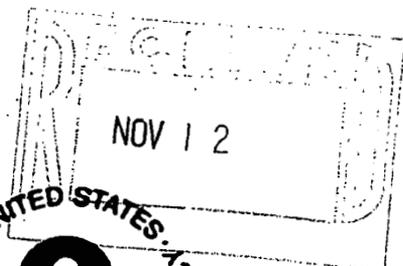




Colorado Department  
of Public Health  
and Environment



NOV - 6 1996

Dear Community Member:

The U.S. Department of Energy (DOE), Colorado Department of Public Health and Environment (CDPHE), and the U.S. Environmental Protection Agency (EPA) have prepared the attached responsiveness summary to address the comments and questions received on the action levels for radionuclides in soils. The responsiveness summary is available in the Rocky Flats reading rooms and from the agencies.

The DOE, CDPHE and EPA believe all comments and questions received through the formal comment period have been addressed in this responsiveness summary. The agencies will continue to address concerns in the most appropriate manner as they develop. Further, members of the community are encouraged to participate in future reviews of the action levels and in other matters of public concern at the Rocky Flats site.

DOE, CDPHE and EPA thank the community for its interest in the actions levels, for taking the time to comment on the agencies' proposals, and for ongoing participation in the public process.

Questions about this responsiveness summary may be directed to Steve Slaten (DOE) at 303-966-4839, Steve Tarlton (CDPHE) at 303-692-3013, or Tim Rehder (EPA) at 303-312-6293.

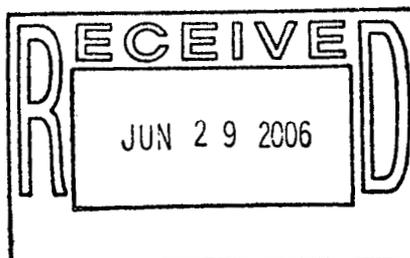
Sincerely,

Steve Slaten  
U.S. Department of Energy

Steve Tarlton  
Colorado Department of Public  
Health and Environment

Tim Rehder  
U.S. Environmental  
Protection Agency

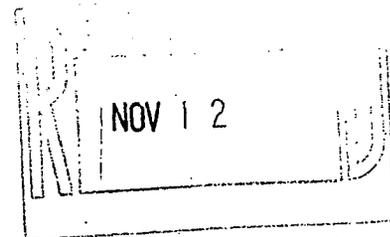
Enclosure



ADMIN RECORD

1/24

SW-A-005591



# **RESPONSIVENESS SUMMARY FOR SOIL ACTION LEVELS**

**November 6, 1996**

## RESPONSIVENESS SUMMARY FOR SOIL ACTION LEVELS

### Comment:

Promulgate national standards before setting them for Rocky Flats.

### Response:

Finalizing national standards can be a lengthy process, sometimes taking years. The Parties to RFCA believe that ER work is too important to delay for the following reasons:

- Heavy precipitation events like the one in May 1995 could transport some of the contaminated soils away from their current location making the cleanup more complicated and expensive in the future.
- Certain off-site disposal options that are available at present, such as Envirocare may not be available in the future. Off-site disposal options could be more expensive in the future.
- Rocky Flats currently has staff experienced in ER projects and knowledgeable about the geology, hydrology and ecology of the site. If ER work were to be delayed for a number of years, DOE and its contractor would probably lose much of that expertise.
- The Ten Year Plan calls for DOE to cleanup approximately 50 of the high-priority individual hazardous substance sites (IHSSs). To accomplish that goal, the Site need to make significant progress during the first five years of the plan, and not backload all the ER work into years six through 10.
- We must look at the very real possibility that site budgets will decline in the future when high priority tasks such as SNM consolidation and stabilization have been completed.

The draft EPA regulation is consistent with other promulgated or proposed national standards that establish 15 mRem/year as an appropriate level of protection. These standards include:

- WIPP Certification Criteria (40 CFR 194),
- Standards for Spent Fuel, High-Level and Transuranic Waste (40 CFR 191), and
- NRC's Proposed Rule published in the Federal Register on August 22, 1994 (59 CFR 43200).

A national debate over the draft EPA Radiation Sites Cleanup Rule will take place. Should the rule change as a result of the debate, the interim soil action levels for Rocky Flats will be revised accordingly.

**Comment:**

**Focus first on the Special Nuclear Material (SNM) stabilization.**

**Response:**

The DOE, EPA and CDPHE agree that SNM poses the highest risks at Rocky Flats and that stabilization of SNM should be the site's highest priority. However, the site also has the budget and resources to perform environmental restoration (ER) work now. The parties believe that given the large amount of ER work that needs to be done, it is important to begin that effort as soon as possible.

**Comment:**

**The interim action should not add 85 mRem to the Denver area's high level of naturally occurring radiation.**

**Response:**

When EPA developed its draft Radiation Sites Cleanup Regulation, it chose the 15 and 85 mRem/yr dose numbers because they were fractions of the 100 mRem/yr dose number that the International Commission on Radiologic Protection (ICRP) has stated is protective of public health. The ICRP is an international body of health physicist that researches radiation exposure and sets standards for radiation protection. When the ICRP developed the 100 mRem/yr number, it considered locations such as Denver where the background radiation levels are high. Therefore, the EPA, DOE and CDPHE believe it is appropriate to apply the standard to Rocky Flats.

**Comment:**

**Is budget driving soil action levels, or are soil action levels driving future funding scenarios?**

**Response:**

The projected budget was not a consideration in setting any of the parameters in the Action Levels and Standards Framework, including the radionuclide action levels for soils. The parties examined the issue from a scientific and technical perspective and derived the action levels to be protective of human health and the environment. The resulting projected volumes of remediation waste to be managed in the future and the associated costs were only determined after the scientific and technical analysis was completed.

Similarly, soil action levels for radionuclides are not a key driver for future funding. DOE HQ has given the Site the planning levels for funding for the entire Ten Year Plan. The target levels of funding were not based on the soil action levels but are essentially a flat funding scenario. Additionally, when the closure of the site is looked at in its entirety, the costs associated with the soil cleanup are relatively small in comparison to those associated with activities related to special nuclear materials.

**Comment:**

**Conduct additional modeling and documentation of the prospect for any future loadings and initiate corrective action to strive for zero offsite releases.**

**Response:**

The Preamble to the Rocky Flats Cleanup Agreement states that "At the completion of cleanup activities, all surface water onsite and all surface and groundwater leaving RFETS will be of acceptable quality for all uses."

It is in the Site's best interest to identify cost-effective means to reduce active management of environmental contaminants and potential offsite releases. Therefore, the Site is pursuing cleanup and control methodologies using the advice of the Actinide Migration Panel, implementing watershed improvements and the Pond Operations Plan and working with the cities and regulatory agencies to implement the Integrated Water Management Plan.

The Community Advisory issued October 18, 1996, states "DOE commits to conducting further investigations of plutonium migration in surface water and groundwater, including potential impacts of future accumulation of contaminants offsite due to migration from Rocky Flats. These investigations will result in a clearer understanding of how high precipitation events affect the residual plutonium in soils at Rocky Flats." The next meeting of the Actinide Migration Panel will take place within the next several months. The panel will be finalizing a report on the Evaluation of Existing Data On Actinide Migration at the Rocky Flats Environmental Technology Site and making recommendations that may influence the prioritization of cleanup activities and requirements for additional data required for engineering remediation activities. Panel meetings have always been open to the public.

**Comment:**

**Conduct feasibility research into cost-effective ways to remove areas contaminated with residual plutonium.**

**Response:**

DOE is assessing cost-effective ways to remove areas contaminated with residual plutonium. As previously stated, the next meeting of the Actinide Migration Panel will take place within the next several months. The panel will be finalizing a report on the Evaluation of Existing Data On Actinide Migration at the Rocky Flats Environmental Technology Site and making recommendations that may influence the prioritization of cleanup activities and requirements for additional data required for assessing remediation activities.

In 1997 the Kaiser Hill Team will begin addressing the 903 Pad and Lip Area. An IM/IRA or PAM that outlines the proposed action will be submitted for public review and comment. The 903 Pad and Lip Area represents the major portion of surface soils on site contaminated with residual plutonium and is one of the site's highest priorities.

The Kaiser-Hill Team continues to implement the Industrial Area IM/IRA monitoring program to identify any previously unidentified sources of plutonium and americium contamination. Individual watersheds are monitored to identify new sources of contamination.

In addition, the Kaiser-Hill Team is constantly evaluating new technologies for detection and remediation of radionuclides in soils, sediments and groundwater. For example, Kaiser-Hill is working closely with DOE's complex-wide subsurface task force in evaluating and implementing new cost-effective technologies to address subsurface contaminants.

**Comment:**

**Conduct periodic review of the interim action levels and new remediation technology.**

**Response:**

In addition to the annual review prescribed in paragraph 5 of RFCA, the agencies will be responsible for conducting an internal annual review of the soil action levels. An annual report summarizing the review will be given to the public. Questions that will be addressed on an annual basis include:

1. Is there new scientific information available that would impact the interim action levels?
2. Has a national soil action level been promulgated within the year? If yes, the parties commit to revisit Rocky Flats' interim action levels.
3. How were the interim action levels applied to the site over the course of the year?
4. Have the remedies been effective?

**Comment:**

**Establish an autonomous board for remediation activities.**

**Response:**

Establishing an autonomous board that ensures appropriate oversight for remediation activities is not necessary because each proposed cleanup action is subject to public and regulatory scrutiny through the CERCLA process. This process ensures that all proposed cleanup actions must first go through a public and regulatory review. Additionally, stakeholders groups such as the Rocky Flats Citizens Advisory Board (RFCAB), Rocky Flats Local Impacts Initiative (RFLII) and others were established to provide such external review. An additional layer of oversight would be redundant and is not warranted.

**Comment:**

**Although it may be necessary to return contaminated material to the ground in the interim, it is not an acceptable long-term state.**

**Response:**

Soils, once extracted as part of a remedial action, may or may not be returned to the ground. Put-back levels are those levels at which excavated soils will be allowed to be placed back into the ground. Soils with radionuclide levels below Tier II action levels may be replaced; soils with radionuclide levels above Tier I action levels may not be replaced. Decisions regarding soils containing radionuclide levels between Tier I and Tier II will be determined on a case-by-case basis. Because many of the variables used to determine put-back levels are project-specific, put-back level decisions should be made and explained within the decision documents associated with those actions. Decision factors to be considered include remedy effectiveness and protectiveness, anticipated future land uses, contaminant levels in surrounding soils, and costs.

The agencies believe that soils containing radionuclides below the action levels are protective of human health and the environment for the interim. Performance monitoring will be required to ensure that the selected remedy was effective. The frequency and location will be determined on a case-by-case basis. The site will also conduct an annual review to determine all applicable new and revised statutes, regulations, written policy and guidance. In addition, an evaluation of the entire site at the completion of the interim actions will be taken at the time of the final CAD/ROD for the site to determine if residual contamination warrants further action. If further action is warranted, the exact location of soils returned to the ground is known and is part of the administrative record for that action. This knowledge will allow the soils that require further action to be easily located for either treatment or removal.

**Comment:**

**The action levels should be based on projected use and cost/benefit analysis.**

**Response:**

In developing the action levels, the agencies based their recommendation on the anticipated land uses outlined in the Rocky Flats Vision. No formal cost/benefit analysis was performed, but cleanup of the Site to these projected uses will ensure that the surrounding communities receive the benefit of cleanup that is protective of human health and the environment at a reasonable cost.

**Comment:**

**The most cautious approach should be taken for the RBE (relative biological effectiveness) for plutonium. All potential health risks should be assessed, not just cancer.**

**Response:**

Federal radiation protection standards for the public are based on an annual radiation dose limit. This annual limit is based on the sum of external radiation dose and internal radiation dose. A quality factor of 20 is prescribed for use by these federal agencies for quantifying internal radiation dose from plutonium. Therefore, a quality factor of 20 was used to calculate plutonium action levels. This quality factor of 20 was chosen by the ICRP and the NCRP based on a range of RBE values. RBE values are variable, based on the type of organ, the type of radiation, the type of effect and the type of radionuclide being evaluated.

For exposure to radioactive material in the environment, EPA has stated that the most significant consequence of this exposure is cancer induction. Therefore, EPA believes that cancer risk may be used as the primary basis for assessing radionuclides in the environment.

**Comment:**

**In calculating soil contamination, use readings from specific soil samples rather than averages from multiple samples.**

**Response:**

There will not be enough time or money to sample every square foot of Rocky Flats. Therefore some amount data averaging will need to be employed and discrete data points will be used to represent the contamination level of relatively large areas. The amount of averaging employed will vary from project to project depending upon the size and shape to the contaminated area, amount of historical information known about the area, and the sensitivity of direct-reading, field instrumentation. Data points scattered around large geographic areas will never be averaged to make a determination as to whether an area is above or below the action levels.

It is common in environmental restoration work to use a combination of discrete samples (collected at a single location) and composite samples (collected for multiple locations and combined into a single sample) in the site characterization process. At Rocky Flats, analysis of soil samples will be used in conjunction with direct-reading, field instrumentation and best professional judgment to locate the soils that exceed the action levels for radionuclides.

**Comment:**

Use most conservative numbers for respirable fraction of soil; breathing rate calculation; erosion or migration.

**Response:**

The parameters were chosen for input to the RESRAD code to be as site specific as possible so that the characteristics of the Rocky Flats Environmental Technology Site (RFETS) are represented. This is important since all radiation site cleanup actions are unique and must assess different concentrations of radionuclides with variable environmental conditions. These site specific conditions must be incorporated into the RESRAD code to assure that cleanup levels are health protective.

Inhalation exposure is assessed by examining the amount of radioactive material present in the air and the inhalation rate of an individual. To calculate the amount of radioactive material in air, it is first assumed that there is a direct correlation between the concentration of radioactive material in air and the concentration of radioactive material in soil (i.e.,  $(\text{pCi/gram})_{\text{air}}/(\text{pCi/gram})_{\text{soil}} = 1$ ). This is a very conservative assumption since empirical data has shown that this ratio is actually much less than 1.

The next step is to define the amount of respirable dust present in the air. To calculate radiation dose, the annual average PM-10 concentration (the concentration of dust with a diameter of <10 micrometers) should be used to represent the amount of respirable dust present. The annual average concentration should be used since radiation dose regulations are written on an annual basis. The PM-10 concentrations for six air monitors at RFETS were examined for the years 1990 through 1995 to assess the respirable dust present at RFETS. To be conservative, the PM-10 concentration was maximized by using the air monitor closest to the Standley Lake surface water project during construction activities for that project over a five month period. The annual average was actually much less. Due to the use of an air monitor next to heavy construction on a short term basis, the respirable fraction used in the RESRAD code is conservative while assuring that site specific data is utilized.

The breathing rates chosen for use in the RESRAD code are considered Reasonable Maximum Exposure (RME) parameters by the EPA and are used at environmental restoration sites throughout the country. RME parameters represent the highest exposure that EPA believes is reasonably expected to occur at a site (in this case, the highest inhalation rate).

The soil erosion rate was chosen to be as site specific as possible. Soil erosion rates were taken from a report entitled Estimated Soil Erosion and Associated Actinide Transport for the South Interceptor Ditch Drainage. This is the best site-specific erosion rate data available for use at RFETS.

**Comment:**

**Consider effects of events such as fire, storm events, etc.**

**Response:**

EPA's draft 40CFR196 is based on protecting individuals due to a chronic exposure to radionuclides in the environment. This chronic exposure is apparent in EPA's regulation since cleanup levels are based on an annual radiation dose due to chronic exposure to radionuclides in soils. The assessment of short term exposures (i.e., fire, storm event) is not required by EPA's draft standard. Even though these short term events are unusual, the soil action levels should not be compromised. First, it is anticipated that an individual would seek protection from a short-term event and not remain in the area. Radiation dose from a short-term event decreases with increasing distance from the event since resuspended soils readily disperse in air. Also, the amount of soil that an individual could be exposed to, on a short term basis, is limited by the duration of the event. These circumstances will combine to limit an individual's radiation dose from soils during short term events.

**Comment:**

**Utilize ALARA and ARAR in determining the standard.**

**Response:**

The As Low As Reasonably Achievable (ALARA) philosophy is used in radiation protection to assure that radiation dose is reduced to acceptable levels taking into account technical, social and economic factors. In determining its radiation dose requirements of 15 mRem and 85 mRem in 40CFR196, EPA performed an analysis that is functionally equivalent to an ALARA analysis. Specifically, EPA performed the following:

- A detailed review of prior decisions made by the federal government to address environmental risks with special emphasis on decisions concerning radiation and site remediation.
- A technical analysis to ensure that the cleanup standards being considered would be both achievable and measurable.
- A cost analysis of various cleanup levels.

An ARAR is an Applicable or Relevant and Appropriate Requirement (ARAR) under EPA's environmental restoration program and is used to identify requirements that need to be addressed during environmental restoration activities. Current and proposed regulations from the EPA, DOE and the Nuclear Regulatory Commission (NRC) were reviewed for use at RFETS for deriving action levels. EPA's draft 40CFR196 was chosen for use due to the following:

- Remediation activities at the RFETS follow EPA and State of Colorado remediation requirements as outlined in the Rocky Flats Cleanup Agreement. For radionuclide remediation, EPA's most current regulations were addressed.

- 40CFR196 is based on an extensive review of available radiation protection information.
- 40CFR196 is not inconsistent with the requirements of DOE Order 5400.5, DOE's draft 10CFR834 and the draft NRC decommissioning regulations.
- NRC regulations only apply at DOE facilities in limited situations.

**Comment:**

**The action levels are not protective of long-term public health because of the large uncertainties associated with radiation exposure from plutonium, americium and uranium and, particularly concerns with the RESRAD projected long-term migration to the East -- downwind and down elevation gradient -- of on-site radionuclides.**

**Response:**

The action levels are interim and were developed to be protective of public health using the most current scientific knowledge provided by the International Commission on Radiological Protection and the National Committee on Radiation Protection and Measurement, as well as the Environmental Protection Agency. Any new, validated scientific knowledge that indicates the action levels are not protective of public health would result in revision of the action levels to make them more protective. The on-site cleanup will result in less source material for long-term transport off-site. While the RESRAD model assumes a certain amount of off-site transport of radionuclides due to erosion, the amount of radionuclides leaving the site would be very limited over time. Continued studies (such as those surrounding actinide migration) will address whether off-site migration poses a threat to human health and the environment.

Investigations as part of the Health Advisory Panel dose reconstruction studies attribute nearly all the radioactive contamination in the soils of eastern RFETS and immediately off-site to one wind event in January 1969. Since then, the activity levels have been decreasing.

**Comment:**

**A site-specific, risk-based standard of not more than one additional lifetime (70 years) cancer risk per million exposed persons -- is an approach more consistent with the national trend regarding application of human health risk-based standards and more acceptable than the proposed dose-based approach.**

**Response:**

The national trend for limiting radionuclide exposures is to use a dose-based approach. This trend follows recommendations from the International Commission on Radiological Protection, National Committee on Radiological Protection and Measurement, the Nuclear Regulatory Commission, DOE and EPA. A dose-based approach used in the action levels

represents a higher risk than the one in a million excess cancer risk. However, the 15/85 mrem dose still falls within the acceptable CERCLA risk range for intended use of the site.

**Comment:**

**It is not acceptable to add dirt to "dilute" the concentration.**

**Response:**

The Soil Action Level Framework does not allow mixing clean soil with contaminated soil as part of a cleanup remedy to meet the action level.

**Comment:**

**Promulgate the CDPHE radiation standard at Rocky Flats.**

**Response:**

The CDPHE radiation standard was never meant to be used at Rocky Flats as a cleanup standard. The CDPHE standard applies only to uncontrolled off-site areas as a construction standard, and requires special techniques to be utilized during construction activities to minimize the potential for migration of plutonium. There is no legal or human health basis to use the standard on-site as a cleanup standard, as it would result in a dose and risk level less than required by CERCLA or recommended by the ICRP and the NCRP.

**Comment:**

**Are action levels consistent with downstream water quality standards?**

**Response:**

Cleanup actions will control and prevent the potential for releases into surface water. The regulatory agencies will have oversight authority of cleanup actions, and the communities and public will be asked to review cleanup proposals. The action levels by themselves do not ensure DOE's ability to comply with downstream water quality standards and points of compliance.

Surface water standards will be applied independently of the soil action levels. The site will be required to meet the standards. The Integrated Water Management Plan contains a variety of elements to ensure that Rocky Flats maintains control of its surface water quality and compliance with standards.

Actions required by the action levels, such as removals or stabilizations, will provide sufficient protection for surface water. Those actions will control the worst areas of radiological contamination. Even these areas, so far, have not impacted surface water above standards.

As recommended, ongoing studies of plutonium mobility and transport have been committed to by DOE. Groundwater modeling is being refined and hydrogeological conditions will continue to be studied by DOE and the regulatory agencies.

**Comment:**

**How will the site reconcile the more stringent state standard with the proposed standard as it pertains to the 1985 landowners' lawsuit settlement?**

**Response:**

The State Construction Standard for Plutonium does not apply to the DOE site and is not a cleanup standard. The State Standard, when exceeded, requires an evaluation of special construction techniques to be used to keep plutonium from becoming wind blown during construction activities. It does not require soil remediation.

The State was not a party to the 1985 lawsuit. The action that resulted from the lawsuit was decided by a court settlement, not by a regulatory enforcement. No reconciliation is needed between the Soil Action Levels and the 1985 lawsuit.

**Comment:**

**What assurances are there to protect downstream cities from failed assumptions?**

**Response:**

CERCLA provides for a regular review of remedies to assure they remain protective of human health and the environment. The proposed remedy of no action for off-site areas is based on existing conditions and could be changed in the future if a new contaminant release threatened human health or the environment. Also, see response to comment #6 regarding independent application of surface water standards.

**Comment:**

**During all remediation activities, indicate measures to ensure maximum protection of the work force and the public.**

**Response:**

The health and safety of workers is protected by DOE orders and requirements of the health and safety plan prepared by contractors and sub-contractors. The plan specifies the types, frequencies and locations of monitoring, along with required protective clothing and gear. In addition, the plan describes decontamination and emergency response for the actions to be performed.

Remediation activities, including treatment phases of cleanup, require public-reviewed and agency-approved decision documents that describe actions to mitigate the release of contaminants. The decision documents must also include monitoring plans that cover sampling locations, analytical suites, and sample frequencies to prove that the mitigating actions are working. The decision documents must also meet the requirements outlined in the Plan for Prevention of Contaminant Dispersion, developed by RFETS, CDPHE and EPA and finalized in 1992.

Decision documents at RFETS include Records of Decision, Interim Measures/Interim Remedial Actions, Closure Plans, and Proposed Action Memorandums.

In addition to the monitoring required for specific cleanup projects, CDPHE and the site maintain an ambient environmental monitoring program for the air and surface water at Rocky Flats.

**Comment:**

**Delay most ER work, but initiate remediation immediately in areas where highly contaminated soils pose urgent risks through erosion to surface water, seepage to ground water or other pathways.**

**Response:**

There is no clear evidence that contaminated soils at Rocky Flats will present a threat of significant migration in the near future. So, in effect, this comment calls for a delay of all ER work. The DOE, CDPHE and EPA believe that the removal of contaminated soils using the interim action level should proceed in order to minimize the threat of contaminate migration in surface water and ground water or possible re-suspension by wind.

**Comment:**

**Addressing the highest priority risks at RFETS may cause additional soil contamination. So, ER work should be delayed until the highest risks are completed.**

**Response:**

Plutonium stabilization and consolidation, and other activities such as building decontamination and decommissioning, will be conducted in a safe manner that will not cause additional environmental degradation. If minor environmental contamination does occur, it will be cleaned up.

**Comment:**

**Clean up to average background when economically and technologically possible; any cleanup not to average background is considered "interim".**

**Response:**

The DOE, EPA and CDPHE have not committed to cleanup to background. The reasons for this are:

1. CERCLA and RCRA, the laws that govern the cleanup of contaminated sites in this country, say that cleanups should be protective of public health and the environment, not that sites be cleaned up to background.

2. Until those laws are changed to require cleanup to background, Congress will not appropriate money to clean Rocky Flats or the approximately 1,200 other Superfund sites in the U.S. to background.
3. The DOE, EPA and CDPHE have agreed that the interim action levels will be revisited at the time of the final cleanup decision for Rocky Flats.
4. The DOE, EPA and CDPHE have also agreed that the cleanup will be performed in a manner that will not preclude a more stringent cleanup at a later time.

**Comment:**

**Although soil action levels are interim, there is no guarantee of additional cleanup after the interim levels have been met.**

**Response:**

Additional cleanup beyond that needed to meet the interim action levels will be dependent upon:

1. An evaluation of the entire site at the completion of the interim actions to determine if residual contamination warrants further action.
2. Continuing evaluation of new cleanup standards and new research concerning the health effects of ionizing radiation.

**Comment:**

**If the industrial area is never reused for commercial/industrial purposes, why shouldn't a 15 mRem residential standard be applied sitewide?**

**Response:**

The Vision for Rocky Flats anticipates potential commercial reuse in part of the industrial area and open space use in the Buffer Zone. If the industrial area is not used for commercial purposes, the only use it is likely to see is open space. The interim action level for the industrial area would also be protective of open space use. Residential development of either the industrial area or the Buffer Zone is not considered to be a likely future use scenario.

**Comment:**

**Tier I is a very conservative approach and should be the way to go.**

**Response:**

The parties agree.

**Comment:**

**More stringent standards will paralyze site cleanup.**

**Response:**

The parties agree.

**Comment:**

**Cleanup to background is unrealistic, use the proposed national standards and get on with it.**

**Response:**

The DOE, CDPHE and EPA believe that the interim soil action levels are protective of human health and the environment and, at the same time, allow the site to proceed expeditiously with environmental restoration.

## HEALTH EFFECTS OF PLUTONIUM CONTAMINATED SOIL

J. Goldfield

September 16, 1996  
Rev. October 29, 1996

### Summary

Plutonium is found in soil in Colorado at background levels of 0.04 pCi/g average and up to 0.08 pCi/g. At Rocky Flats, most of the area is contaminated to well above background with some readings as high as 12,200 pCi/g--300,000 times average background. The problem posed is how far to go to clean up.

Some have insisted that the soil should be cleaned to background levels. In 1975 the Colorado Department of Health set a level of 1 pCi/g--25 times as high as background. A report by Iggy Litaor presented a level of 3.8 pCi/g, 95 times as high as background. All these proposals have been rejected as too costly, with no adequate study presented.

The DOE, the EPA, and the CDH have produced an "action level"--clean-up standard--of 651 pCi/g. The claim is made that a resident living on such soil will suffer a yearly exposure of 85 mrem which will cause no more than an "acceptable" level of cancer. Since the proposed soil concentration is 16,000 times average background, the proposal is causing some dismay among residents of the surrounding area.

There is probably nowhere on the face of the earth where people are living on soil contaminated to the proposed action level. No study can therefore be made on the effect of such soil directly on the health of residents. Instead calculations made using a computer program called RESRAD are used to study the health effects of plutonium soil concentrations.

About 70 parameters must be evaluated and fed into the program to come up with results. This report includes a study of only four of the parameters and concludes that values being used are insufficiently conservative and may cause health effects to be underestimated by factors of 170 to 290.

## **Background**

Plutonium is considered to be a dangerous and poisonous material. It is a man-made element not found normally in nature. Experience with it has been obtained only with the dawn of the nuclear era 1994-1995. The entire earth is now contaminated with this element as a result of atmospheric testing of hundreds of nuclear warheads. Fortunately this "background" contamination of soil is quite low with a mean concentration of about 0.04 pCi/g to a maximum of about 0.08 pCi/g in the state of Colorado. This is unfortunately untrue of the Rocky Flats site. Most of the site is contaminated to levels well above background with readings as high as 12,200 pCi/g having been found.

An intensive discussion has taken place over the course of the last few weeks about "action levels" of plutonium concentrations in soil at Rocky Flats. The action level is defined as the level to which soil will be cleaned to be in accord with the cleanup agreement concluded by the DOE, EPA, and the CDPHE.

"Action levels" have been set before. In 1975 the CDH set a level of 1 pCi/g (1 picocurie of Pu per gram of soil = 2 disintegrations per minute per gram of soil). Since the average background is about 0.04 pCi/g, the CDH level was 25 times as high as background.

According to a paper prepared by M. Iggy Litaor, et al in February, 1995, a level called "the programmatic preliminary remediation goal for residential occupancy scenario" was given as 3.8 pCi/g (126 Bqg<sup>-1</sup>).

Since readings of as high as 12,210 pCi/g of soil are reported at Rocky Flats (300,000 times as high as average background), there is no question that cleanup is necessary. The question is how much. Some people have strongly recommended cleanup to background levels. The CDH at one time opted for levels that were 25 times that of average background. The level given in the Litaor paper was 95 times as high as average background.

The EPA, the DOE, and the CDPHE have issued a study that purports to show that soil contamination levels per gram of soil of 651 pCi of Pu 239/240 and also contaminated by 117 pCi of Am-241 produce exposure levels of

85 mrem/yr for residents living on such soil for 8400 hrs/yr. There is also the corollary conclusion that such contaminated soil produces acceptable health effects in families--men, women and children--living on such soils.

The proposed "action level" is 16,000 times as high as background. It is also 700 times as high as the Colorado Department of Health guideline of 1 pCi/gm. The proposed action level is 171 times as high as the one discussed in the Litaor paper of a year ago.

The only real clue that we have of the probable cause of such increases is the concluding sentence of the Litaor paper, before the conclusions: "The cleanup of such a large area (1,469,110 m<sup>2</sup> at 80% probability) (*down to the action level of 3.8 pCi/g--JG Italics*) is probably unrealistic in terms of cost, waste generation, and land reclamation to minimize slope erosion that must follow such a large scale removal of the top soil."

There are no studies cited or costs given to justify this conclusion.

#### Derivation of the Soil Action Level

The latest soil action level of 651 pCi/g is derived by means of a calculation using a computer program called RESRAD. Seventy different inputs must be fed into the program. Based on these inputs a soil action level is derived that purports to give a health exposure of mrem/year. In this case--85mrem/year.

The only reason to resort to this awkward and roundabout method is that the previous action levels produced soil removal requirements that were considered to be too costly. The bias in the direction of producing action levels that are less costly is therefore overwhelming. (I wonder what would have resulted if the calculated action levels were lower than the previously set levels.)

The trouble with the calculated action levels is that elements of the 70 input parameters have large sources of error. It would not take many such errors to produce enormous changes in the final result--producing large increases in the health effects due to soil contamination of 651 pCi/g.

Some of the errors produced by a relatively small number of the seventy parameters is given below. (See items marked 3, 5, 5a and 7.)

### Questions Raised by "Action" Level

1. Is there anywhere on the face of the earth where people in residential areas have been exposed to such concentrations of plutonium and americium in soil? This question is extremely important because such exposure could be used to study the health effects directly and limit much of the anxiety and apprehension of citizens who may be exposed to such levels at Rocky Flats. This question was posed to the DOE but received no direct reply. They cited studies made of other types of exposures such as the victims of the Hiroshima and Nagasaki bomb blasts but did not cite any direct evidence provided by people living on soil contaminated with 651 pCi/g.

2. Has any study ever been made of the health effects of such exposures over a period of years? This question was also answered by the DOE. Since no equivalent exposure could be cited, the health studies cited above plus other exposures that are even further afield were cited.

### 3. Errors Caused by Using Average Concentrations in Health Studies

The concentrations in soil are determined (it is my understanding) by taking averages of soil readings. The following factors cause *understatement* of the health effects:

- a. Using an average soil concentration means that half of the soil area is contaminated with more than 651 pCi/gm. Half the population is exposed to higher levels.
- b. If the distribution of soil concentration readings is normal, there are probably peak concentrations that are three times as high or 2,000 pCi/gm.

A case in point may be found in the paper cited above by Litaor. He gives the results of a study of background Pu levels in soil made by Purtymun et al. The mean level of Pu was  $1.13 \text{ Bq Kg}^{-1}$  but the maximum was  $2.99 \text{ Bq Kg}^{-1}$ --2.7 times as high.

The answer by DOE to this question claimed that the average obtained with

## PLUTONIUM IN SOIL

J. Goldfield

November 15, 1996

### Amount of Plutonium in Soil as Presented September 9, 1996

At a CAB workshop at Westminster, September 9, 1996, a presentation was made, entitled, "Soil Action Levels at Rocky Flats". It was presented jointly by the Colorado Department of Health and Environment, the Department of Energy, and the Environmental Protection Agency. On page 5 of the notes accompanying the presentation there is a bar chart labeled "Plutonium at Rocky Flats". The quantities of major categories of plutonium forms are depicted by bars that are labeled. The height of the bars are in proportion to the amounts given. Of the seven categories depicted, the last bar (so small that it is not shown as a bar) is marked "Soils". Although not specifically stated, it appears to represent  $\frac{1}{100}$  of the plutonium estimated to be in soil. The amount shown is 0.01 kg (10 grams).

The bar chart is attached to this letter.

### Amount of Plutonium in Soil Based on Presentation August 15, 1996

On August 15, 1996, a presentation was made by John Hopkins, RMRS-Environmental Restoration. A number of sites where plutonium contamination in the soil exists were described. Among these were the 903 pad and the Industrial Area. The contamination of the Industrial Area was described in ways that allowed calculations to be made of the amount of plutonium in the soil of that location. That calculation is attached to this letter. From the data presented there is between 2.5 and 7.5 Kg of plutonium in the soil of the Industrial Area. Those quantities are 250 to 750 times as great as the amount given in the September 9, 1996 presentation.

A great deal of the plutonium contamination in the Industrial Area is suspected to be below 15 buildings. Since measurements beneath those

buildings are difficult to make, the contamination under the buildings can only be estimated from measurements made between buildings. We have no detailed data on the measurements made. It is entirely possible that the contamination below the 15 buildings and in the overall Industrial area is being underestimated.

It is important that the soil contamination be removed as quickly as possible, because as time passes the plutonium in the soil will move to other areas as well.

#### Discussion of Soil Contamination Estimates.

The first estimate presented of a total soil contamination of 10 grams for the entire Rocky Flats complex is ludicrous on the face of it. It is disturbing that it was presented by the most important players in the cleanup of the site. As more is learned about the plutonium contamination in all portions of the complex, it is probable that the estimated plutonium contamination will increase. Meanwhile the data that has been presented up to now contains such great disparity that it casts doubt on the entire process for establishing soil action levels.

Is the plutonium in soil at Rocky Flats 0.01 kg or is it 250 to 750 times as great (2.5 to 7.5 kg)? ... or is it much more?

Should the soil action level be 0.04 pCi/g (background), or 1 pCi/g (per the Colorado Department of Health), or 3.8 pCi/g (as per the Iggy Litaor paper), or should it be 651 pCi/g?

## QUANTITY OF PLUTONIUM IN SOIL OF INDUSTRIAL AREA

J. Goldfield

September 26, 1996

### Introduction

In August a presentation on "Radionuclides in Soils at the Rocky Flats Environmental Technology Site" was made by John Hopkins of RMRS-- Environmental Restoration. In the course of that presentation he revealed that the surface soil of the industrial area was contaminated with plutonium to a level of 7000-8000 pCi per gram of soil. 62,000 cubic yards of soil (plus or minus 50%) must be removed to get the surface contamination down to a level of 700-800 pCi/g of soil.

### Total Soil Plutonium

From the information presented a calculation can be made of the estimated quantity of plutonium in the soil to be removed. The only assumption is that the soil weighs 100 pounds per cubic foot.

The calculation is as follows:

$62,000 \text{ cu yds} \times 27 \text{ cu ft/ cu yd} \times 100 \text{ lbs/cu ft} \times 454 \text{ g/lb} \times 7500 \text{ pCi/g} \times 1 \times 10^{-12} \text{ Ci/pCi} \times 16.1 \text{ g Pu/Ci} =$

$6.2 \times 10^4 \times 2.7 \times 10^2 \times 4.54 \times 10^2 \times 7.5 \times 10^3 \times 10^{-12} \times 1.61 \times 10^1$

$= 900 \times 10^{13} \times 10^{-12} = 9000 \text{ grams of plutonium} = 9 \text{ kg of PU}$

7500 pCi/g of soil is the surface concentration. The average concentration in the soil removed is  $(7500 + 750) / 2 = 4125 \text{ pCi/g}$

$4125/7500 \times 9 \text{ kg} = 5 \text{ kg.}$

The volume of soil to be removed is  $\pm 50\%$  (Given by John Hopkins)--

Therefore the total plutonium in the soil is between 2.5 kg and 7.5 Kg.

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# Plutonium at Rocky Flats

