Session 2: Experience with Stakeholder Dialogue in Complex Radiological Protection Situations

“Development of release criteria for contaminated areas: experience from the US Rocky Flats situation”

John E. Till, PhD
Risk Assessment Corporation
The RAC Team
Building Trust and Credibility in Environmental Risk Assessment

- Must be based on data and science
- Must be transparent
- Must be effectively communicated
- Must be earned
- Must go beyond what is expected
Rocky Flats Environmental Technology Site
(2,525 ha ~ 6,240 a)

Denver, 26 km
Arvada, Westminster, Broomfield, 10 km
What is the future of the site?
The Primary Source of Plutonium Was from Leaking Barrels Containing Waste
Another Source of Contamination: 1957 and 1969 Fires

Coal Creek Canyon

Source of Contamination:

1957 and 1969 Fires

Rundle Reservoir

Rocky Flats

Another Source of Contamination:

1957 and 1969 Fires
Plutonium in Soil at the Rocky Flats Site Prior to Cleanup

Bq kg\(^{-1}\)

- < 3.7 (960 ha.)
- > 3.7 - 37 (960 ha.)
- > 37 and < 190 (380 ha.)
- > 190 and < 370 (75 ha.)
- > 370 and < 930 (110 ha.)
- > 930 and < 3,700 (21 ha.)
- > 3,700 and < 9,300 (4.5 ha.)
- > 9,300 and < 53,000 (2 ha.)
- > 53,000 and < 370,000 (1.2 ha.)
- > 370,000 (0.24 ha.)
Study Objective

- To estimate the levels of plutonium and other actinides in soil released from Rocky Flats such that subsequent human exposure during future use of the site does not result in levels of radiation dose that exceed specified limits.

- These activity levels are called Radionuclide Soil Action Levels or RSALs.
Requirements

- Project supported by Citizen’s Advisory Board (Grant provided by DOE)
- 0.15 mSv per year dose constraint
- Unrestricted use of the land
- 1000 year time frame
- Use of available site specific data
- Account for uncertainties
We Did Not Take into Account

- Cost of cleanup
- Risk (operational) associated with cleanup
- Institutional controls
Radionuclide Soil Action Level Oversight Panel
## Soil Action Levels Used at Different Sites

<table>
<thead>
<tr>
<th>Location</th>
<th>Pu-239 soil action level (Bq/kg)</th>
<th>Dose (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanford</td>
<td>1300</td>
<td>0.15</td>
</tr>
<tr>
<td>Nevada Test Site</td>
<td>12,000</td>
<td>0.78</td>
</tr>
<tr>
<td>Johnston Atoll</td>
<td>629</td>
<td>0.20</td>
</tr>
<tr>
<td>Palomares</td>
<td>~45,500</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Exposure Scenarios
## Exposure Scenarios

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Resident rancher</th>
<th>Infant of rancher</th>
<th>Child of rancher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dose constraint (mSv)</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Time on the site (h y⁻¹)</td>
<td>8760</td>
<td>8760</td>
<td>8760</td>
</tr>
<tr>
<td>Time indoors onsite(%)</td>
<td>60</td>
<td>90</td>
<td>75</td>
</tr>
<tr>
<td>Breathing rate (m³ y⁻¹)</td>
<td>10800</td>
<td>1900</td>
<td>8600</td>
</tr>
<tr>
<td>Soil ingestion rate (g y⁻¹)</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Irrigation water source</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Onsite drinking water</td>
<td>na</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Fraction food homegrown</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
\[ RSAL = \frac{D_{\text{lim}}}{DSR} \]

Where:

- \( RSAL \) = radionuclide soil action level
- \( D_{\text{lim}} \) = annual dose limit (0.15 mSv)
- \( DSR \) = dose to source ratio (mSv per Bq kg\(^{-1}\))
The Process

- 18 month schedule
- Monthly meetings
- Workshops to focus on specific issues (uncertainty, scenario parameters, models)
- RSAL panel selected by Citizen’s Advisory Board (scientists and non-scientists)
- Panel had voting authority (majority)
Resuspension of Plutonium Contaminated Soils was a Dominant Pathway
A resuspension rate was determined using data available for plutonium concentration in soil and measurements of plutonium in air.
A Prairie Fire Could Significantly Increase Exposure
Probability Curve

A

50% chance of exceeding dose limit

10% chance of exceeding dose limit (90% chance of not exceeding dose limit)

Soil action level (Bq/kg)
Scenario 1 — Rancher

- Rancher with fire probability = 1

- Rancher with probabilistic fire

- RSAL is about 1300 Bq kg\(^{-1}\) at the 10% level

Probability of exceeding the dose constraint

\[\text{RSAL is about 1300 Bq kg}^{-1}\] at the 10% level

\[\text{239}+\text{240 Pu (Bq kg}^{-1}\)\]
Probability of Exceeding Dose Limit

- **Rancher scenario**
  - Curve A
  - Rancher with probability of fire = 1
- **Child scenario**
  - Curve B
- **RSAL = 1300 Bq/kg**
The Radionuclide Soil Action Level Panel recommended the cleanup level to be implemented at the Rocky Flats Environmental Technology Site be
~ 1300 Bq/kg

The actual level used was
~ 1,800 Bq/kg
Rocky Flats National Wildlife Refuge: An Example of Successful Stakeholder Dialogue in Complex Situations