+01
	Liver	2.33	3.46E-01	7.05	6.15E-02	9.81E+01	1.81E+01

Table 15 (Continued)

40 CFR 190 Doses of Selected Receptor Locations by Dose Pathway and Radionuclide (Emission Control Scenario 1)

Pathway	Organ	U-238	U-234	Th-230	Ra-226	Pb-210	Total
		Block D Organ Doses (mrem/yr)					
Inhalation	W. Body	3.15E-01	3.59E-01	2.73	2.74E-01	1.01E-01	3.78
	Lung	2.22	2.54	5.18E+01	4.57E+01	1.70E+01	1.20E+02
	Bone	5.31	5.79	9.81E+01	2.74	3.14	1.15E+02
	Kidney	1.21	1.38	2.74E+01	9.67E-03	2.62	3.26E+01
	Liver	--	--	5.63	3.41E-04	8.00E-01	6.44
Cloud Immersion	Skin	2.02E-04	3.29E-06	2.08E-06	1.65E-04	7.53E-05	4.48E-04
	W. Body	4.25E-06	6.02E-08	5.13E-08	8.98E-05	2.72E-07	9.40E-05
Ground Plane	Skin	7.73E-01	3.44E-01	1.91E-01	6.10E-02	6.33E-01	2.00
	W. Body	4.25E-01	6.50E-02	5.33E-02	4.98E-02	2.16E-01	8.09E-01
Ingestion	W. Body	7.88E-02	8.98E-02	3.36E-02	1.25	5.02E-01	1.95
	Bone	1.31	1.43	1.48	1.16E+01	1.27E+01	2.85E+01
	Kidney	2.61E-01	2.97E-01	1.60E-01	5.35E-02	1.04E+01	1.12E+01
	Liver	--	--	8.12E-02	1.99E-03	3.52	3.60
Total	Skin	7.73E-01	3.44E-01	1.91E-01	6.12E-02	6.33E-01	2.00
	W. Body	8.19E-01	5.14E-01	2.82	1.57	8.19E-01	6.54
	Lung	2.65	2.61	5.19E+01	4.57E+01	1.72E+01	1.21E+02
	Bone	7.05	7.29	9.96E+01	1.44E+01	1.61E+01	1.44E+02
	Kidney	1.90	1.74	2.76E+01	1.13E-01	1.32E+01	4.46E+01
	Liver	4.25E-01	6.50E-02	5.76	5.22E-02	4.54	1.08E+01
		Block E Organ Doses (mrem/yr)					
Inhalation	W. Body	3.90E-01	4.44E-01	2.14	2.35E-01	7.45E-02	3.28
	Lung	2.19	2.50	4.01E+01	3.62E+01	1.25E+01	9.35E+01
	Bone	6.58	7.19	7.67E+01	2.35	2.31	9.51E+01
	Kidney	9.23	1.71	2.15E+01	8.29E-03	1.92	3.44E+01
	Liver	--	--	4.41	2.93E-04	5.87E-01	5.00
Cloud Immersion	Skin	2.38E-04	3.87E-06	1.68E-06	1.39E-04	5.52E-05	4.38E-04
	W. Body	5.01E-06	7.09E-08	4.13E-08	7.55E-05	2.00E-07	8.09E-05
Ground Plane	Skin	9.05E-01	4.04E-01	1.65E-01	6.03E-03	4.69E-01	1.95
	W. Body	4.99E-01	7.41E-02	4.57E-02	4.92E-03	1.00E-01	7.84E-01
Ingestion	W. Body	9.38E-02	1.07E-01	3.36E-02	1.25	5.02E-01	1.99
	Bone	1.56	1.70	1.21	1.16E+01	1.27E+01	2.88E+01
	Kidney	3.11E-01	3.53E-01	1.60E-01	5.35E-02	1.03E+01	1.13E+01
	Liver	--	--	6.67E-02	1.99E-03	3.52	3.59
Total	Skin	9.05E-01	4.04E-01	1.65E-01	6.17E-03	4.69E-01	1.95
	W. Body	9.83E-01	6.26E-01	2.22	1.49	7.37E-01	6.05
	Lung	2.69	2.57	4.01E+01	3.62E+01	1.27E+01	9.43E+01
	Bone	8.64	8.96	7.80E+01	1.40E+01	1.52E+01	1.25E+02
	Kidney	1.00E+01	2.14	2.17E+01	6.68E-02	1.25E+01	4.65E+01
	Liver	4.99E-01	7.41E-02	4.52	7.28E-03	4.27	9.37

Table 16

Contribution to Ingested Activity
by Airborne and Ground Concentrations

	Airborne Ingested Activity, pCi/yr				Ground Ingested Activity, pCi/yr				Total Ingested Activity, pCi/yr			
Receptor	U-238	Th-230	Ra-226	Pb-210	U-238	Th-230	Ra-226	Pb-210	U-238	Th-230	Ra-226	Pb-210
Location 1	1.47E+03	4.05E+02	1.80E+02	5.17E+02	1.11E+02	6.13E+01	6.97E+01	6.01E+01	1.58E+03	4.66E+02	2.50E+02	5.77E+02
Location 2	3.34E+03	4.02E+02	1.65E+02	5.17E+02	2.43E+02	5.73E+01	6.17E+01	5.77E+01	3.58E+03	4.59E+02	2.26E+02	5.75E+02
Location 3	2.78E+03	1.26E+03	5.52E+02	1.81E+03	2.08E+02	1.90E+02	2.39E+05	2.13E+02	2.99E+03	1.45E+03	7.91E+02	2.02E+03
Block A	2.45E+03	3.76E+02	1.63E+02	4.63E+02	1.81E+02	5.86E+01	7.13E+01	5.70E+01	2.63E+03	4.34E+02	2.34E+02	5.20E+02
Block B	3.11E+03	4.46E+02	1.94E+02	5.65E+02	1.83E+02	6.68E+01	7.71E+01	6.56E+01	3.29E+03	5.13E+02	2.71E+02	6.31E+02
Block C	5.52E+03	6.71E+02	2.71E+02	8.45E+02	4.03E+02	9.65E+01	1.05E+02	9.65E+01	5.93E+03	7.68E+02	3.76E+02	9.41E+02
Block D	9.31E+02	5.43E+02	2.45E+02	7.29E+02	7.34E+01	8.18E+01	9.05E+01	8.47E+01	1.00E+03	6.25E+02	3.36E+02	8.14E+02
Block E	1.10E+03	4.43E+02	2.11E+02	5.40E+02	8.62E+01	6.98E+01	8.95	4.21E+01	1.19E+03	5.13E+02	2.20E+02	5.82E+02

Table 17

Total 40 CFR 190 Doses of Selected Receptor Locations by Radionuclide
(Emission Control Scenarios 2, 3, 4, and 5)

Receptor	Scenario	Organ	Dose Rate, mrem/yr U-238	U-234	Th-230	Ru-226	Pb-210	Total
Location 1	2	Whole Body	8.84E-01	3.72E-01	8.44E-01	9.01E-01	2.95E-[illegible]	3.30
		Lung	1.62	1.21	1.49E+01	1.73E+01	3.15	3.82E+01
		Bone	4.73	4.55	2.87E+01	8.13	3.86	5.00E+01
		Kidney	1.55	1.13	8.90E-01	7.46E-02	3.19	6.83
		Liver	6.42E-01	9.53E-02	1.70	3.98E-02	1.17	3.65
	3	Whole Body	7.89E-01	2.63E-01	8.28E-01	8.99E-01	2.93E-01	3.07
		Lung	1.24	7.73E-01	1.46E+01	1.73E+01	3.12	3.70E+01
		Bone	3.12	2.79	2.82E+01	8.12	3.81	4.60E+01
		Kidney	1.10	7.24E-01	8.73E-01	7.45E-02	3.15	6.01
		Liver	6.42E-01	9.53E-02	1.66	3.98E-02	1.15	3.59
	4	Whole Body	7.56E-01	2.26E-01	2.64E-01	3.71E-01	1.79E-01	1.80
		Lung	1.10	6.22E-01	4.19	6.72	7.11E-01	1.33E+01
		Bone	2.57	2.19	8.04	3.16	8.42E-01	1.68E+01
		Kidney	1.07	5.84E-01	2.77E-01	5.24E-02	7.18E-01	2.70
		Liver	6.42E-01	9.53E-02	5.02E-01	3.90E-02	3.42E-01	1.62
	5	Whole Body	7.62E-01	2.32E-01	8.16E-01	1.47E-01	1.71E-01	2.13
		Lung	1.24	7.73E-01	1.46E+01	1.73E+01	3.12	3.70E+01
		Bone	2.66	2.30	2.77E+01	1.12	7.01E-01	3.45E+01
		Kidney	1.10	6.21E-01	8.16E-01	4.23E-02	6.10E-01	3.19
		Liver	6.42E-01	9.53E-02	1.64	3.86E-02	2.93E-01	2.71

Table 17

Total 40 CFR 190 Doses of Selected Receptor Locations by Radionuclide
(Emission Control Scenarios 2, 3, 4, and 5) (Continued)

Receptor	Scenario	Organ	Dose Rate, mrem/yr U-238	U-234	Th-230	Ru-226	Pb-210	Total
Location 2	2	Whole Body	1.95	8.00E-01	7.01E-01	7.23E-01	2.73E-01	4.45
		Lung	3.30	2.27	1.24E+01	1.43E+01	2.82	3.51E+01
		Bone	1.05E+01	9.72	2.38E+01	6.50	3.43	5.40E+01
		Kidney	3.43	2.42	6.65	6.26E-02	2.82	1.54E+01
		Liver	1.41	2.09E-01	1.40	3.47E-02	1.05	4.10
	3	Whole Body	1.71	5.53E-01	6.61E-01	7.20E-01	2.64E-01	3.91
		Lung	2.46	1.41	1.16E+01	1.42E+01	2.62	3.23E+01
		Bone	6.48	5.74	2.23E+01	6.47	3.18	4.42E+01
		Kidney	2.54	1.50	6.25	6.24E-02	2.63	1.30E+01
		Liver	1.41	2.09E-01	1.32	3.47E-02	9.78	1.28E+01
	4	Whole Body	1.68	5.15E-01	2.07E-01	2.75E-01	1.70E-01	2.85
		Lung	2.35	1.28	3.18	5.03	6.40E-01	1.25E+01
		Bone	5.92	5.14	6.08E+01	2.30	7.52E-01	2.02E+01
		Kidney	2.42	5.14	6.08E-01	2.30	7.52E-01	2.02E+01
		Liver	1.41	2.09E-01	3.86E-01	3.40E-02	3.13E-01	2.35
	5	Whole Body	1.66	4.91E-01	6.51E-01	1.19E-01	1.62E-01	3.08
		Lung	2.46	1.41	1.16E+01	1.42E+01	2.62	3.23E+01
		Bone	5.58	4.76	[illegible].20E+01	8.92E-01	6.02E-01	3.38E+01
		Kidney	2.36	1.29	[illegible].01	3.67E-02	5.26E-01	1.02E+01
		Liver	1.41	2.09E-01	1.30	3.38E-02	2.63E-01	3.22

Table 17

Total 40 CFR 193 Doses of Selected Receptor Locations by Radionuclide
(Emission Control Scenarios 2, 3, 4, and 5) (Continued)

			Dose Rate, mrem/yr					
Receptor	Scenario	Organ	U-238	U-234	Th-230	Ru-226	Pb-210	Total
Location 3	2	Whole Body	1.65	6.88E-01	2.32	2.40	9.83E-01	7.94
		Lung	3.30	2.57	3.95E+01	4.52E+01	9.89	1.00E+02
		Bone	8.63	8.40	7.52E+01	2.15E+01	1.20E+01	1.26E+02
		Kidney	2.87	2.09	2.10E+01	2.26E-01	9.93	3.61E+01
		Liver	1.20	1.79E-01	4.44	1.35E-01	3.68	9.63
	3	Whole Body	1.48	5.01E-01	2.19	2.40	9.81E-01	7.55
		Lung	2.52	1.69	3.89E+01	4.51E+01	9.85	9.81E+01
		Bone	5.90	5.37	7.40E+01	2.14E+01	1.19E+01	1.19E+02
		Kidney	2.26	1.38	2.06E+01	2.26E-01	9.89E-01	3.44E+01
		Liver	1.20	1.79E-01	4.37	1.35E-01	3.66	9.54
	4	Whole Body	1.38	3.86E-01	4.49E-01	6.76E-01	6.21E-01	3.51
		Lung	2.05	1.15	6.22E+01	1.09E+01	2.21	2.25E+01
		Bone	4.22	3.52	1.18E+01	5.25	2.59	2.74E+01
		Kidney	1.88	9.54E-01	3.35	1.54E-01	2.22	8.56
		Liver	1.20	1.79E-01	7.92E-01	1.32E-01	1.10	3.40
	5	Whole Body	1.43	4.39E-01	2.16	4.21E-01	5.98E-01	4.88
		Lung	2.52	1.69	2.89E+01	4.51E+01	9.85	9.81E+01
		Bone	5.00	4.39	7.30E+01	3.03	2.25	8.77E+01
		Kidney	2.08	1.18	2.05E+01	1.41E-01	1.97	2.59E+01
		Liver	1.20	1.79E-01	4.31	1.32E-01	9.78E-01	6.70

Table 17

Total 40 CFR 190 Doses of Selected Receptor Locations by Radionuclide
(Emission Control Scenarios 2, 3, 4, and 5) (Continued)

Receptor	Scenario	Organ	Dose Rate, mrem/yr					
			U-238	U-234	Th-230	Ru-226	Pb-210	Total
Block A	2	Whole Body	1.45	6.12E-02	8.02E-01	8.71E-01	2.95E-01	3.48
		Lung	2.51	1.81	1.41E+01	1.61E+01	3.27	3.78E+01
		Bone	7.77	7.51	2.74E+01	7.87	4.03	5.46E+01
		Kidney	2.55	1.86	7.66	7.43E+02	3.35	1.55E+01
		Liver	1.05	1.56E-01	1.62	4.06E-02	1.21	4.08
	3	Whole Body	1.28	4.15E-01	7.73E-01	8.70E-01	2.95E-01	3.63
		Lung	1.88	1.09	1.36E+01	1.61E+01	3.27	3.59E+01
		Bone	4.86	4.33	2.64E+01	7.85	4.03	4.75E+01
		Kidney	1.90	1.12	7.36	7.42E-02	3.35	1.38E+01
		Liver	1.05	1.56E-01	1.55	4.06E-02	1.21	4.01
	4	Whole Body	1.24	3.78E-01	2.48E-01	3.71E-01	1.71E-01	2.41
		Lung	1.76	9.62E-01	3.90	6.43	6.92E-01	1.37E+01
		Bone	4.32	3.74	7.54	3.16	8.25E-01	1.96E+01
		Kidney	1.78	9.87E-01	2.13	5.32E-02	7.07E-01	5.66
		Liver	1.05	1.56E-01	4.70E-01	3.98E-02	3.32E-01	2.05
	5	Whole Body	1.24	3.68E-01	7.61E-01	1.06E+01	1.64E-01	2.94E+01
		Lung	1.88	1.09	1.36E+01	1.61E+01	3.27	3.59E+01
		Bone	4.18	3.58	2.60E+01	1.10	7.32E-01	3.56E+01
		Kidney	1.76	9.70E-01	7.31	4.30E-02	6.50E-01	1.07E+01
		Liver	1.05	1.56E-01	1.53	3.94E-02	2.95E-01	3.07

Table 17

Total 40 CFR 190 Doses of Selected Receptor Locations by Radionuclide
(Emission Control Scenarios 2, 3, 4, and 5) (Continued)

			Dose Rate, mrem/yr					
Receptor	Scenario	Organ	U-238	U-234	Th-230	Ru-226	Pb-210	Total
Block B	2	Whole Body	1.47	6.29E-01	9.09E-01	9.20E-01	3.21E-01	4.25
		Lung	2.53	1.84	1,61E+01	1.86E+01	3.42	4.25E+01
		Bone	8.02	7.77	3.10E+01	8.73	4.19	5.97E+01
		Kidney	2.61	1.92	9.22	8.12E-02	3.45	1.73E+01
		Liver	1.06	1.57E-01	1.89	4.39E-02	1.27	4.42
	3	Whole Body	1.29	4.23E-01	8.80E-01	9.17E-01	3.18E 01	3.83
		Lung	1.89	1.10	1.56E+01	1.85E+01	3.3[illegible]	4.04E+01
		Bone	4.98	4.45	3.00E+01	8.70	4.11	5.22E+01
		Kidney	1.93	1.45	8.91	8.11E-02	3.38	1.58E+01
		Liver	1.06	1.57E-01	1.83	4.39E-02	1.24	4.33
	4	Whole Body	1.26	3.89E-01	2.63E-01	3.66E-01	1.95E-01	2.47
		Lung	1.78	9.82E-01	4.18	6.89	7.53E-01	1.46E+01
		Bone	4.48	3.90	8.01	3.25	8.92E-01	2.05E+01
		Kidney	1.82	1.02	2.40	5.68E-02	7.58E-01	6.05
		Liver	1.06	1.57E-01	5.17E-01	4.30E-02	3.65E-01	2.14
	5	Whole Body	1.24	3.62E-01	8.67E-01	1.15E-01	1.69E-01	2.75
		Lung	1.89	1.10	1.56E+01	1.85E+01	3.35	4.04E+01
		Bone	9.99	3.53	2.96E+01	1.21	7.55E-01	4.51E+01
		Kidney	1.76	9.58E-01	8.31	4.66E-02	6.58E-01	1.17E+01
		Liver	1.06	1.57E-01	1.81	4.26E-02	3[illegible]-01	3.39

Table 17

Total 40 CFR 190 Doses of Selected Receptor Locations by Radionuclide
(Emission Control Scenarios 2, 3, 4, and 5) (Continued)

Receptor	Scenario	Organ	Dose Rate, mrem/yr					
			U-238	U-234	Th-230	Ru-226	Pb-210	Total
Block C	2	Whole Body	3.22	1.36	1.35	1.29	4.80E-01	7.70
		Lung	5.44	3.86	2.39E+01	2.60E+01	5.22	6.44E+01
		Bone	2.36E+01	1.67E+01	4.60E+01	1.16E+01	6.37	1.04E+02
		Kidney	5.66	4.14	1.28E+01	1.09E-01	5.25	2.80E+01
		Liver	2.33	3.46E-01	2.70	5.96E-02	1.92	7.36
	3	Whole Body	2.82	9.05E-01	1.28	1.28	4.73E-01	6.76
		Lung	4.04	2.28	2.26E+01	2.59E+01	5.07	5.99E+01
		Bone	1.40E+01	9.35	4.35E+01	1.15E+01	6.18	8.45E+01
		Kidney	4.16	2.44	1.21E+01	1.09E-01	5.10	2.39E+01
		Liver	2.33	3.46E-01	2.56	5.96E-02	1.87	7.17
	4	Whole Body	2.77	8.42E-01	3.21E-01	3.94E-01	2.83E-01	4.61
		Lung	3.85	2.07	4.85	7.15	1.06	1.90E+01
		Bone	1.27E+01	8.34	9.30	3.21	1.24	3.48E+01
		Kidney	3.96	2.20	2.62	7.18E-02	1.06	9.91
		Liver	2.33	3.46E-01	5.93E-01	5.82E-02	5.18E-01	3.85
	5	Whole Body	2.73	8.05E-01	1.26	2.13E-01	2.74E-01	5.28
		Lung	4.04	2.28	2.26E+01	2.59E+01	5.07	5.99E+01
		Bone	1.26E+01	7.75	4.29E+01	1.58	1.14	6.60E+01
		Kidney	3.87	2.11	1.20E+01	6.32E-02	9.88E-01	1.90E+01
		Liver	2.33	3.46E-01	2.52	5.79E-01	4.72E-01	6.25

Table 17

Total 40 CFR 190 Doses of Selected Receptor Locations by Radionuclide
(Emission Control Scenarios 2, 3, 4, and 5) (Continued)

Receptor	Scenario	Organ	Dose Rate, mrem/yr U-238	U-234	Th-230	Ru-226	Pb-210	Total
Block D	2	Whole Body	5.83E-01	2.45E-01	1.13	8.35E-01	3.69E-01	3.16
		Lung	1.32	1.08	2.02E+01	2.36E+01	4.53	5.07E+01
		Bone	2.27	2.07	3.84E+01	7.42	4.22	5.44E+01
		Kidney	8.34E-01	5.31E-01	1.07E+01	8.24E-02	3.51	1.57E+01
		Liver	4.25E-01	6.50E-02	2.25	5.11E-02	1.31	4.10
	3	Whole Body	5.34E-01	1.90E-01	1.12	8.33E-01	3.69E-01	3.05
		Lung	1.04	7.71E-01	2.00E+01	2.35E+01	4.52	4.98E+01
		Bone	2.27	2.07	3.84E+01	7.42	4.22	5.44E+01
		Kidney	8.34E-01	5.31E-01	1.07E+01	8.24E-02	3.51	1.57E+01
		Liver	4.25E-01	6.50E-02	2.25	5.11E-02	1.31	4.10
	4	Whole Body	4.90E-01	1.39E-01	2.91E-01	3.07E-01	2.45E-01	1.47
		Lung	7.89E-01	4.82E-01	4.50	7.77	1.04	1.46E+01
		Bone	1.51	1.25	8.61	2.47	9.86E-01	1.48E+01
		Kidney	6.66E-01	3.40E-01	2.42	6.06E-02	8.49E-01	4.34
		Liver	4.25E-01	6.50E-02	5.44E-01	5.03E-02	4.26E-01	1.51
	5	Whole Body	5.13E-01	1.65E-01	1.10	1.91E-01	2.42E-01	2.21
		Lung	1.04	7.71E-01	2.00E+01	2.35E+01	4.52	4.98E+01
		Bone	1.90	1.67	3.78E+01	1.46	1.01	4.38E+01
		Kidney	7.61E-01	4.49E-01	1.06E+01	5.49E-02	8.79E-01	1.27E+01
		Liver	4.25E-01	6.50E-02	2.22	5.01E-02	4.18E-01	3.18

Table 17

Total 40 CFR 190 Doses cf Selected Receptor Locations by Radionuclide
(Emission Control Scenarios 2, 3, 4, and 5) (Continued)

Receptor	Scenario	Organ	Dose Rate, mrem/yr					
			U-238	U-234	Th-230	Ru-226	Pb-210	Total
Block E	2	Whole Body	6.89E-01	2.91E-01	1.03	8.87E-01	3.17E-01	3.21
		Lung	1.36	1.06	1.82E+01	2.15E+01	3.57	4.57E+01
		Bone	3.70	3.57	3.53E+01	8.29	4.26	5.51E+01
		Kidney	4.25	8.85E-01	9.86	4.17E-02	3.52	1.86E+01
		Liver	4.99E-01	7.41E-02	2.07	6.35E-03	1.28	3.93
	3	Whole Body	6.25E-01	2.18E-01	1.02	8.897E-01	3.16E-01	3.07
		Lung	1.07	7.27E-01	1.80E+04	2.15E+01	3.55	4.48E+01
		Bone	2.62	2.39	3.49E+01	8.29	4.23	5.24E+01
		Kidney	2.99	6.13E-01	9.75	4.17E-02	3.50	1.69E+01
		Liver	4.99E-01	7.41E-02	2.05	6.35E-03	1.27	3.90
	4	Whole Body	5.87E-01	1.74E-01	3.65E-01	4.12E-01	1.87E-01	1.72
		Lung	8.98E-01	5.29E-01	5.94	9.92	7.40E-01	1.80E+01
		Bone	1.98	1.69	1.15E+01	3.83	8.56E-01	1.99E+01
		Kidney	2.24	4.50E-01	3.23	2.19E-02	7.32E-01	6.67
		Liver	4.99E-01	7.41E-02	7.04E-01	5.62E-03	3.51E-01	1.63
	5	Whole Body	6.01E-01	1.90E-01	1.00	1.45E-01	1.80E-01	2.12
		Lung	1.07	7.27E-01	1.80E+01	2.15E+01	3.55	4.48E+01
		Bone	2.22	1.95	3.44E+01	1.40	7.86E-01	4.08E+01
		Kidney	2.91	5.20E-01	9.68	9.92E-03	6.80E-01	1.38E+01
		Liver	4.99E-01	7.41E-02	2.02	5.17E-03	3.19E-01	2.92

Table 18

Total 40 CFR 190 Radiological Doses for Alternative Emission Control Scenarios

	Control Scenario 1 Dose Rates (mrem/yr)					Control Scenario 2 Dose Rates (mrem/yr)				
Receptor	W. Body	Lung	Bone	Kidney	Liver	W. Body	Lung	Bone	Kidney	Liver
Monitoring Location 1	6.61	8.88E+01	1.27E+02	3.87E+01	9.19	3.30	3.82E+01	5.00E+01	6.88	3.65
Monitoring Location 2	9.24	9.32E+01	1.57E+02	5.79E+01	1.00E+01	4.45	3.51E+01	5.40E+01	1.54E+01	4.10
Monitoring Location 3	1.86E+01	2.88E+02	3.84E+02	1.21E+02	3.01E+01	7.94	1.00E+02	1.26E+02	3.61E+01	9.63
Monitoring Location 4	2.29	2.96E+01	4.34E+01	1.37E+01	3.07	1.07	1.19E+01	1.61E+01	4.42	1.18
Monitoring Location 5	3.55E-01	4.58	6.71	2.11	4.76	1.66E-01	1.84	2.49	6.81E-01	1.83
Block A	7.78	8.48E+01	1.36E+02	4.03E+01	8.94	3.48	3.78E+01	5.46E+01	1.55E+01	4.08
Block B	8.56	1.00E+02	1.56E+02	4.66E+01	1.07E+01	4.25	4.25E+01	5.97E+01	1.73E+01	4.42
Block C	1.69E+01	1.58E+02	2.83E+02	7.89E+01	1.81E+01	7.70	6.44E+01	1.04E+02	2.80E+01	7.36
Block D	6.54	1.21E+02	1.44E+02	4.46E+01	1.08E+01	3.16	5.07E+01	5.64E+01	1.60E+01	4.12
Block E	6.05	9.43E+01	1.25E+02	4.65E+01	9.37	3.12	4.57E+01	5.51E+01	1.86E+01	3.93
Block F	6.03	7.78E+01	1.14E+02	3.59E+01	8.08	2.82	3.12E+01	4.22E+01	1.16E+01	3.11
Block G	4.63	5.97E+01	8.75E+01	2.75E+01	6.29	2.17	2.40E+01	3.24E+01	8.87	2.39
Block H	6.88	8.88E+01	1.30E+02	4.10E+01	9.22	3.22	3.57E+01	4.81E+01	1.32E+01	3.55
Block J	7.40	7.44E+01	1.25E+02	3.69E+01	7.92	3.46	2.99E+01	4.63E+01	1.23E+01	3.05
Trailer Court	5.87	7.57E+01	1.11E+02	3.49E+01	7.86	2.75	3.04E+01	4.11E+01	1.13E+01	3.03
Mining Camp 1	2.71	3.49E+01	5.11E+01	1.61E+01	3.62	1.27	1.40E+01	1.89E+01	5.20	1.34
Mining Camp 2	2.29	2.96E+01	4.34E+01	1.37E+01	3.07	1.07	1.19E+01	1.61E+01	4.42	1.18
Winter Range 1	9.38E-01	1.21E+01	1.77E+01	5.58	1.26	4.39E-01	4.86	6.55	1.80	4.85E-01
Winter Range 2	2.16E-01	2.79	4.09	1.29	2.90E-01	1.01E-01	1.12	1.51	4.16E-01	1.12E-01
Winter Range 3	3.70E-01	4.77	6.99	2.20	4.95E-01	1.73E-01	1.92	2.59	7.10E-01	1.91E-01
Summer Range	2.25E-01	2.90	4.25	1.34	3.01E-01	1.05E-01	1.16	1.57	4.32E-01	1.16E-01
Ranch 1	4.76E-02	6.16E-01	9.03E-01	2.84E-01	6.40E-02	2.23E-02	2.47E-01	3.34E-01	9.16E-02	2.46E-02
Ranch 2	3.07E-02	3.96E-01	5.80E-01	1.83E-01	4.11E-02	1.44E-02	1.59E-01	2.15E-01	5.19E-02	1.58E-02
Ranch 3	2.43E-01	3.14	4.60	1.45	3.26E-01	1.14E-01	1.26	1.70	4.68E-01	1.26E-01
Ranch 4	1.35E-01	1.74	2.55	8.03E-01	1.81E-01	6.32E-02	6.99E-01	9.44E-01	2.59E-01	6.97E-02
Nucla	2.84E-02	3.67E-01	5.38E-01	1.69E-01	3.81E-02	1.33E-02	1.47E-01	1.99E-01	5.45E-02	1.47E-02
West Vancorium	3.12E-02	4.02E-01	5.89E-01	1.85E-01	4.18E-02	1.46E-02	1.61E-01	2.18E-01	5.97E-02	1.61E-02
Paradox	2.50E-02	3.22E-01	4.72E-01	1.49E-01	3.34E-02	1.17E-02	1.29E-01	1.75E-01	4.81E-02	1.29E-02
Bedrock	3.35E-02	4.32E-01	6.33E-01	1.99E-01	4.49E-02	1.57E-02	1.73E-01	2.34E-01	6.42E-02	1.73E-02
Gateway	1.13E-02	1.46E-01	2.14E-01	6.73E-02	1.52E-02	5.29E-03	5.86E-02	7.93E-02	2.17E-02	5.85E-03

Table 1[illegible] (Continued)

Total 40 CFR 190 Radiological Doses for
Alternative Emission Control Scenarios

Receptor	Control Scenario 3 Dose Rates (mrem/yr)					Control Scenario 4 Dose Rates (mrem/yr)				
	W. Body	Lung	Bone	Kidney	Liver	W. Body	Lung	Bone	Kidney	Liver
Monitoring Location 1	3.07	3.70E+01	4.60E+01	6.01	3.55	1.80	1.33E+01	1.68E+01	2.70	1.62
Monitoring Location 2	3.91	3.23E+01	4.42E+01	1.30E+01	1.2[illegible]E+01	2.85	1.25[illegible]+01	2.02E+01	6.18	2.35
Monitoring Location 3	7.55	9.81E+01	1.19E+02	3.44E+01	9.54	3.51	2.2[illegible]+01	2.74E+01	8.56	3.40
Monitoring Location 4	9.98E-01	1.14E+01	1.44E+01	4.01	1.42	5.95E-01	3.67	5.01	1.44	5.32E-01
Monitoring Location 5	1.55E-01	1.77	2.22	6.17E-01	2.20	9.23E-02	5.68E-01	7.74E-01	2.22E-01	8.24E-01
Block A	3.63	3.59E+01	4.75E+01	1.38E+01	4.01	2.41	1.37E+01	1.96E+01	5.66	2.05
Block B	3.83	4.04E+01	5.22E+01	1.58E+01	4.33	2.47	1.46E+01	2.05E+01	6.05	2.14
Block C	6.76	5.99E+01	8.45E+01	2.39E+01	7.17	4.61	1.90E+01	3.48E+01	9.91	3.85
Block D	3.05	4.98E+01	5.44E+01	1.57E+01	4.10	1.47	1.46E+01	1.48E+01	4.34	1.51
Block E	3.07	4.48E+01	5.24E+01	1.69E+01	3.90	1.72	1.80E+01	1.99E+01	6.67	1.63
Block F	2.63	3.00E+01	3.80E+01	1.05E+01	3.73	1.57	9.65	1.31E+01	3.77	1.40
Block G	2.02	2.30E+01	2.89E+01	8.04	2.86	1.20	7.40	1.01E+01	2.89	1.07
Block H	3.00	3.43E+01	4.30E+01	1.20E+01	4.25	1.79	1.10E+01	1.50E+01	4.31	1.60
Block J	3.23	2.87E+01	4.13E+01	1.08E+01	3.65	1.92	9.23	1.44E+01	3.88	1.37
Trailer Court	2.56	2.92E+01	3.67E+01	1.02E+01	3.62	1.53	9.39	1.28E+01	3.67	1.37
Mining Camp 1	1.18	1.35E+01	1.69E+01	4.71	1.67	7.05E-01	4.33	5.89	1.69	6.27E-01
Mining Camp 2	9.98E-01	1.14E+01	1.44E+01	4.01	1.42	7.05E-01	4.33	5.89	1.69	6.27
Winter Range 1	4.09E-01	4.67	5.85	1.63	5.81E-01	5.95E-01	3.67	5.01	1.44	5.32E-01
Winter Range 2	9.42E-02	1.08	1.35	3.77E-01	1.34E-01	2.44E-01	1.50	2.04	5.87E-01	2.18E-01
Winter Range 3	1.61E-01	1.84	2.31	6.43E-01	2.28E-01	5.62E-02	3.46E-01	4.72E-01	1.36E-01	5.02E-02
Summer Range	9.81E-02	1.12	1.41	3.92E-01	1.39E-01	5.85E-02	3.60E-01	4.90E-01	1.41E-01	5.21E-02
Ranch 1	2.08E-02	2.38E-01	2.99E-01	8.31E-02	2.95E-02	1.24E-02	7.64E-02	1.04E-01	2.99E-02	1.11E-02
Ranch 2	1.34E-02	1.53E-01	1.92E-01	5.35E-02	1.90E-02	7.98E-03	4.91E-02	6.69E-02	1.93E-02	7.12E-03
Ranch 3	1.06E-01	1.21	1.52	4.24E-01	1.50E-01	6.32E-02	3.89E-01	5.31E-01	1.53E-01	5.64E-02
Ranch 4	5.89E-02	6.72E-01	8.43E-01	2.35E-01	8.35E-02	3.51E-02	2.16E-01	2.94E-01	8.45E-02	3.13E-02
Nucla	1.24E-02	1.42E-01	1.78E-01	4.94E-02	1.76E-02	7.38E-03	4.55E-02	6.21E-02	1.78E-02	6.60E-03
West Vancorium	1.36E-02	1.55E-01	1.95E-01	5.41E-02	1.93E-02	8.11E-03	4.99E-02	6.79E-02	1.95E-02	7.24E-03
Paradox	1.09E-02	1.24E-01	1.56E-01	4.36E-02	1.54E-02	6.50E-03	3.99E-02	5.44E-02	1.57E-02	5.78E-03
Bedrock	1.46E-02	1.67E-01	2.09E-01	5.82E-02	2.07E-02	8.71E-03	5.36E-02	7.30E-02	2.09E-02	7.77E-03
Gateway	4.93E-03	5.64E-02	7.08E-02	1.97E-02	7.01E-03	2.94E-03	1.81E-02	2.47E-02	7.08E-03	2.63E-03

Table 18 (Continued)

Total 40 CFR 190 Radiological Doses for
Alternative Emission Control Scenarios

Receptor	Control Scenario 5 Dose Rates (mrem/yr)				
	W. Body	Lung	Bone	Kidney	Liver
Monitoring Location 1	2.13	3.70E+01	3.45E+01	3.19	2.71
Monitoring Location 2	3.08	3.23E+01	3.38E+01	1.02E+01	3.22
Monitoring Location 3	4.88	9.81E+01	8.77E+01	2.59E+01	6.70
Monitoring Location 4	7.19E-01	1.14E+01	1.11E+01	3.09	8.98E-01
Monitoring Location 5	1.11E-01	1.77	1.72	4.75E-01	1.39
Block A	2.65	3.59E+01	3.56E+01	1.07E+01	3.67
Block B	2.75	4.04E+01	4.51E+01	1.17E+01	3.39
Block C	5.28	5.99E+01	6.60E+01	1.90E+01	6.25
Block D	2.21	4.98E+01	4.38E+01	1.27E+01	3.18
Block E	2.12	4.48E+01	4.08E+01	1.38E+01	2.92
Block F	1.89	3.00E+01	2.92E+01	8.09	2.36
Block G	1.45	2.30E+01	2.24E+01	6.19	1.81
Block H	2.16	3.42E+01	3.33E+01	9.23	2.70
Block J	2.32	2.87E+01	3.20E+01	8.31	2.32
Trailer Court	1.84	2.92E+01	2.84E+01	7.86	2.30
Mining Camp 1	8.51E-01	1.35E+01	1.31E+01	3.63	1.06
Mining Camp 2	7.19E-01	1.14E+01	1.11E+01	3.09	8.98E-01
Winter Range 1	2.95E-01	4.67	4.53	1.26	3.69E-01
Winter Range 2	6.78E-02	1.08	1.05	2.91E-01	8.48E-02
Winter Range 3	1.16E-01	1.84	1.79	4.95E-01	1.45E-01
Summer Range	7.06E-02	1.12	1.09	3.02E-01	8.81E-02
Ranch 1	1.49E-02	2.38E-01	2.31E-01	6.40E-02	1.87E-02
Ranch 2	9.64E-03	1.53E-01	1.49E-01	4.12E-02	1.20E-02
Ranch 3	7.63E-02	1.21	1.18	3.27E-01	9.54E-02
Ranch 4	4.24E-02	6.72E-01	6.53E-01	1.81E-01	5.29E-02
Nucla	8.92E-03	1.42E-01	1.38E-01	3.81E-02	1.11E-02
West Vancorium	9.80E-03	1.55E-01	1.51E-01	4.17E-02	1.22E-02
Paradox	7.85E-03	1.24E-01	1.21E-01	3.36E-02	9.77E-03
Bedrock	1.05E-02	1.67E-01	1.62E-01	4.48E-02	1.31E-02
Gateway	3.55E-03	5.64E-02	5.48E-02	1.42E-02	4.45E-03

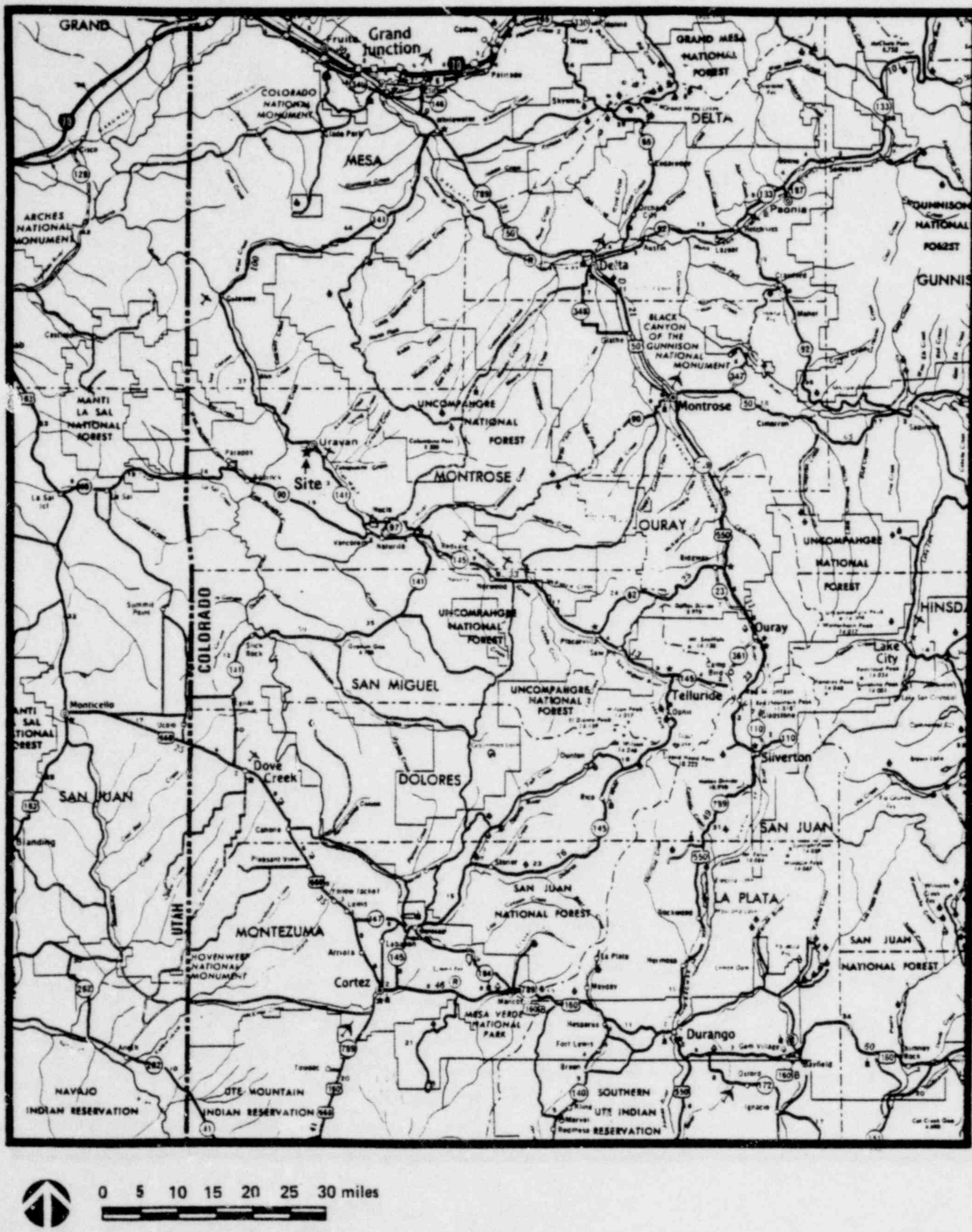
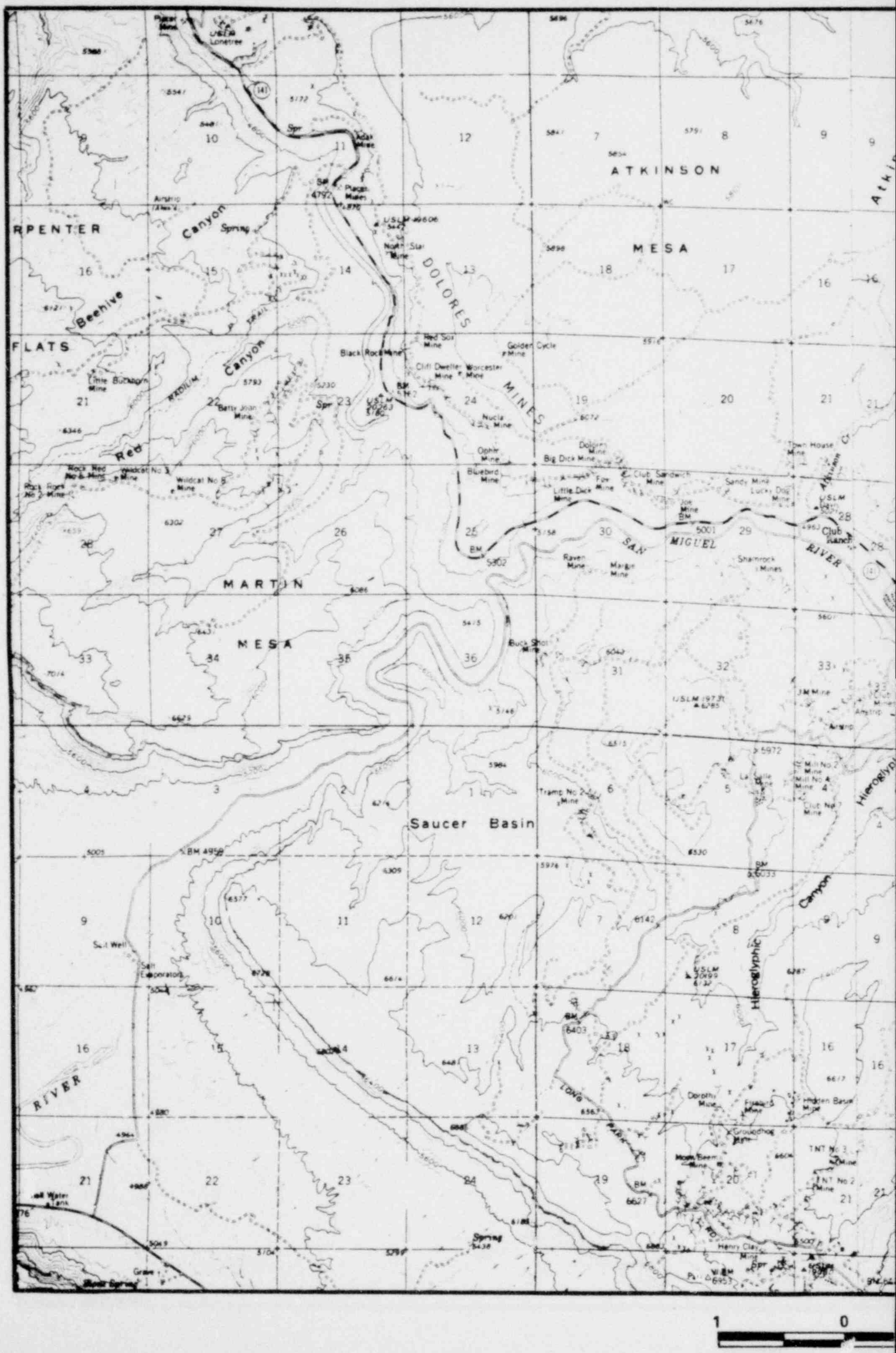
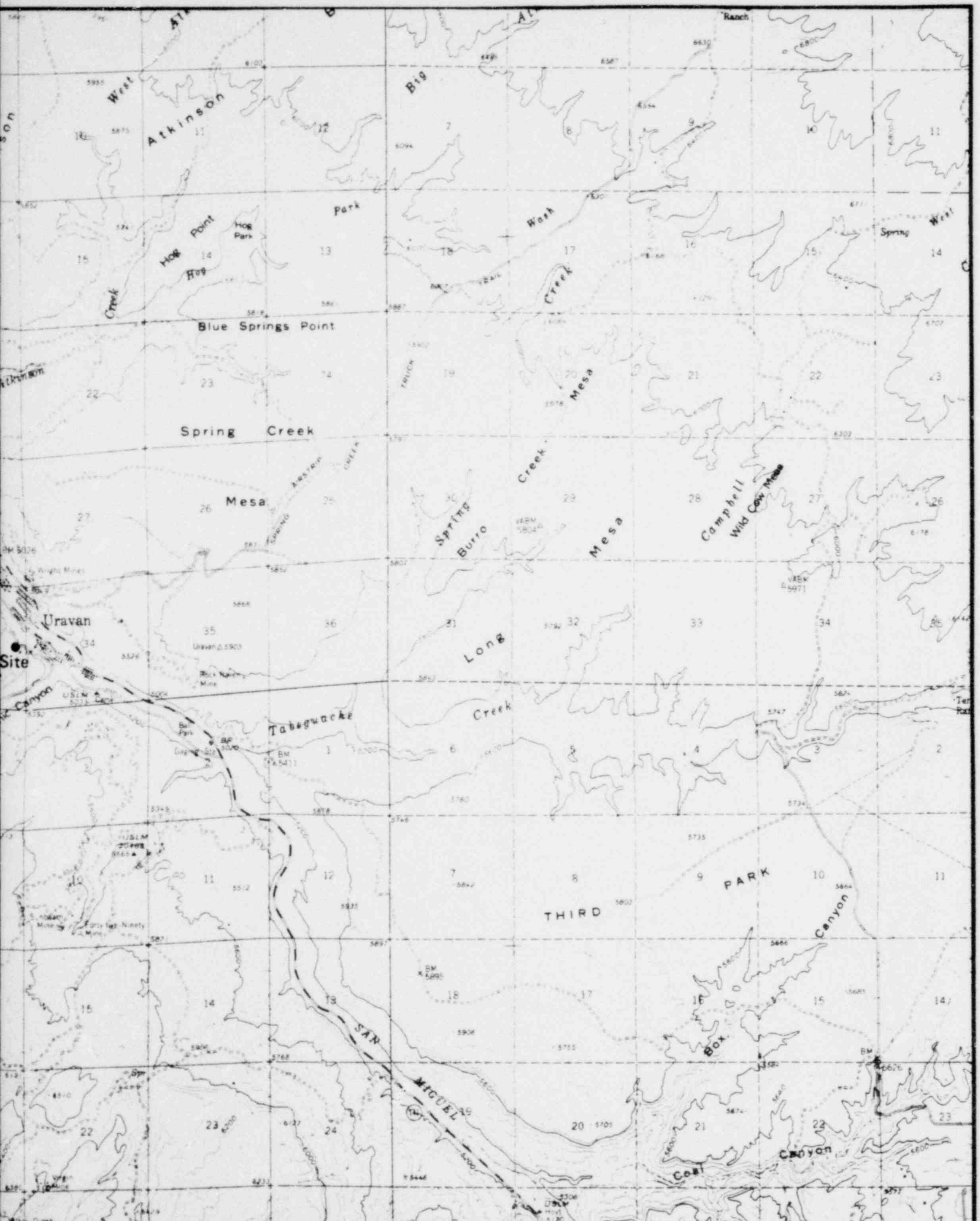


Figure 1. Regional Setting of the Site

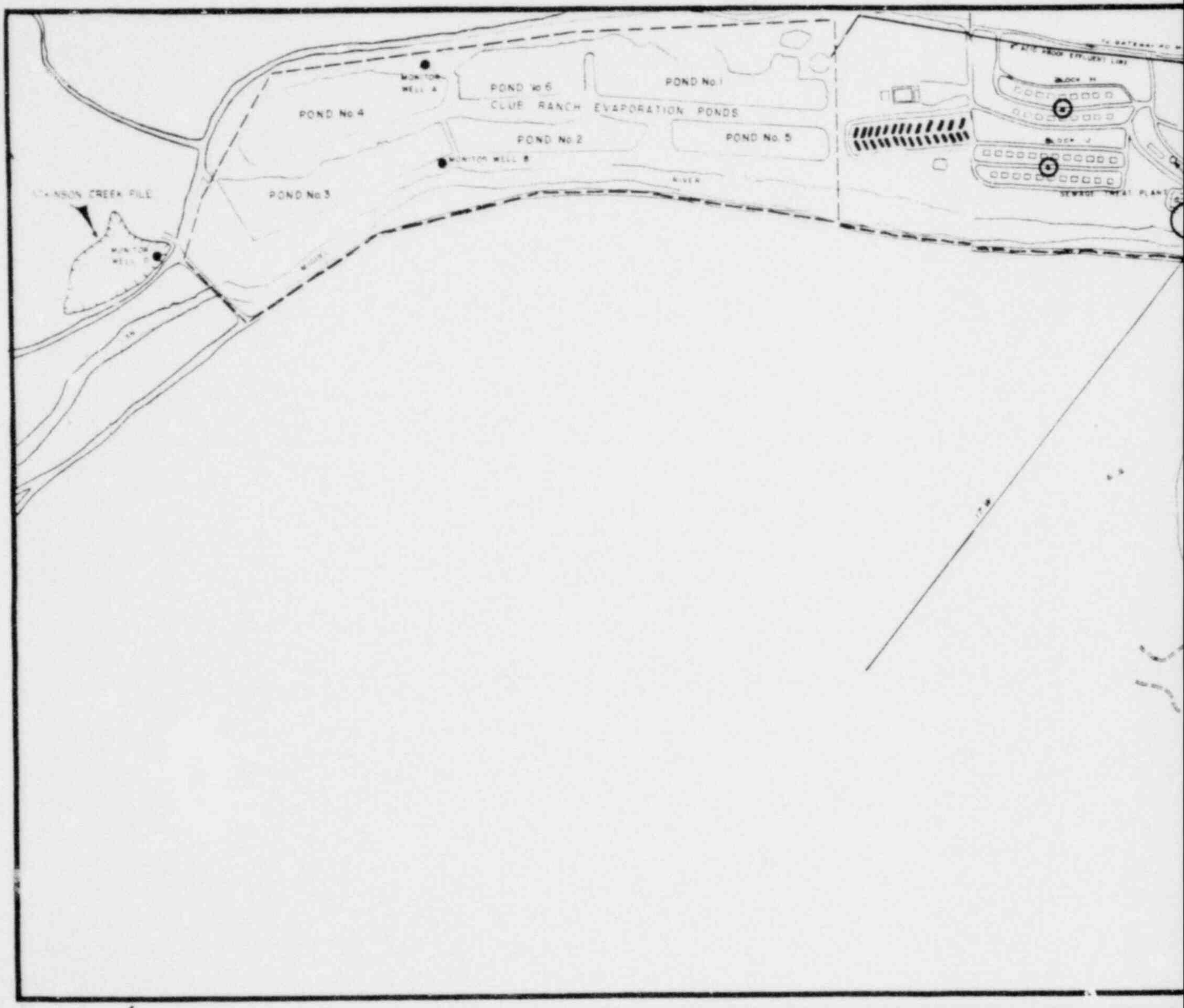


ATKINSON
MESA
RPENTER
FLATS
Beehive
Canyon
Red
Canyon
RADIUM
DOLORES
MINES
MARTIN
MESA
Saucer Basin
SAN
MIGUEL
RIVER
RIVER
Hieroglyphic
Canyon
LONG
PARK
Black Rock Mine
Red Sox Mine
Golden Cycle Mine
Cliff Dweller Mine
Worcester Mine
North Star Mine
Nucla Mine
Ophir Mine
Bluebird Mine
Big Dick Mine
Dolores Mine
Club Sandwich Mine
Fox Mine
Little Dick Mine
Sandy Mine
Lucky Dog Mine
Town House Mine
Club Ranch
Raven Mine
Margie Mine
Shamrock Mines
Buck Shot Mine
Little Buckhorn Mine
Betty Joan Mine
Wildcat No 3 Mine
Wildcat No 6 Mine
Tramp No 2 Mine
Salt Well
Salt Evaporators
Water Tank
Dorothy Mine
Groundhog Mine
Hidden Basin Mine
TNT No 3 Mine
TNT No 2 Mine
Henry Clay Mine
Saucer Basin
1
0



1 miles

Figure 2. Site Vicinity Map



LEGEND

- ◯ Selected Monitoring Locations
- ⊙ Receptor Locations
- ■ Radon Gas Monitoring Stations
- • Monitor Wells
- — — — Restricted Area Boundary

0

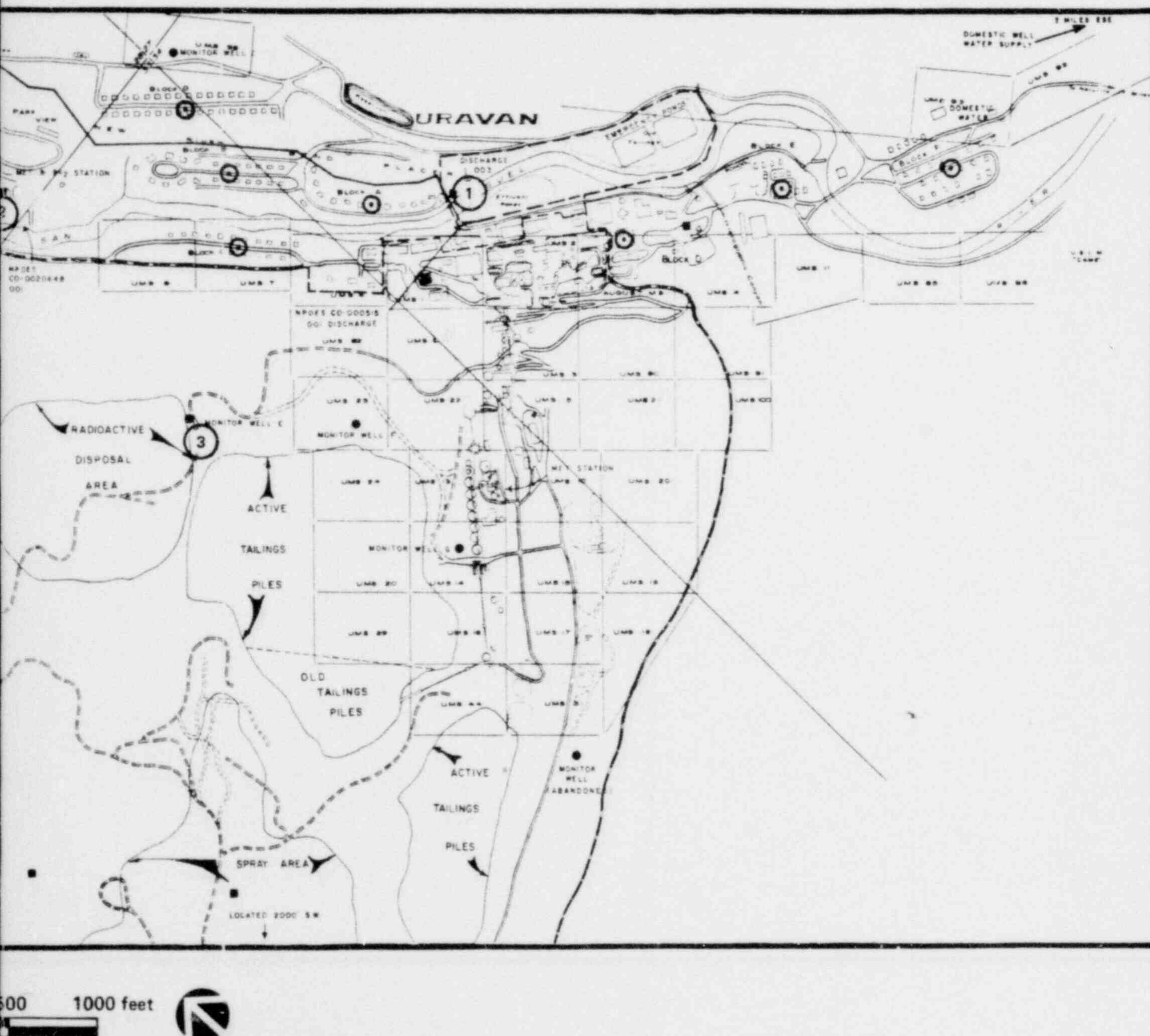


Figure 3. Layout of Uravan and the Site

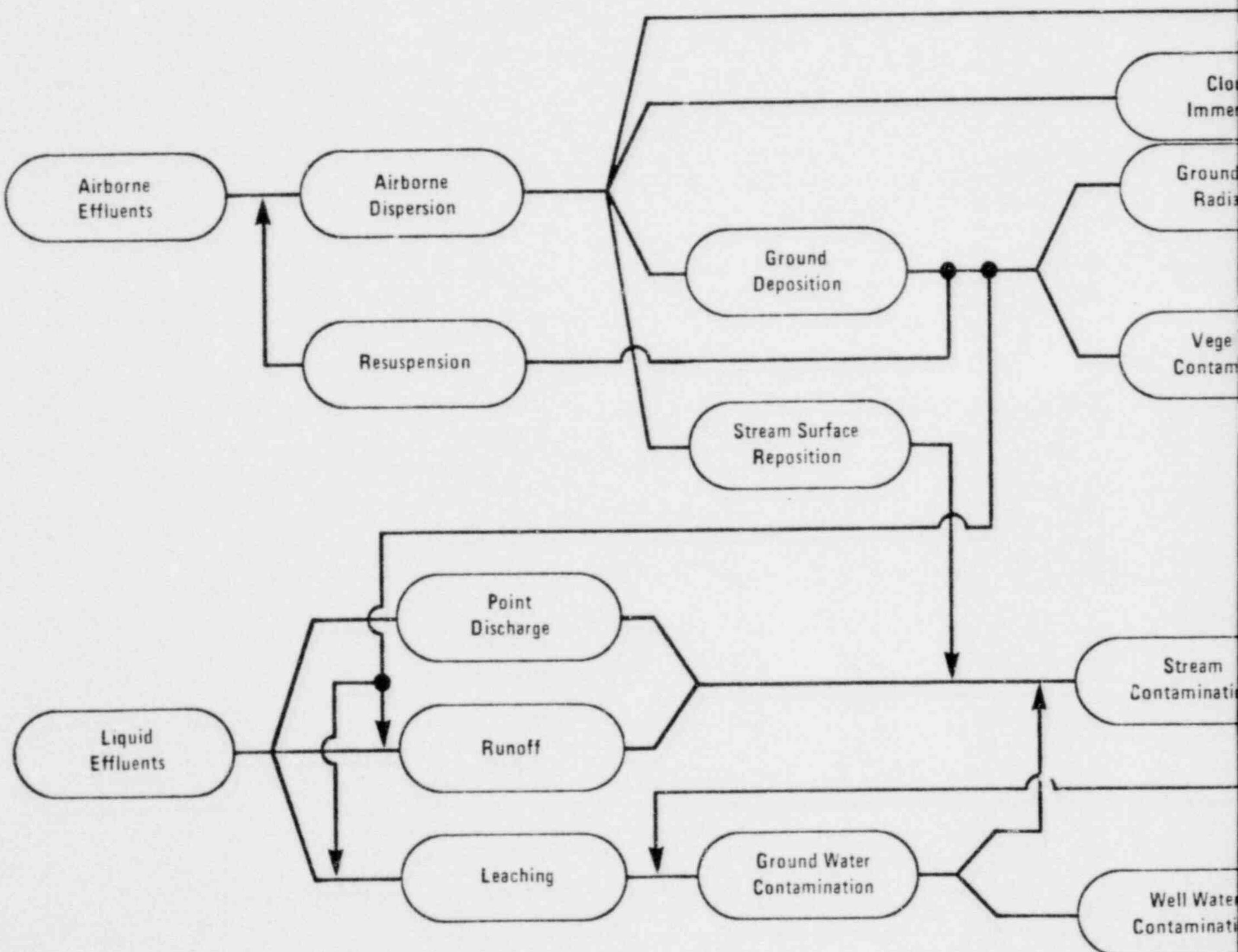
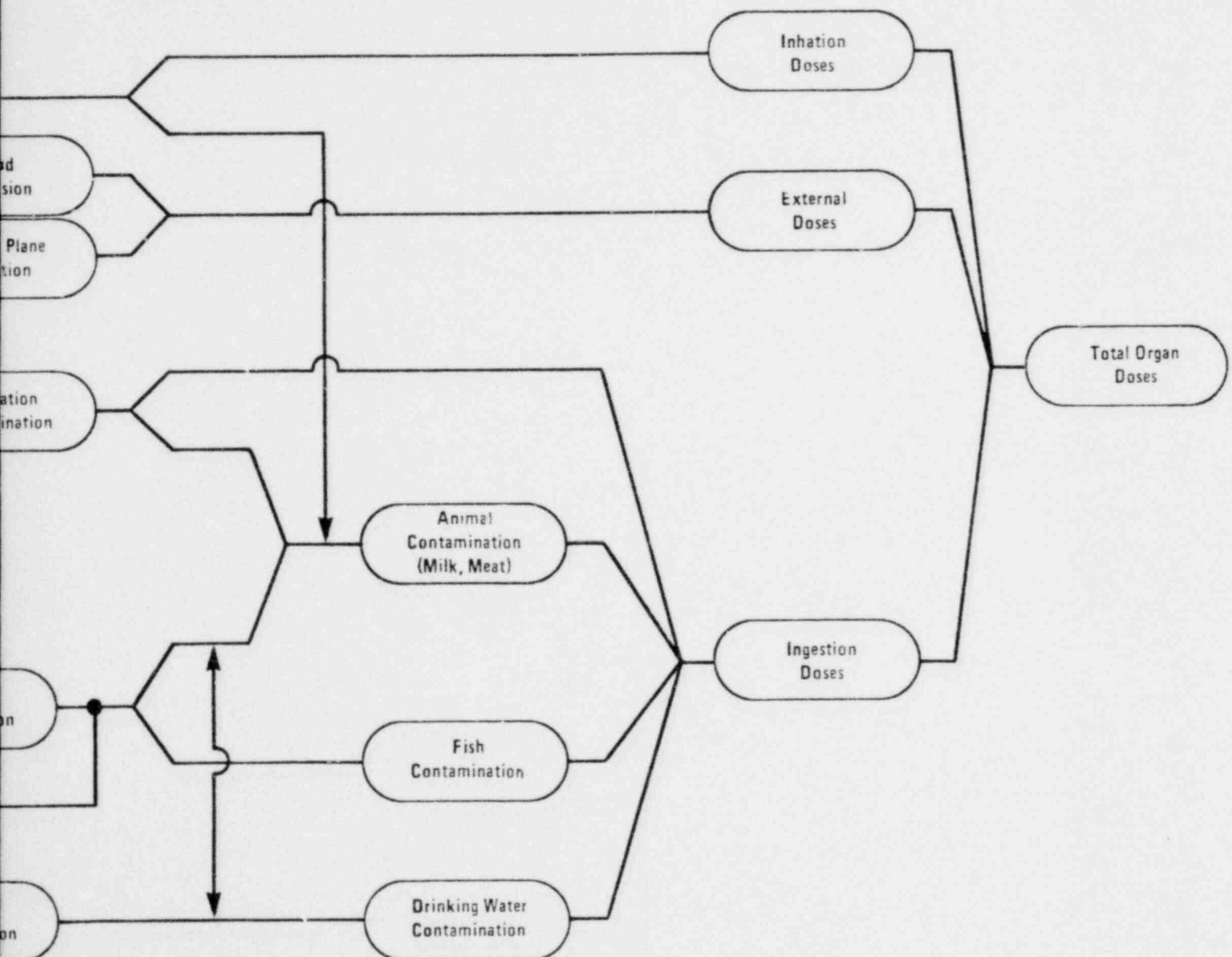
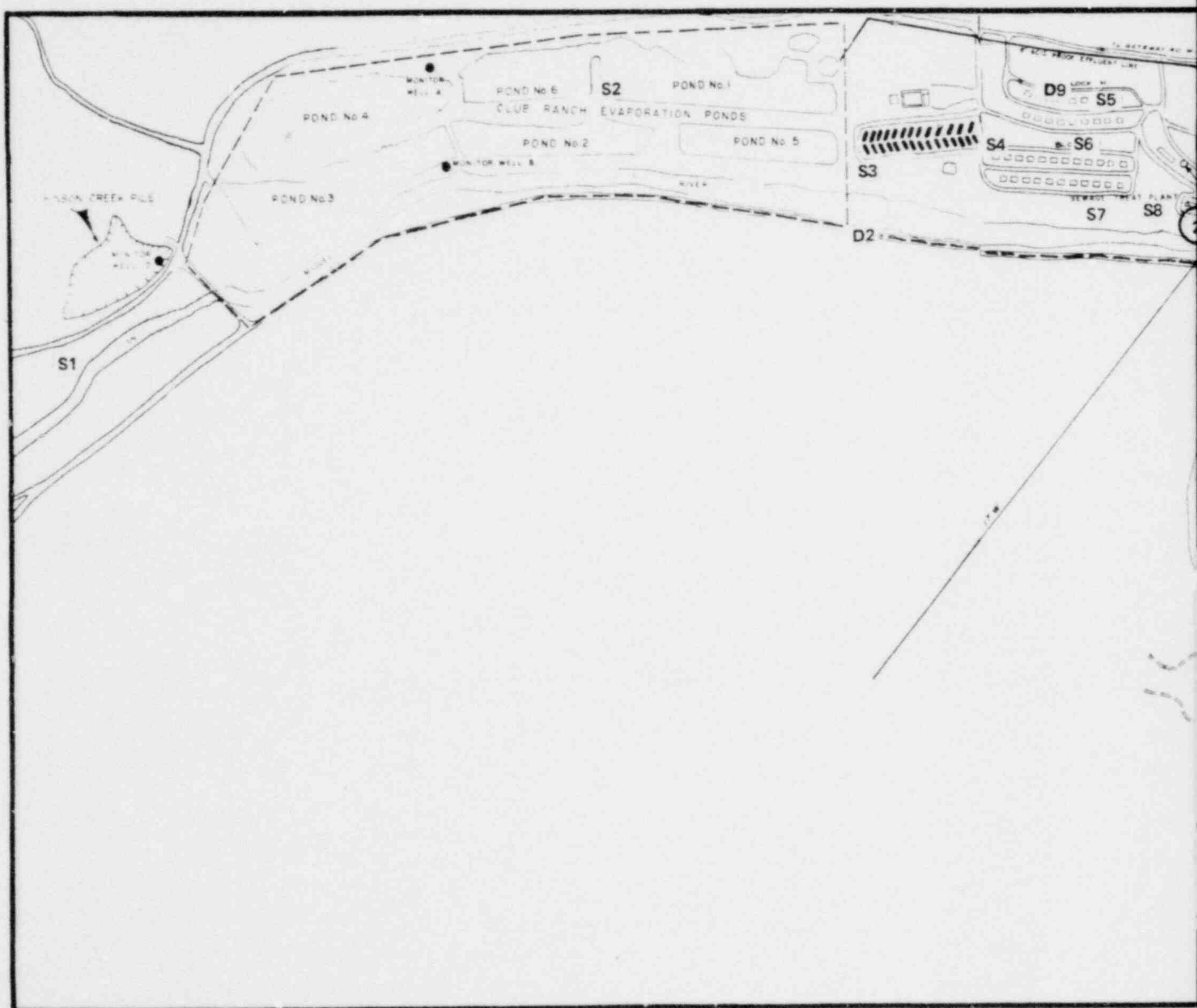


Figure 4 Potential Env
Exposure Pat



ironmental Radiological
hways



LEGEND

■	Radon Gas Monitoring Stations	(1)	Air Monitoring Location
•	Monitor Wells	S1	Soil Sampling Location
– – –	Restricted Area Boundary	D1	Road Dust Sampling Location

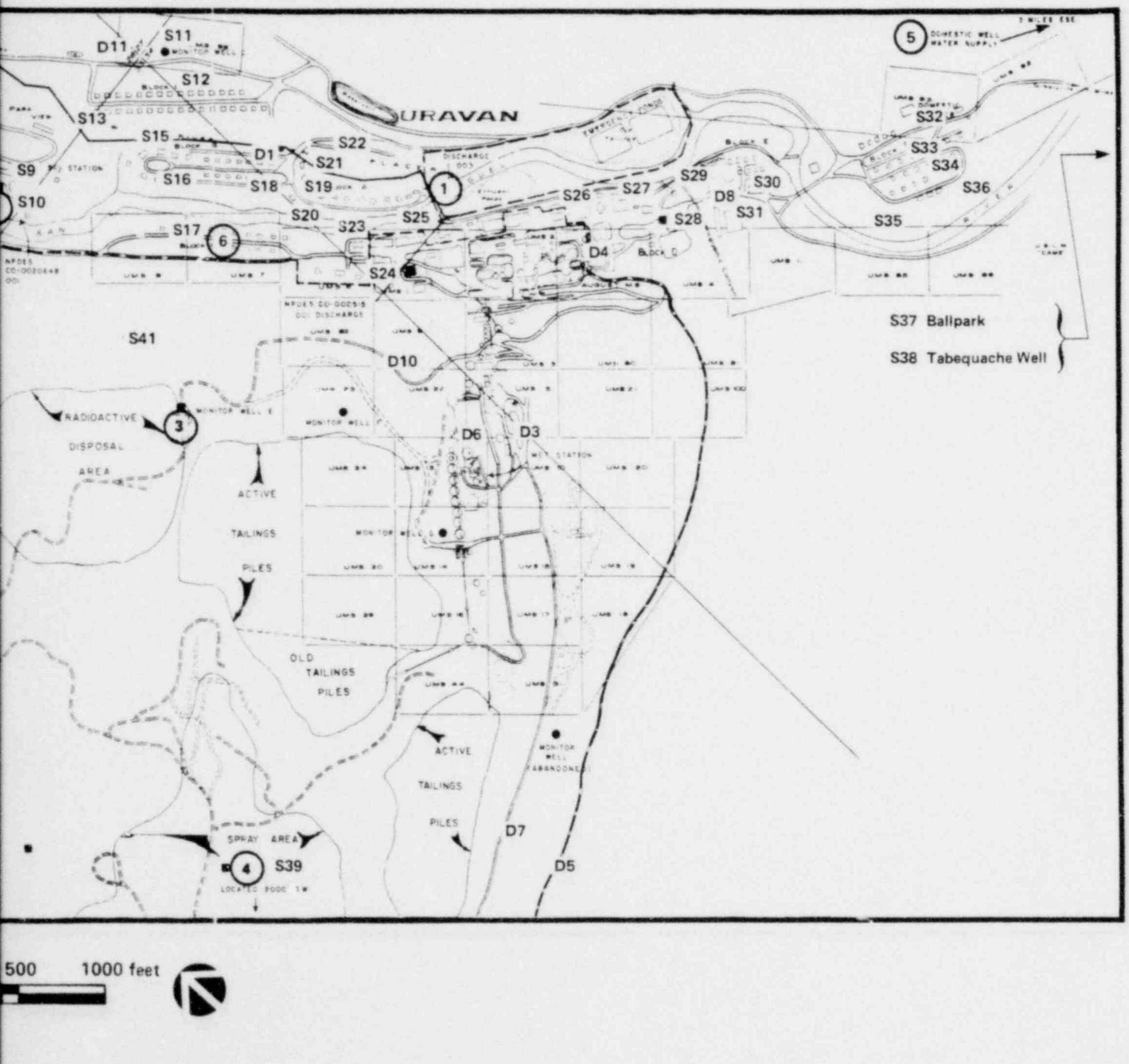


Figure 5. Radiological Monitoring Locations

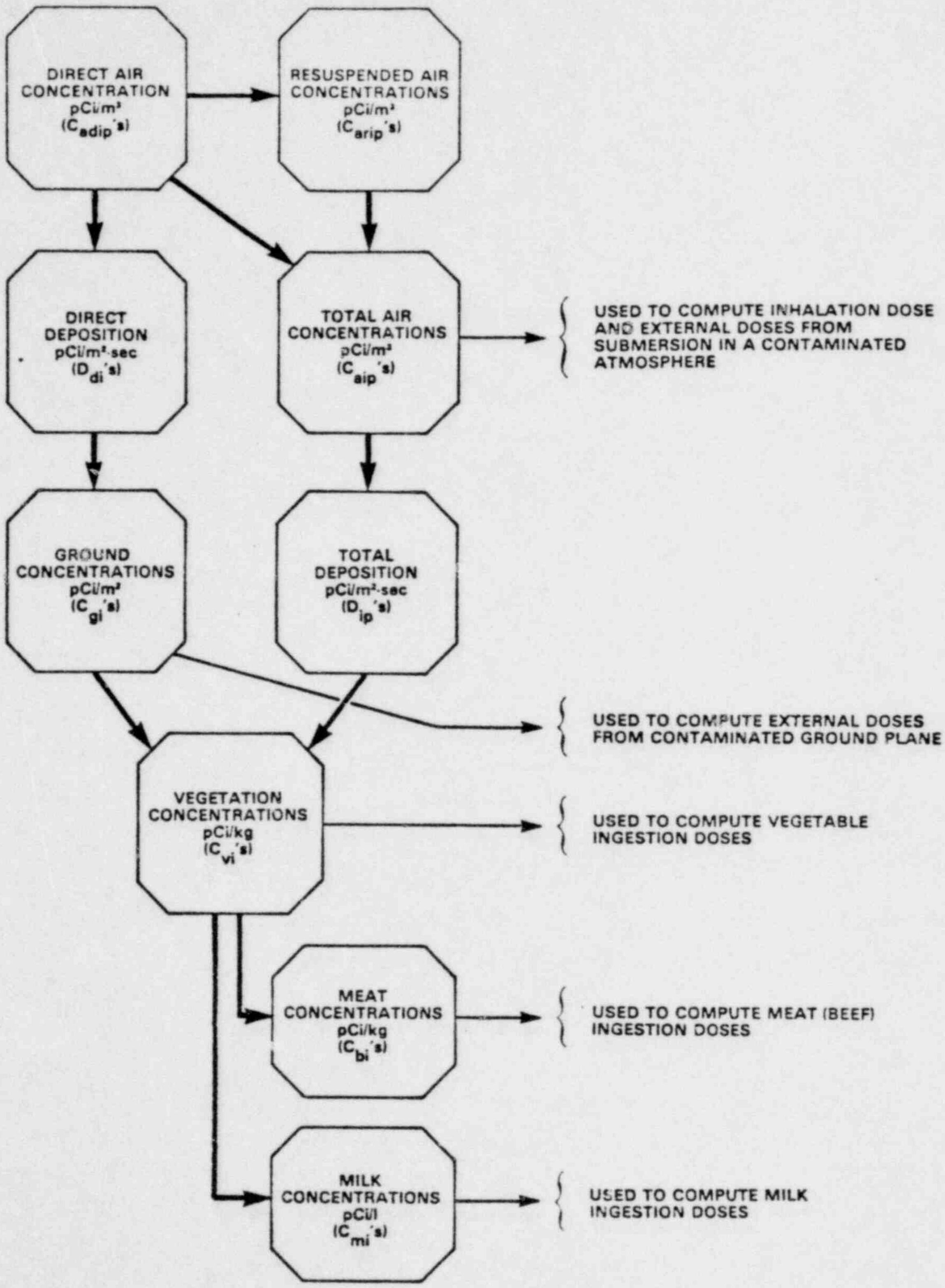
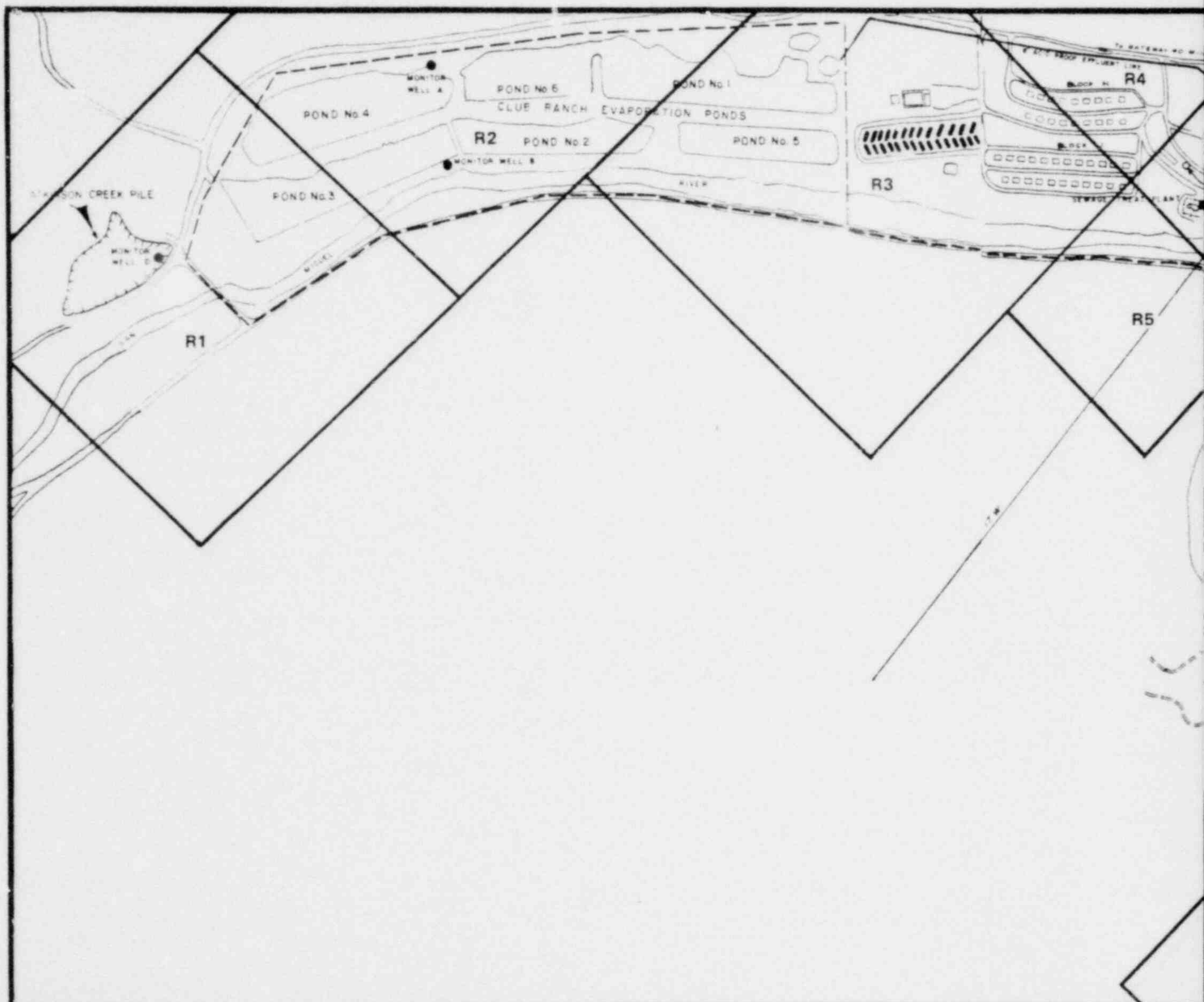


Figure 6 Schematic Diagram of Information Flow and Use for Dose Calculations



LEGEND

⊙	Stack Emission Points	— — —	Restricted Area Boundary
■	Radon Gas Monitoring Stations	R1	Road Area 1
●	Monitor Wells	T1	Tailings Area 1

0 50

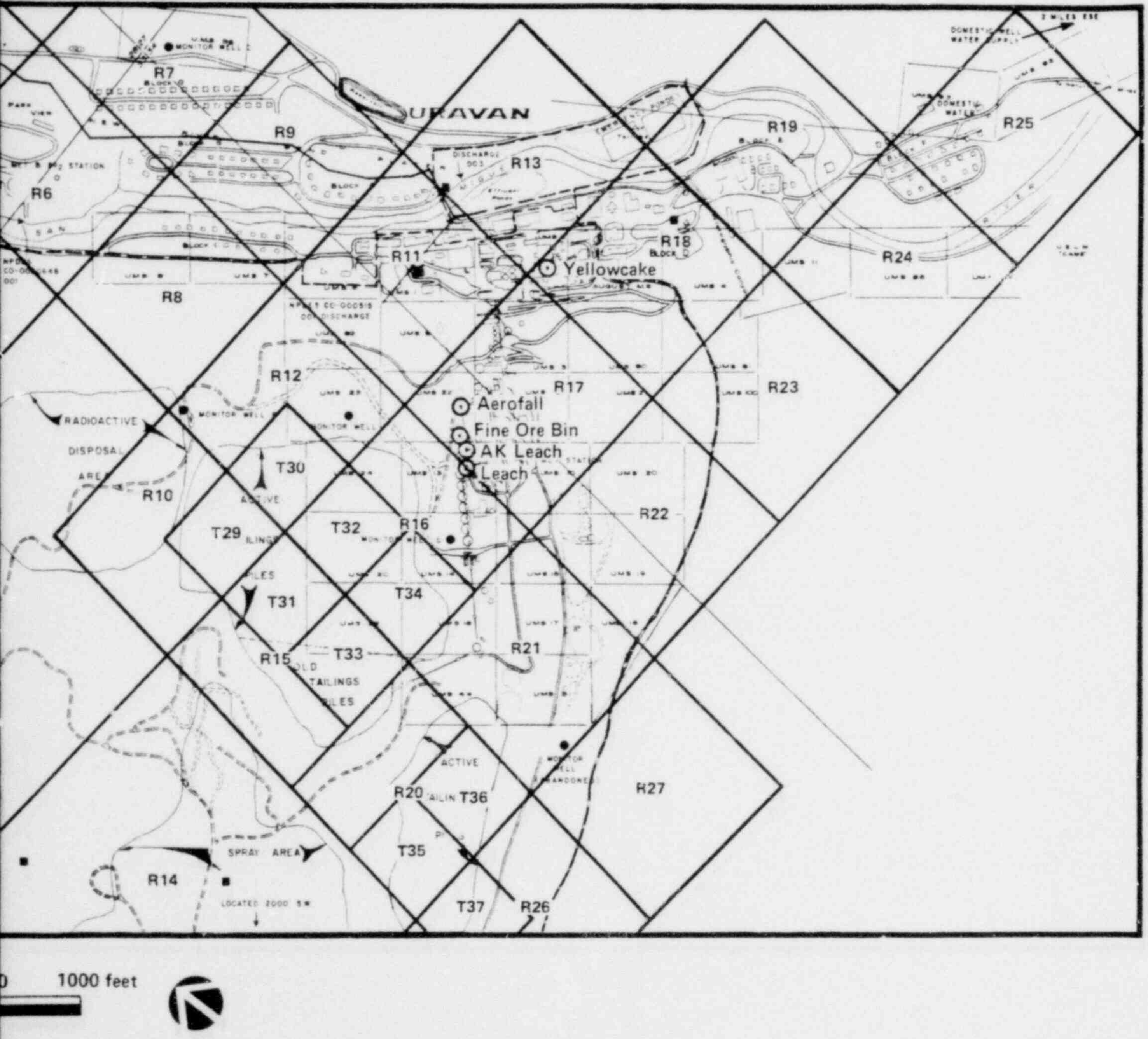
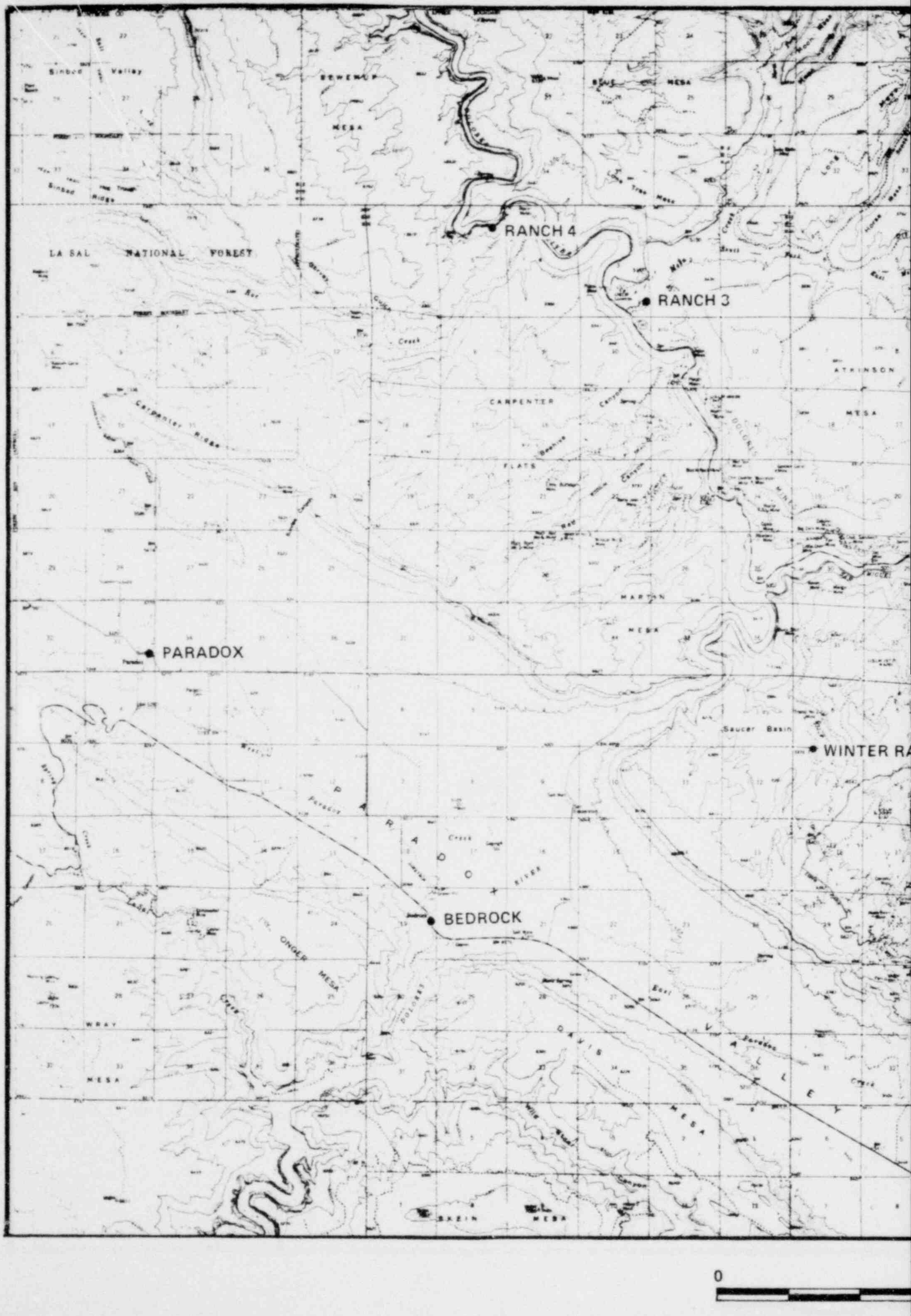


Figure 7. Location of Point and Area Emission Sources Considered in the Analysis


RANCH 4
RANCH 3
LA SAL NATIONAL FOREST
Sinbad Valley
MESA
CAMPENTER
FLATS
ATKINSON
MESA
MARTIN
MESA
PARADOX
Saucer Basin
WINTER RA
P A R A D O X
Creek
BEDROCK
MESA
WRAY
MESA
DAVIS
MESA
V A L L E Y
BASIN
MESA
0

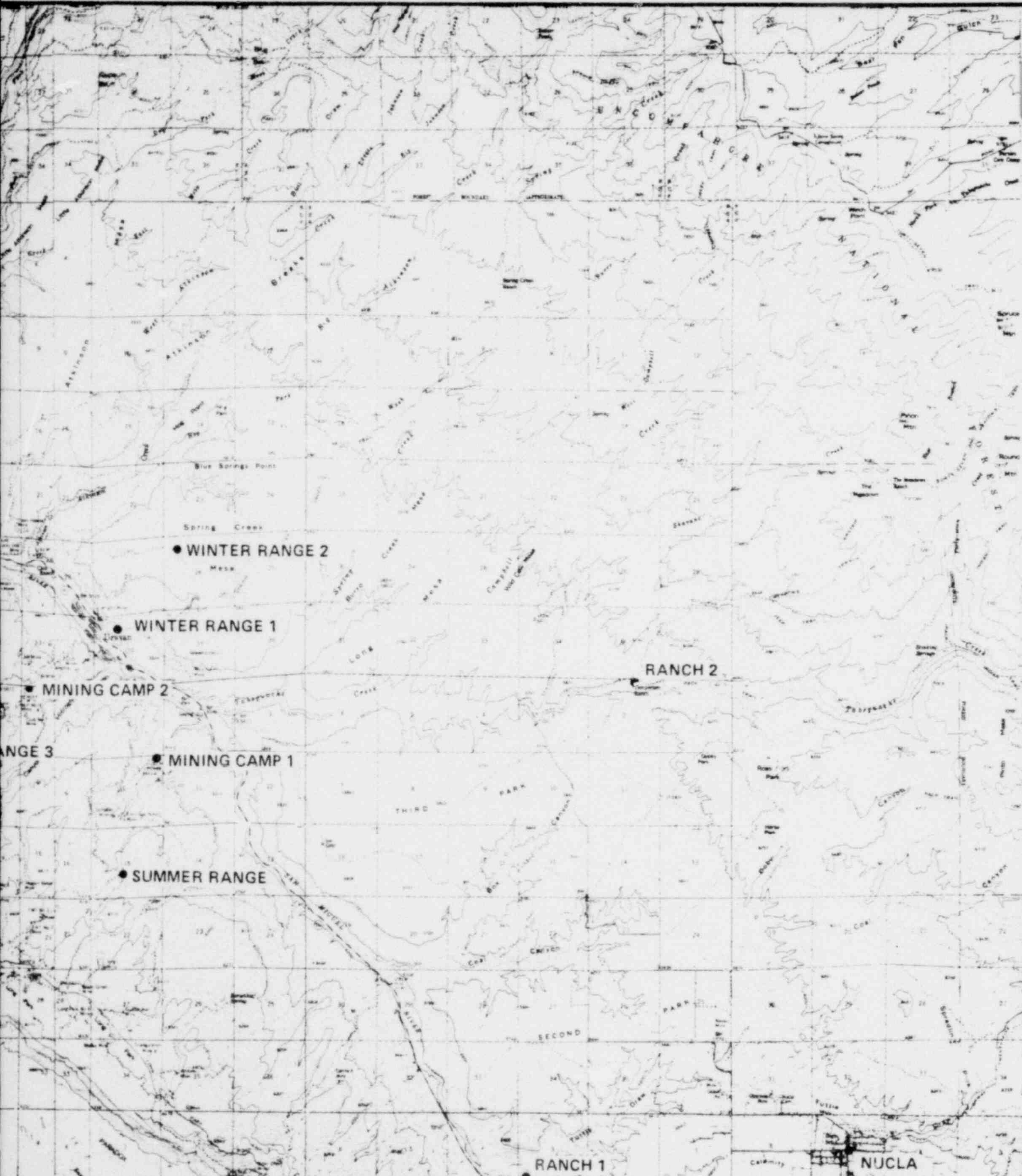
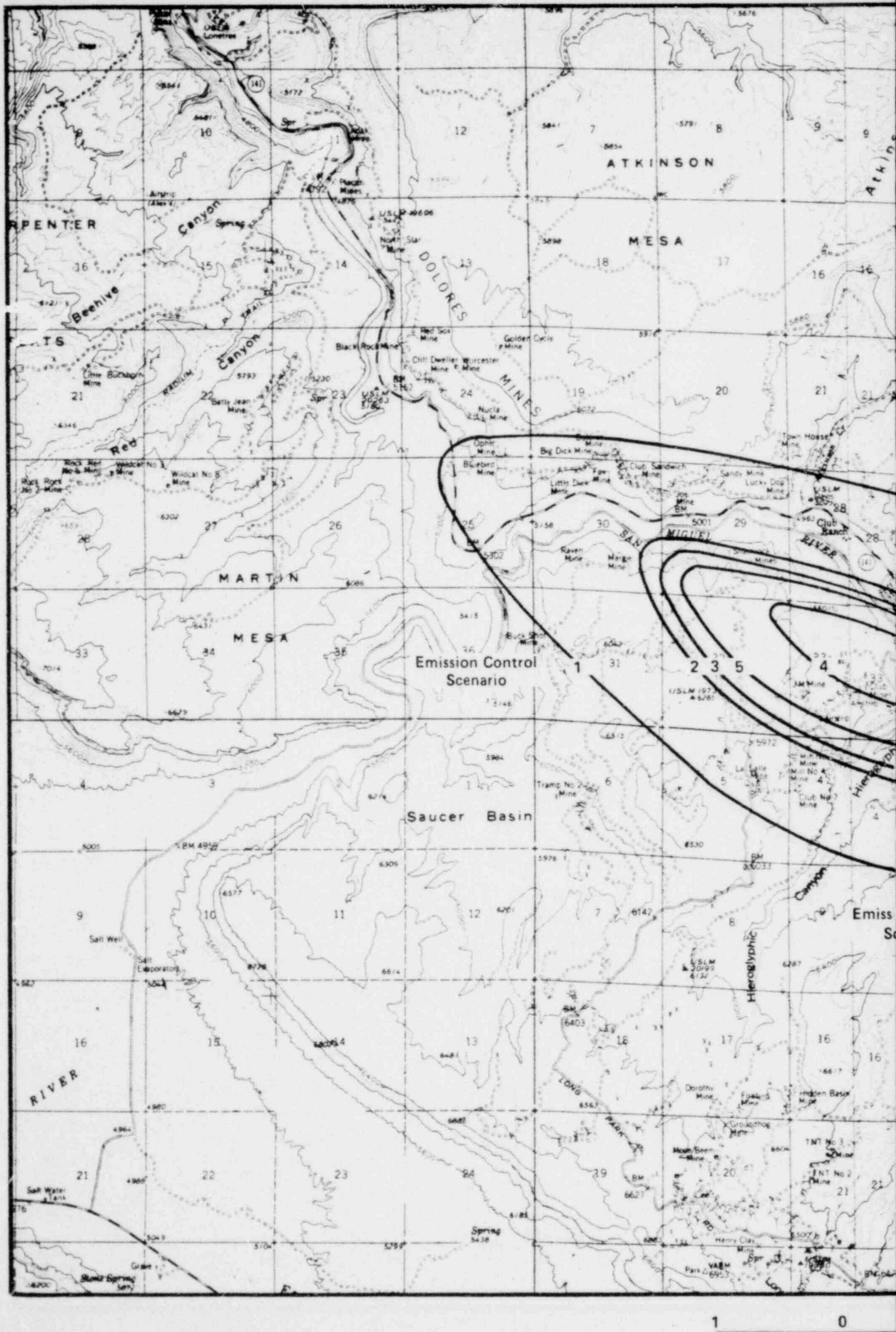


Figure 8. Special Receptor Locations Within the Site Region Considered in the Analysis


ATKINSON
MESA
DOLORES
MINES
MARTIN
MESA
Emission Control
Scenario
Saucer Basin
SAN MIGUEL
RIVER
Beehive
Red
Canyon
RIVER
LONG PARK
Hieroglyphic
Canyon
Emiss
Sc
1
2 3 5
4
1
0

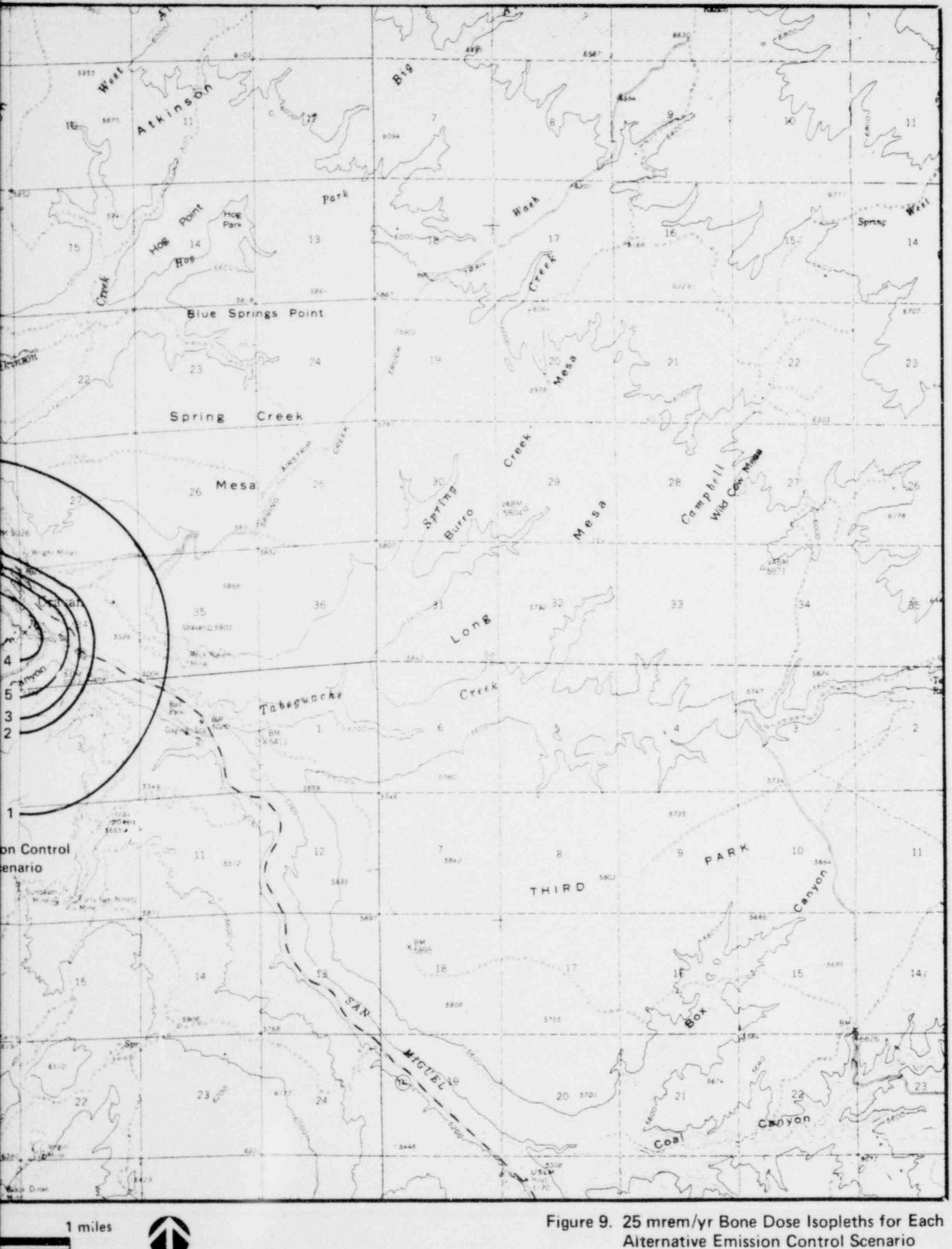


Figure 9. 25 mrem/yr Bone Dose Isopleths for Each Alternative Emission Control Scenario

APPENDIX A METEOROLOGICAL JOINT FREQUENCY DISTRIBUTION (VALLEY TRAILER SITE)

UCC URAVAN URANIUM MILL
METSET VALLEY STATION JFD

UEAD 9

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 1

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00010	0.0	0.0	0.0	0.0	0.0	0.00010
NNE	0.00040	0.0	0.0	0.0	0.0	0.0	0.00040
NE	0.00020	0.0	0.0	0.0	0.0	0.0	0.00020
ENE	0.00030	0.0	0.0	0.0	0.0	0.0	0.00030
E	0.00169	0.0	0.0	0.0	0.0	0.0	0.00169
ESE	0.00566	0.0	0.0	0.0	0.0	0.0	0.00566
SE	0.00855	0.0	0.0	0.0	0.0	0.0	0.00855
SSE	0.00139	0.0	0.0	0.0	0.0	0.0	0.00139
S	0.00089	0.0	0.0	0.0	0.0	0.0	0.00089
SSW	0.00010	0.0	0.0	0.0	0.0	0.0	0.00010
SW	0.00020	0.0	0.0	0.0	0.0	0.0	0.00020
WSW	0.00010	0.0	0.0	0.0	0.0	0.0	0.00010
W	0.00050	0.0	0.0	0.0	0.0	0.0	0.00050
WNW	0.00050	0.0	0.0	0.0	0.0	0.0	0.00050
NW	0.00099	0.0	0.0	0.0	0.0	0.0	0.00099
NNW	0.00040	0.0	0.0	0.0	0.0	0.0	0.00040
COLUMN TOTALS:	0.02197	0.0	0.0	0.0	0.0	0.0	0.02197

UCC URAVAN URANIUM MILL
METSET VALLEY STATION JFD

UDAD 9

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 2

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTAL
N	0.00053	0.00026	0.00011	0.0	0.0	0.0	0.00090
NNE	0.00158	0.00036	0.00015	0.0	0.0	0.0	0.00209
NE	0.00075	0.00010	0.00004	0.0	0.0	0.0	0.00089
ENE	0.00102	0.00005	0.00002	0.0	0.0	0.0	0.00109
E	0.00665	0.00036	0.00015	0.0	0.0	0.0	0.00716
ESE	0.02183	0.00107	0.00046	0.0	0.0	0.0	0.02336
SE	0.03477	0.00476	0.00201	0.0	0.0	0.0	0.04154
SSE	0.00575	0.00113	0.00048	0.0	0.0	0.0	0.00736
S	0.00369	0.00041	0.00017	0.0	0.0	0.0	0.00427
SSW	0.00045	0.00010	0.00004	0.0	0.0	0.0	0.00059
SW	0.00087	0.00015	0.00006	0.0	0.0	0.0	0.00108
WSW	0.00032	0.00005	0.00002	0.0	0.0	0.0	0.00039
W	0.00207	0.00036	0.00015	0.0	0.0	0.0	0.00258
WNW	0.00239	0.00077	0.00032	0.0	0.0	0.0	0.00348
NW	0.00512	0.00297	0.00126	0.0	0.0	0.0	0.00935
NNW	0.00196	0.00128	0.00054	0.0	0.0	0.0	0.00378
COLUMN TOTALS:	0.08975	0.01418	0.00598	0.0	0.0	0.0	0.10991

UCC URAVAN URANIUM MILL
METSET VALLEY STATION JFD

UDAD 9

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 3

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00066	0.00128	0.00054	0.0	0.0	0.0	0.00248
NNE	0.00090	0.00174	0.00074	0.0	0.0	0.0	0.00338
NE	0.00032	0.00061	0.00026	0.0	0.0	0.0	0.00119
ENE	0.00013	0.00026	0.00011	0.0	0.0	0.0	0.00050
E	0.00096	0.00184	0.00078	0.0	0.0	0.0	0.00358
ESE	0.00282	0.00542	0.00229	0.0	0.0	0.0	0.01053
SE	0.01247	0.02399	0.01015	0.0	0.0	0.0	0.04661
SSE	0.00295	0.00568	0.00240	0.0	0.0	0.0	0.01103
S	0.00109	0.00210	0.00089	0.0	0.0	0.0	0.00408
SSW	0.00029	0.00056	0.00024	0.0	0.0	0.0	0.00109
SW	0.00037	0.00072	0.00030	0.0	0.0	0.0	0.00139
WSW	0.00016	0.00031	0.00013	0.0	0.0	0.0	0.00060
W	0.00088	0.00169	0.00071	0.0	0.0	0.0	0.00328
WNW	0.00199	0.00384	0.00162	0.0	0.0	0.0	0.00745
NW	0.00779	0.01498	0.00634	0.0	0.0	0.0	0.02911
NNW	0.00340	0.00655	0.00277	0.0	0.0	0.0	0.01272
COLUMN TOTALS:	0.03718	0.07157	0.03027	0.0	0.0	0.0	0.13902

UCC URAVAN URANIUM MILL
METSET VALLEY STATION JFD

UDAD 9

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 4

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00077	0.00148	0.00133	0.00153	0.00075	0.0	0.00586
NNE	0.00106	0.00205	0.00131	0.00097	0.00047	0.0	0.00586
NE	0.00037	0.00072	0.00047	0.00036	0.00017	0.0	0.00209
ENE	0.00016	0.00031	0.00015	0.00005	0.00002	0.0	0.00069
E	0.00109	0.00210	0.00154	0.00143	0.00070	0.0	0.00686
ESE	0.00324	0.00624	0.00590	0.00716	0.00350	0.0	0.02604
SE	0.01444	0.02777	0.02334	0.02547	0.01244	0.0	0.10346
SSE	0.00340	0.00625	0.00352	0.00164	0.00080	0.0	0.01561
S	0.00125	0.00240	0.00132	0.00066	0.00032	0.0	0.00595
SSW	0.00035	0.00066	0.00031	0.00005	0.00002	0.0	0.00139
SW	0.00043	0.00082	0.00049	0.00031	0.00015	0.0	0.00220
WSW	0.00019	0.00036	0.00029	0.00031	0.00015	0.0	0.00130
W	0.00101	0.00194	0.00308	0.00496	0.00242	0.0	0.01341
WNW	0.00231	0.00445	0.00398	0.00460	0.00225	0.0	0.01759
NW	0.00902	0.01734	0.01867	0.02491	0.01216	0.00189	0.08399
NNW	0.00394	0.00757	0.00[illegible]	0.00992	0.00484	0.00070	0.03469
COLUMN TOTALS:	0.04303	0.08246	0.07342	0.08433	0.04116	0.00259	0.32699

UCC URAVAN URANIUM MILL UDAD 9 DATE
METSET VALLEY STATION JFD

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 5

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00078	0.00036	0.00015	0.0	0.0	0.0	0.00129
NNE	0.00223	0.00046	0.00019	0.0	0.0	0.0	0.00288
NE	0.00107	0.00015	0.00006	0.0	0.0	0.0	0.00128
ENE	0.00142	0.00005	0.00002	0.0	0.0	0.0	0.00149
E	0.00931	0.00051	0.00022	0.0	0.0	0.0	0.01004
ESE	0.03029	0.00148	0.00063	0.0	0.0	0.0	0.03240
SE	0.04835	0.00660	0.00279	0.0	0.0	0.0	0.05774
SSE	0.00798	0.00159	0.00067	0.0	0.0	0.0	0.01024
S	0.00506	0.00056	0.00024	0.0	0.0	0.0	0.00586
SSW	0.00068	0.00015	0.00006	0.0	0.0	0.0	0.00089
SW	0.00120	0.00020	0.00009	0.0	0.0	0.0	0.00149
WSW	0.00045	0.00010	0.00004	0.0	0.0	0.0	0.00059
W	0.00282	0.00046	0.00019	0.0	0.0	0.0	0.00347
WNW	0.00334	0.00107	0.00045	0.0	0.0	0.0	0.00486
NW	0.00712	0.00414	0.00175	0.0	0.0	0.0	0.01301
NNW	0.00282	0.00179	0.00076	0.0	0.0	0.0	0.00537
COLUMN TOTALS:	0.12492	0.01967	0.00831	0.0	0.0	0.0	0.15290

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METSET VALLEY STATION JFD

UDAD 9

DATE

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 6

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00109	0.0	0.0	0.0	0.0	0.0	0.00109
NNE	0.00447	0.0	0.0	0.0	0.0	0.0	0.00447
NE	0.00219	0.0	0.0	0.0	0.0	0.0	0.00219
ENE	0.00338	0.0	0.0	0.0	0.0	0.0	0.00338
E	0.01918	0.0	0.0	0.0	0.0	0.0	0.01918
ESE	0.06400	0.0	0.0	0.0	0.0	0.0	0.06400
SE	0.09740	0.0	0.0	0.0	0.0	0.0	0.09740
SSE	0.01580	0.0	0.0	0.0	0.0	0.0	0.01580
S	0.01014	0.0	0.0	0.0	0.0	0.0	0.01014
SSW	0.00109	0.0	0.0	0.0	0.0	0.0	0.00109
SW	0.00219	0.0	0.0	0.0	0.0	0.0	0.00219
WSW	0.00109	0.0	0.0	0.0	0.0	0.0	0.00109
W	0.00566	0.0	0.0	0.0	0.0	0.0	0.00566
WNW	0.00566	0.0	0.0	0.0	0.0	0.0	0.00566
NW	0.01133	0.0	0.0	0.0	0.0	0.0	0.01133
NNW	0.00447	0.0	0.0	0.0	0.0	0.0	0.00447
COLUMN TOTALS:	0.24914	0.0	0.0	0.0	0.0	0.0	0.24914

UCC URAVAN URANIUM MILL
METSET VALLEY STATION JFD

UDAD 9

ANNUAL RELATIVE FREQUENCE OF OCCURENCE -- SUM OF ALL STABILITY CLASSES

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00393	0.00338	0.00213	0.00153	0.00075	0.0	0.01172
NNE	0.01064	0.00461	0.00239	0.00097	0.00047	0.0	0.01908
NE	0.00490	0.00158	0.00083	0.00036	0.00017	0.0	0.00784
ENE	0.00641	0.00067	0.00030	0.00005	0.00002	0.0	0.00745
E	0.03888	0.00481	0.00269	0.00143	0.00070	0.0	0.04851
ESE	0.12784	0.01421	0.00928	0.00716	0.00350	0.0	0.16199
SE	0.21598	0.06312	0.03829	0.02547	0.01244	0.0	0.35530
SSE	0.03727	0.01465	0.00707	0.00164	0.00080	0.0	0.06143
S	0.02212	0.00547	0.00262	0.00066	0.00032	0.0	0.03119
SSW	0.00296	0.00147	0.00065	0.00005	0.00002	0.0	0.00515
SW	0.00526	0.00189	0.00094	0.00031	0.00015	0.0	0.00855
WSW	0.00231	0.00082	0.00048	0.00031	0.00015	0.0	0.00407
W	0.01294	0.00445	0.00413	0.00496	0.00242	0.0	0.02[illegible]
WNW	0.01619	0.01013	0.00637	0.00460	0.00225	0.0	0.03954
NW	0.04137	0.03943	0.02802	0.02491	0.01216	0.00189	0.14778
NNW	0.01699	0.01719	0.01179	0.00992	0.00484	0.00070	0.06143
OLUMN TOTALS:	0.56599	0.18788	0.11798	0.08433	0.04116	0.00259	0.99992

APPENDIX B METEOROLOGICAL JOINT FREQUENCY DISTRIBUTION (GRAND JUNCTION)

UCC URAVAN URANIUM MILL
METSET GRAND JUNCTION JFD

UDAD 9

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 1

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00050	0.00023	0.0	0.0	0.0	0.0	0.00073
NNE	0.00020	0.00014	0.0	0.0	0.0	0.0	0.00033
NE	0.00049	0.00014	0.0	0.0	0.0	0.0	0.00063
ENE	0.00037	0.00016	0.0	0.0	0.0	0.0	0.00053
E	0.00035	0.00011	0.0	0.0	0.0	0.0	0.00046
ESE	0.00064	0.00025	0.0	0.0	0.0	0.0	0.00090
SE	0.00079	0.00043	0.0	0.0	0.0	0.0	0.00123
SSE	0.00114	0.00091	0.0	0.0	0.0	0.0	0.00206
S	0.00141	0.00078	0.0	0.0	0.0	0.0	0.00219
SSW	0.00091	0.00069	0.0	0.0	0.0	0.0	0.00159
SW	0.00109	0.00080	0.0	0.0	0.0	0.0	0.00189
WSW	0.00131	0.00084	0.0	0.0	0.0	0.0	0.00216
W	0.00107	0.00082	0.0	0.0	0.0	0.0	0.00189
WNW	0.00183	0.00126	0.0	0.0	0.0	0.0	0.00308
NW	0.00093	0.00059	0.0	0.0	0.0	0.0	0.00153
NNW	0.00036	0.00021	0.0	0.0	0.0	0.0	0.00056
COLUMN TOTALS:	0.01340	0.00835	0.0	0.0	0.0	0.0	0.02176

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 2

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00231	0.00112	0.00027	0.0	0.0	0.0	0.00370
NNE	0.00147	0.00041	0.00014	0.0	0.0	0.0	0.00202
NE	0.00141	0.00050	0.00014	0.0	0.0	0.0	0.00204
ENE	0.00135	0.00032	0.00011	0.0	0.0	0.0	0.00179
E	0.00164	0.00069	0.00011	0.0	0.0	0.0	0.00244
ESE	0.00341	0.00224	0.00098	0.0	0.0	0.0	0.00663
SE	0.00379	0.00397	0.00185	0.0	0.0	0.0	0.00961
SSE	0.00479	0.00454	0.00215	0.0	0.0	0.0	0.01148
S	0.00529	0.00441	0.00162	0.0	0.0	0.0	0.01132
SSW	0.00307	0.00169	0.00069	0.0	0.0	0.0	0.00544
SW	0.00350	0.00194	0.00103	0.0	0.0	0.0	0.00647
WSW	0.00348	0.00217	0.00126	0.0	0.0	0.0	0.00690
W	0.00390	0.00290	0.00231	0.0	0.0	0.0	0.00910
WNW	0.00685	0.00523	0.00425	0.0	0.0	0.0	0.01633
NW	0.00429	0.00324	0.00203	0.0	0.0	0.0	0.00956
NNW	0.00272	0.00164	0.00064	0.0	0.0	0.0	0.00500
COLUMN TOTALS:	0.05327	0.03701	0.01957	0.0	0.0	0.0	0.12985

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 3

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00113	0.00119	0.00126	0.00011	0.0	0.0	0.00368
NNE	0.00073	0.00069	0.00053	0.00005	0.00002	0.0	0.00201
NE	0.00068	0.00048	0.00062	0.0	0.00002	0.0	0.00180
ENE	0.00091	0.00027	0.00066	0.00002	0.0	0.0	0.00187
E	0.00118	0.00075	0.00048	0.00007	0.0	0.0	0.00248
ESE	0.00182	0.00400	0.00589	0.00039	0.0	0.0	0.01209
SE	0.00225	0.00617	0.01208	0.00073	0.00005	0.00005	0.02131
SSE	0.00186	0.00580	0.00902	0.00066	0.00005	0.0	0.01739
S	0.00182	0.00386	0.00434	0.00059	0.00016	0.00009	0.01087
SSW	0.00068	0.00130	0.00121	0.00069	0.00014	0.00016	0.00417
SW	0.00079	0.00135	0.00096	0.00071	0.00023	0.00011	0.00414
WSW	0.00079	0.00155	0.00151	0.00041	0.0	0.0	0.00426
W	0.00145	0.00290	0.00406	0.00082	0.00009	0.0	0.00932
WNW	0.00309	0.00676	0.01034	0.00233	0.00023	0.0	0.02275
NW	0.00203	0.00443	0.00653	0.00126	0.00014	0.00002	0.01440
NNW	0.00123	0.00224	0.00256	0.00046	0.00007	0.0	0.00655
COLUMN TOTALS:	0.02242	0.04373	0.06204	0.00929	0.00119	0.00043	0.13911

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ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 4

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00118	0.00258	0.00559	0.00395	0.00041	0.00011	0.01383
NNE	0.00079	0.00110	0.00242	0.00203	0.00030	0.00018	0.00681
NE	0.00119	0.00121	0.00237	0.00224	0.00062	0.00009	0.00772
ENE	0.00145	0.00208	0.00260	0.00222	0.00046	0.00009	0.00890
E	0.00195	0.00215	0.00375	0.00265	0.00025	0.00002	0.01077
ESE	0.00264	0.00587	0.02475	0.03768	0.00306	0.00016	0.07415
SE	0.00185	0.00553	0.01754	0.01690	0.00217	0.00034	0.04432
SSE	0.00147	0.00361	0.00795	0.00740	0.00167	0.00032	0.02241
S	0.00153	0.00249	0.00461	0.00580	0.00180	0.00062	0.01685
SSW	0.00084	0.00075	0.00169	0.00288	0.00132	0.00041	0.00790
SW	0.00103	0.00100	0.00192	0.00340	0.00132	0.00050	0.00918
WSW	0.00099	0.00130	0.00135	0.00210	0.00069	0.00021	0.00663
W	0.00173	0.00281	0.00285	0.00418	0.00148	0.00041	0.01347
WNW	0.00304	0.00737	0.01139	0.01128	0.00253	0.00066	0.03629
NW	0.00223	0.00566	0.01027	0.00996	0.00164	0.00066	0.03042
NNW	0.00143	0.00306	0.00671	0.00559	0.00087	0.00030	0.01796
COLUMN TOTALS:	0.02534	0.04857	0.10777	0.12024	0.02060	0.00509	0.32762

ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 5

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.0	0.00349	0.00379	0.0	0.0	0.0	0.00728
NNE	0.0	0.00215	0.00203	0.0	0.0	0.0	0.00418
NE	0.0	0.00320	0.00244	0.0	0.0	0.0	0.00564
ENE	0.0	0.00582	0.00249	0.0	0.0	0.0	0.00831
E	0.0	0.00553	0.00413	0.0	0.0	0.0	0.00966
ESE	0.0	0.01320	0.03932	0.0	0.0	0.0	0.05252
SE	0.0	0.00683	0.02012	0.0	0.0	0.0	0.02694
SSE	0.0	0.00313	0.00359	0.0	0.0	0.0	0.00671
S	0.0	0.00187	0.00135	0.0	0.0	0.0	0.00322
SSW	0.0	0.00078	0.00039	0.0	0.0	0.0	0.00116
SW	0.0	0.00103	0.00046	0.0	0.0	0.0	0.00148
WSW	0.0	0.00126	0.00039	0.0	0.0	0.0	0.00164
W	0.0	0.00167	0.00078	0.0	0.0	0.0	0.00244
WNW	0.0	0.00422	0.00285	0.0	0.0	0.0	0.00708
NW	0.0	0.00413	0.00436	0.0	0.0	0.0	0.00849
NNW	0.0	0.00315	0.00345	0.0	0.0	0.0	0.00660
COLUMN TOTALS:	0.0	0.06145	0.09193	0.0	0.0	0.0	0.15337

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ANNUAL RELATIVE FREQUENCY OF OCCURENCE -- STABILITY CLASS 6

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.00633	0.00489	0.0	0.0	0.0	0.0	0.01122
NNE	0.00474	0.00304	0.0	0.0	0.0	0.0	0.00778
NE	0.00821	0.00463	0.0	0.0	0.0	0.0	0.01284
ENE	0.01625	0.01359	0.0	0.0	0.0	0.0	0.02984
E	0.01688	0.01130	0.0	0.0	0.0	0.0	0.02819
ESE	0.02282	0.02973	0.0	0.0	0.0	0.0	0.05255
SE	0.01566	0.02121	0.0	0.0	0.0	0.0	0.03688
SSE	0.00685	0.00578	0.0	0.0	0.0	0.0	0.01262
S	0.00564	0.00228	0.0	0.0	0.0	0.0	0.00792
SSW	0.00261	0.00080	0.0	0.0	0.0	0.0	0.00341
SW	0.00293	0.00100	0.0	0.0	0.0	0.0	0.00393
WSW	0.00285	0.00078	0.0	0.0	0.0	0.0	0.00363
W	0.00412	0.00173	0.0	0.0	0.0	0.0	0.00586
WNW	0.00826	0.00450	0.0	0.0	0.0	0.0	0.01276
NW	0.00607	0.00479	0.0	0.0	0.0	0.0	0.01086
NNW	0.00410	0.00390	0.0	0.0	0.0	0.0	0.00800
COLUMN TOTALS:	0.13433	0.11396	0.0	0.0	0.0	0.0	0.24829

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METSET GRAND JUNCTION JFO

ANNUAL RELATIVE FREQUENCE OF OCCURENCE -- SUM OF ALL STABILITY CLASSES

WIND DIRECTION	WIND SPEED, KNOTS 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	OVER 21	ROW TOTALS
N	0.01145	0.01349	0.01091	0.00406	0.00041	0.00011	0.04045
NNE	0.00793	0.00751	0.00511	0.00208	0.00032	0.00018	0.02313
NE	0.01197	0.01016	0.00557	0.00224	0.00064	0.00009	0.03067
ENE	0.02034	0.02224	0.00587	0.00224	0.00046	0.00009	0.05123
E	0.02200	0.02053	0.00847	0.00272	0.00025	0.00002	0.05400
ESE	0.03133	0.05528	0.07094	0.03806	0.00306	0.00016	0.19884
SE	0.02434	0.04414	0.05158	0.01763	0.00221	0.00039	0.14029
SSE	0.01611	0.02377	0.02210	0.00806	0.00171	0.00032	0.07267
S	0.01570	0.01569	0.01192	0.00639	0.00196	0.00071	0.05237
SSW	0.00811	0.00601	0.00397	0.00356	0.00146	0.00057	0.02368
SW	0.00934	0.00712	0.00436	0.00411	0.00155	0.00062	0.02710
WSW	0.00942	0.00790	0.00450	0.00251	0.00069	0.00021	0.02523
W	0.01226	0.01283	0.01000	0.00500	0.00157	0.00041	0.04208
WNW	0.02307	0.02934	0.02884	0.01361	0.00276	0.00066	0.09829
NW	0.01554	0.02286	0.02320	0.01121	0.00178	0.00068	0.07527
NNW	0.00984	0.01420	0.01336	0.00605	0.00094	0.00030	0.04468
COLUMN TOTALS:	0.24877	0.31307	0.28131	0.12954	0.02178	0.00553	0.99999