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The Use of Institutional Controls at Department of Energy Oak Ridge Field Office Environmental Restoration Sites

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FOR THE UNITED STATES
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DISCLAIMER

ABSTRACT

The United States Environmental Protection Agency (EPA), in the National Oil and Hazardous Waste Pollution Contingency Plan (NCP), has determined that institutional controls cannot be applied when determining human health risks from exposure to contaminants present at a hazardous waste site. This report summarizes some of the major issues related to the use of institutional controls at hazardous waste sites under the auspices of the Department of Energy Field Office, Oak Ridge/Environmental Restoration (DOE-OR/ER) Division. In particular, the report addresses the impacts that assumptions regarding institutional controls have on the results and interpretation of the risk assessment, in both the Remedial Investigation (RI) and the Feasibility Study (FS).

Currently, access by the public is prohibited at the majority of hazardous waste sites under the auspices of the DOE-OR/ER Division. Fences, armed security guards, and patrols exclude the public from on-site areas. However, the length of time that the DOE-OR/ER sites will remain under active institutional controls is open to question. The answer might be tens, hundreds, or perhaps thousands of years. We can be reasonably sure that the controls will be in place tomorrow. In the long run, we can also be reasonably certain, in most cases, that the human health risks at the site will diminish through time due to the natural attenuation of contaminants and radioactive decay. But suppose we assume that institutional controls are removed immediately and that a hypothetical family sets up residence on a DOE-OR/ER hazardous waste site tomorrow. Our health risk estimates for that family would be far greater than actual current public risks with institutional controls, and would exceed the

risks that would occur in the more likely event that institutional controls are not removed tomorrow, but in a hundred years.

The issue of institutional controls is having, and will continue to have, a direct impact at DOE-OR/ER sites, both in assessing baseline risks and in selecting feasible remedial action alternatives. Other DOE facilities should expect similar impacts. Institutional control assumptions determine the individual human receptor used to define the reasonable maximum exposure scenario. If the baseline risk assessment considers risks in the absence of institutional controls as the NCP requires, then the reasonable maximum exposure would be defined by a family setting up residence on the hazardous waste sites, conceivably growing crops and raising livestock there. The ultimate magnitude of the resulting hypothetical risk estimate is in many cases likely to be alarmingly high.

The DOE-OR/ER risk assessment program has studied the issues regarding the use of institutional controls and recommends the following approaches:

- Adhere to the NCP's requirement for assessing risks in the absence of institutional controls in the baseline risk assessment.

- Follow EPA's Region IV's definition of industrial and non-industrial sites immediately, and consider the appropriate exposure scenarios under the current and future land use conditions.

- **In addition** to estimating risks in the absence of institutional controls, calculate current risks with institutional controls in place, and future risks when institutional controls are removed.

- For future exposure scenarios, define the period of time over which we expect the institutional controls to remain in place, based on similar approaches used by the radiation regulators.

The DOE-OR/ER risk management program recommends the following actions:

- The issue of institutional controls is of such importance that DOE should immediately correspond with EPA informing them of DOE-OR/ER's current approach and strategy, and requesting written guidance.

- DOE Headquarters should establish a national panel of experts to evaluate a reasonable and consistent approach to institutional controls at the DOE federal sites.

1. PURPOSE

This report summarizes some of the major issues related to the use of institutional controls at hazardous waste sites under the auspices of the Department of Energy Field Office, Oak Ridge/Environmental Restoration (DOE-OR/ER) Division. In particular, the report addresses the impacts that assumptions regarding institutional controls have on the results and interpretation of the risk assessment, both in the Remedial Investigation (RI) and the Feasibility Study (FS). Environmental restoration activities at DOE-OR/ER sites are primarily driven by CERCLA. Therefore, the report focuses on the approaches and assumptions relating to institutional controls under CERCLA. Also the report briefly outlines approaches adopted under other authorities such as RCRA and radiation regulatory authorities (such as NRC regulations/guidance, DOE orders, and EPA standards) in order to contrast these approaches to those adopted under CERCLA. In order to demonstrate the implications of the use of institutional controls at DOE facilities, this report summarizes the approaches and results of the recent baseline risk assessment for Solid Waste Storage Area 6 at Oak Ridge National Laboratory. The report concludes with possible options on the use of institutional controls at DOE-OR/ER sites.

2. DEFINITION

Institutional controls at hazardous waste sites are remedial response actions that mitigate health risks by limiting human activities or access to the site. Institutional controls do not involve reduction of the toxicity, volume, or mobility of the hazardous waste (although they may be used in conjunction with actions that do involve such reductions). Institutional controls act by physically restricting land-use of the site; for example, by erecting and maintaining fences with security guards, patrols, and warning signs. They may also involve

legal land/resource restrictions such as deed restrictions, deed notices, well-drilling prohibitions, well-use advisories, and building permits.

3. IMPLICATIONS

Currently, access by the public is prohibited at the majority of hazardous waste sites under the auspices of the DOE-OR/ER Division. Fences, armed security guards, and patrols exclude the public from on-site areas. However, the length of time that the DOE-OR/ER sites will remain under active institutional controls is open to question. The answer might be tens, hundreds, or perhaps thousands of years. We can be reasonably sure that the controls will be in place tomorrow. In the long run, we can also be reasonably certain, in most cases, that the human health risks at the site will diminish through time due to the natural attenuation of contaminants and radioactive decay. But suppose we assume that institutional controls are removed immediately and that a hypothetical family sets up residence on a DOE-OR/ER hazardous waste site tomorrow. Our health risk estimates for that family would be far greater than actual current public risks with institutional controls, and would exceed the risks that would occur in the more likely event that institutional controls are not removed tomorrow, but in a hundred years.

The residential risk exercise just described, although hypothetical, is not a futile one. If hypothetical risks to an on-site resident are unacceptable, then this argues strongly that DOE-OR/ER should keep in place the very active institutional control mechanisms that prevent those risks from actually occurring. The danger lies in the fact that estimates resulting from this risk assessment approach may mislead and overly distress the general public. There may be a perception amongst the general public that they are actually subjected to the risk level estimates generated by the exercise.

4. INSTITUTIONAL CONTROLS UNDER CERCLA

4.1. Institutional Controls and the Baseline Risk Assessment

According to the National Contingency Plan (NCP), which implements the regulatory requirements established under CERCLA, the baseline risk assessment must consider risk in the absence of any institutional controls (NCP, section 300.430 (d))[1]. The baseline risk assessment should address the potential land use associated with the highest level of exposure and risk. Because DOE-OR/ER sites currently have institutional controls in place, this means that the baseline risk assessment must consider an assumed future land use condition in which one cannot exclude the possibility that a family takes up residence on the sites. However, the NCP does concede that the assumption of future residential land use may not be justifiable if there is only a small probability that the site will support such use. Where the future land use is unclear, risks associated with residential land use should be compared to risks associated with other land uses, such as industrial, recreational, agricultural, etc.

EPA Region IV also have issued a baseline risk assessment guidance memorandum that addresses the exposure scenarios to be assessed under current and future land use conditions[2]. The directives are summarized as follows.

Instead of attempting to define an institutional control period, EPA Region IV has provided instructions to divide exposure scenarios into current and future land use (with no mention of the time frame, i.e., when the "future land use" will occur). Table 1 shows that the exposure scenarios to be considered also depend on whether the site is defined as industrial or non-industrial. EPA Region IV defines industrial sites as strictly buildings and their associated infrastructure. This definition of an industrial site means that a large

Table 1. Land use assumptions for baseline risk assessments - from EPA Region IV Baseline Risk Assessment Guidance

Type of site	Current Land Use	Future Land Use
On-site non-industrial[a,b]		
	Off-site residential	On-site residential
	On-site occupational[c]	
	Inadvertent intruder	
On-site industrial		
	Off-site residential	Off-site residential
	On-site occupational	On-site occupational
	Inadvertent intruder	Inadvertent intruder

[a] "on-site" means those areas that are fenced and patrolled
[b] "industrial" sites are strictly buildings and their associated infrastructure
[c] the on-site worker is a worker not involved with the investigation and remediation of the site

number of the DOE-OR/ER hazardous waste sites will be considered non-industrial. Therefore, under the future land use condition, the baseline risk assessment must use the on-site residential "homesteader" scenario. Furthermore, this assessment under the future land use condition must consider exposures to current contaminant concentrations, even though these concentrations are likely to decrease through time due natural attenuation and radioactive decay.

4.2. Institutional Controls and the Feasibility Study

During the Feasibility Study, remedial action alternatives are developed, screened, and analyzed with respect to their ability to protect human health and the environment and other criteria, so that decision makers can select the appropriate alternative for the site. The NCP describes a number of expectations related to the role of institutional controls in selecting the remedial alternative[1]. The NCP states that institutional controls may be used as a supplement to engineered controls but may not substitute for Active Response Measures (ARMs) unless 1) ARMs are not practicable, as determined by remedy selection criteria, or 2) institutional controls are the only means available to provide protection of human health [NCP, sections 300.430(a)1(iii)(d) and 300.430(e)3(ii)]. If institutional controls are used as a sole remedy, the special precautions must be taken to ensure institutional controls will remain reliable and in place.

Public comment on the NCP urged an expanded role for institutional controls if they could provide a similar level of protection at lower costs (particularly for federal sites). However, the EPA disagreed and refused enhancement or enlargement of the role of institutional controls[1].

5. INSTITUTIONAL CONTROLS UNDER OTHER AUTHORITIES

5.1. RCRA

RCRA does not explicitly acknowledge the use of institutional controls in the RCRA Facility Investigation, although the permitting requirements generally include a 30-year post-closure active control period. The RCRA process involves setting media cleanup target levels at a point of compliance that is negotiated early in the process. RCRA does allow remedial action alternatives that include measures that are not directly related to media clean-up, source control or waste management (e.g., measures to control exposures) as long as the alternative is protective of human health and the environment, reduces or eliminates further releases, and complies with management standards[3].

5.2. Radiation Regulatory Authorities

Radiation-specific regulations are more explicit and tolerant about the use of institutional controls than are CERCLA or RCRA. Radiation requirements for the disposal and management of waste generally involve setting acceptable doses to the public and equivalent concentrations that are calculated assuming a given period of institutional control[4]. We describe specific regulations and associated institutional control periods below, and summarize them in Table 2.

5.2.1. NRC regulations/guidance

The NRC Part 61 requirements for the near-surface disposal of radioactive waste identify three classes of radioactive waste[5]. The concentration limits depend on specific disposal requirements and assumed scenarios for inadvertent intrusion for the different

Table 2. Assumed periods of institutional control under different radiation regulatory authorities.

Standard	Type of Facility	Assumed Period of Institutional Control
NRC Part 61[5]	Near-surface disposal of radioactive waste	Class C waste: 100 years active control 400 years passive control Class A and B waste: 100 years active control
DOE Order 5820.2A[6]	Near-surface disposal of low level waste	100 years active control
EPA CFR Part 191[7,8]	Groundwater protection standards for disposal of high level waste	1,000 years (no direct intrusion)[7] 1,000 or 10,000 years (no direct intrusion)[8]

classes. Waste with the highest activities are designated as Class C waste. For these wastes, an active institutional control period of 100 years is assumed. After 100 years, it is assumed that active institutional controls are removed and the public may intrude on the site, but that the specific requirements for disposal of Class C waste (capping, burial at depths below 5m) prevent direct exposure for an additional 400 years.

An active institutional control period of 100 years is also assumed for Class A and B wastes. However, because of their lower activities, there are no specific disposal requirements that would prevent direct exposure after institutional controls are terminated.

5.2.2. DOE orders

DOE Order 5820.2A for the management of low level waste specifies limits on annual doses for inadvertent intruders after loss of active institutional controls at 100 years after disposal[6].

5.2.3. EPA standards for disposal of high level radioactive waste

The EPA 40 CFR Part 191 groundwater protection requirements for management and disposal of spent nuclear fuel, high-level and transuranic waste set annual dose limits and concentration limits for 1000 years after disposal, assuming undisturbed performance (e.g., no direct human intrusion)[7]. However, the First Circuit Court vacated these requirements, finding them arbitrary in limiting the duration of the requirement to 1000 years. The EPA apparently plans to propose alternative time periods of 1000 and 10,000 years for the application of the requirements[8].

6. CASE STUDY: SWSA 6

Solid Waste Storage Area 6 (SWSA 6) is part of Waste Area Grouping VI at the Oak Ridge National Laboratory (ORNL). SWSA 6 is approximately 2.9 km southwest of the ORNL Main Plant, covers an area of 15 acres, and occupies most of the total acreage of WAG VI (Fig. 1). Since 1969, low level radioactive and chemically hazardous wastes from operational and research activities conducted at ORNL have been deposited at SWSA 6. These include contaminated soil, laboratory equipment, protective clothing, mechanical equipment, construction materials, filter media and resins, radioactive waste, and animal remains. Packaging of wastes ranged from no packaging to stainless steel drums. Since May 1986, radioactive wastes have been stored in underground concrete silos.

SWSA 6 is fenced and regularly patrolled by armed security guards. There is no public access. The entrance is continually guarded and access is limited to ORNL employees with clearance for entering the specific area.

Table 3 shows the exposure scenarios that were used in the baseline risk assessment. The assessment included an off-site residential exposure scenario -- the "off-WAG Clinch River Homesteader" in Table 3. The hypothetical homesteader was placed beside the Clinch River, 9.5 miles downstream of the site, adjacent to the boundaries of the Oak Ridge Reservation. This scenario was used to provide a measure of the potential public risks posed by the site with the current instituional controls in place. Current risk estimates for this scenario were on the order of 10^{-5}, primarily due to external exposure to cesium-137 in the soil[9]. The current institutional controls apparently are effective in reducing public risks from the site to levels that are within the EPA's acceptable risk range.

Figure 1. Solid Waste Storage Area 6 10

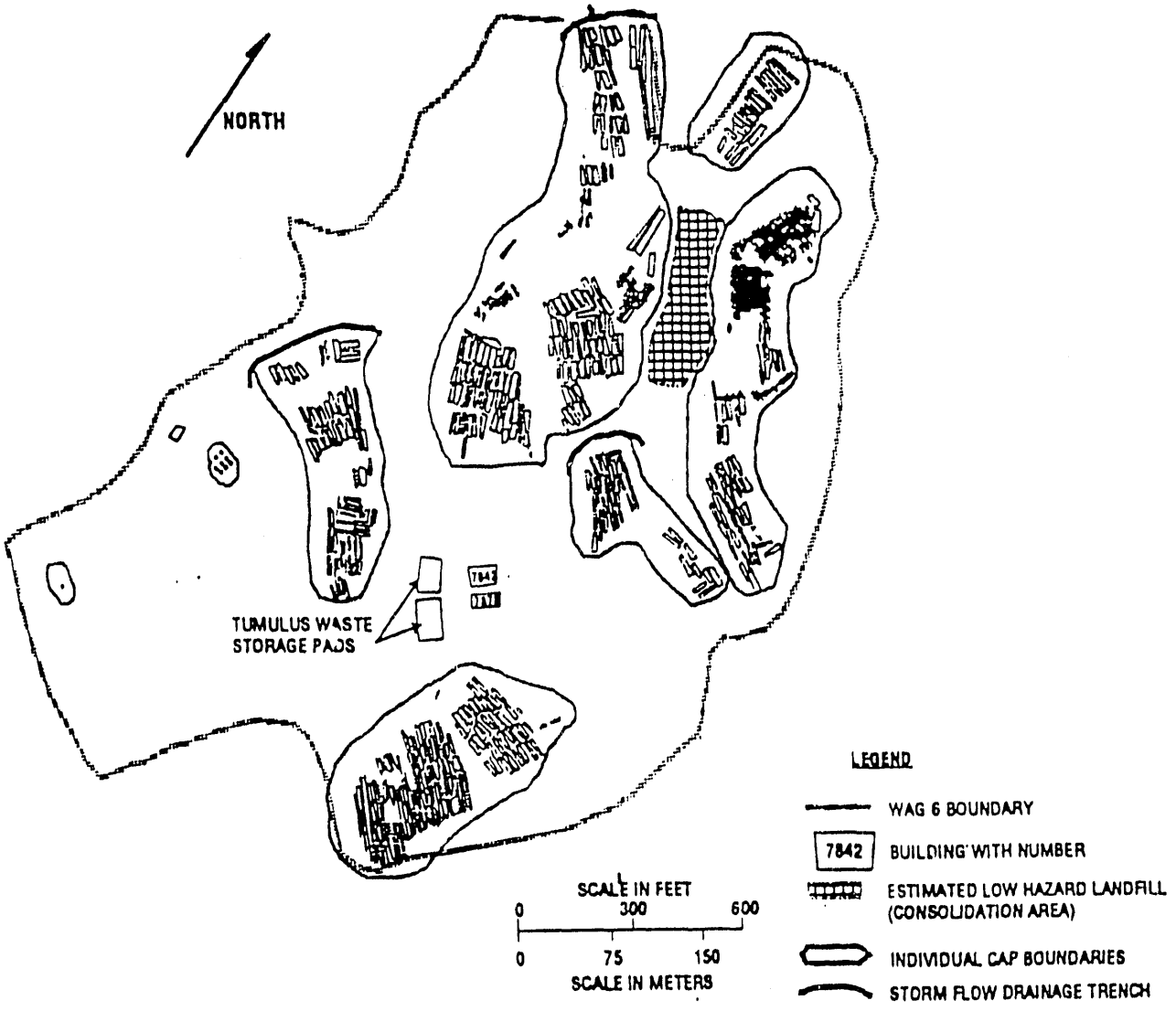

Table 3. Significant SWSA 6 receptor scenarios.

POTENTIAL RECEPTORS	PERIOD OF INSTITUTIONAL CONTROL		
	CONTROLLED (OPERATIONAL: 0-10 YR & POST-OPERATIONAL:>10-110 YR)		UNCONTROLLED [1] (NON-OPERATIONAL>110 YR)
	ON-WAG	OFF-WAG	WAG 6 AREA
WAG 6 BOUNDARY-HUNTER RECEPTOR [2]		· INGESTION-FAUNA (R,C)	
WAG 6 BOUNDARY-FENCEPOST RECEPTOR [2]		· INHALATION-AIR (R,C) · DIRECT RADIATION-SOIL (R)	
WAG 6 ORNL EMPLOYEE [3]	· INHALATION-AIR (4)(R,C) · DIRECT RADIATION-SOIL (R)		
ON-WAG HOMESTEADER [5]	· DIRECT RADIATION-SOIL (R) · INHALATION-AIR, GW (R,C) · INGESTION-GW,BIOTA (R,C) · INCIDENTAL INGESTION-SOIL, SW,SEDIMENT (R,C)		· DIRECT RADIATION- SOIL (R) · INHALATION-AIR, GW (R,C) · INGESTION-GW,BIOTA (R,C) · INCIDENTAL INGESTION-SOIL, SW,SEDIMENT (R,C)
OFF-WAG CLINCH RIVER HOMESTEADER [5][6]		· DIRECT RADIATION- SOIL (R) · INHALATION-AIR (7)(R,C) · INGESTION-SW,BIOTA (R,C) · INCIDENTAL INGESTION-SOIL, (R,C)	

KEY: GW = GROUNDWATER
SW = SURFACE WATER
R = ASSESSED FOR RADIONUCLIDE COMPONENTS
C = ASSESSED FOR CHEMICAL COMPONENTS

1 = WAG 6 AREA IN UNCONTROLLED PERIOD, NO WAG BOUNDARIES EXIST.

2 = THE BOUNDARY RECEPTORS (DEER HUNTER AND FENCEPOST RECEPTOR) ARE PRESENT ONLY IN AREAS THAT ARE NOT CONTIGUOUS WITH OTHER WAGS (I.E., WAG 2); FOR WAG 6 THIS INCLUDES AREAS TO THE WEST AND NORTH OF THE WAG; THERE ARE NO SURFACE WATER DRAINAGES EXITING THE WAG FROM THESE AREAS, THEREFORE NO SURFACE WATER/SEDIMENT EXPOSURES ARE ANTICIPATED FOR THIS RECEPTOR.

3 = ASSUME NORMAL WORKING CONDITIONS AND NO ACCIDENT SCENARIOS.

4 = INCLUDES INHALATION OF VOLATILES AND PARTICULATES FOR ALL AIR EXPOSURE ROUTES.

5 = IN ADDITION TO THE TIME FRAMES INDICATED, MAXIMUM CONCENTRATIONS ASSOCIATED WITH THE IDENTIFIED EXPOSURE ROUTES AND THE YEAR THEY OCCUR WILL ALSO BE PROVIDED.

6 = OFF – ORR (OAK RIDGE RESERVATION) RECEPTOR LOCATED DOWNSTREAM FROM WAG 6 NEXT TO CLINCH RIVER. INCLUDES CONTAMINATION TO SPECIFIC MEDIA THROUGH IRRIGATION USING CONTAMINATED CLINCH RIVER SURFACE WATER.

7 = ASSESSED FOR TRITIUM ONLY.

As required under CERCLA, the baseline risk assessment also included an evaluation of risk in the absence of institutional controls. Thus, the risk assessment included an on-site residential exposure scenario -- the "on-WAG homesteader" scenario in Table 3. Using estimates of current contaminant levels, the main source of risk for this hypothetical exposure scenario was from external exposure to europium-154 while excavating the soil to build the house. Estimates of current risk from this pathway alone approached unity (i.e., almost a 100% probability of developing cancer). Estimates of risk 110 years later for the same pathway and for europium-154 alone were similar to current risk estimates, but risks 500 years later had essentially disappeared due to the radioactive decay of europium-154. (Risks from other pathways and contaminants were on the order of 10^{-3} after 500 years.) Clearly, this case study suggests that the DOE should keep active institutional control measures in place for at least 500 years.

7. IMPACTS OF INSTITUTIONAL CONTROL AT DOE FACILITIES

The issue of institutional controls is having, and will continue to have, a direct impact at DOE-OR/ER sites, both in assessing baseline risks and in selecting feasible remedial action alternatives. Other DOE facilities should expect similar impacts. Institutional control assumptions determine the individual human receptor used to define the reasonable maximum exposure scenario. If the baseline risk assessment considers risks in the absence of institutional controls as the NCP requires, then the reasonable maximum exposure would be defined by a family setting up residence on the hazardous waste sites, conceivably growing crops and raising livestock there. The ultimate magnitude of the resulting hypothetical risk estimate is in many cases likely to be alarmingly high, as the SWSA 6 case study shows.

However, the concept of assessing baseline risks in the absence of institutional controls is a valid one. The assessment predicts what possible risk levels could be if the current institutional controls were to be removed. However, it is important that the general public are not given the impression that they are actually subjected to the estimated risk levels. Therefore, DOE-OR/ER risk assessments should also include an assessment of risks with the present institutional controls (fences, guards, patrols, etc.) in place, as well as future risks when the institutional controls are removed after some period of time. For the assessment of future risks, one needs to define the period of time over which we expect the institutional controls to remain in place, as the radiation regulators have done. In general, the longer the time period, the lower the eventual risks when controls are removed because of natural attenuation of contaminants and radioactive decay.

The role of institutional controls in selecting feasible alternatives will also have an impact at DOE-OR/ER and other DOE sites. The NCP emphasizes the use of engineered alternatives for remediation. Institutional controls are intended to supplement, but not replace, such active response measures. However, perhaps the current institutional control measures at DOE-OR/ER sites are more effective in terms of overall protection of human health and the environment than are present-day engineering technologies. The SWSA 6 case study suggests that an appropriate period of institutional controls would be on the order of 500 years due to the presence of long-lived radionuclides.

8. CURRENT DOE-OR/ER APPROACHES

The DOE-OR/ER risk assessment program has discussed these issues and recommends the following approaches.

1. Adhere to the NCP's requirement for assessing risks in the absence of institutional controls in the baseline risk assessment. Follow EPA's Region IV's definition of industrial and non-industrial sites (Table 1) immediately, and consider the appropriate exposure scenarios under the current and future land use conditions as summarized above. Under the future land use condition for non-industrial sites, the on-site resident homesteader will hypothetically be exposed to the current contaminant concentrations in most cases. However, if fate and transport models predict that contaminant concentrations may increase through time, then the predicted concentrations would be used rather than the current concentrations. All exposure scenario assumptions will be qualified in the "uncertainties" section of the baseline risk assessment.

2. **In addition** to estimating risks in the absence of institutional controls, calculate current risks with institutional controls in place, and future risks when institutional controls are removed. Under the future land use condition, use fate and transport models to provide realistic estimates of future exposures. Present collectively in the baseline risk assessment all risk estimates for the different exposure scenarios along with assessments of the likelihood of the scenarios occurring.

3. For future exposure scenarios define the period of time over which we expect the institutional controls to remain in place based on similar approaches used by the radiation regulators. Time periods could be developed on a generic basis or they could be determined on a site-specific basis, but they must be fully justified.

4. The issue of institutional controls is of such importance that DOE should immediately correspond with EPA informing them of DOE-OR/ER's current approach and strategy, and requesting written guidance.

5. DOE Headquarters should establish a national panel of experts to evaluate a reasonable and consistent approach to institutional controls at the DOE federal sites. The panel will evaluate the reasonableness of EPA's approaches for the baseline risk assessment. The panel will also discuss the use of institutional controls as a component of the remedial alternatives developed at DOE-OR/ER sites. In addition, the panel will consider the validity of problems involved with DOE's stewardship authority of lands and facilities for periods longer than 100 years. Because the presence of long-lived radionuclides at many of the DOE-OR/ER sites means that 100 years will not be sufficient, as the SWSA 6 case study shows, DOE has two alternatives:

   A) Examine the DOE's authority to commit to perpetual stewardship/guardianship of the sites.

   B) Propose alternative time periods for DOE's commitment to keeping institutional controls in place. Time periods could be developed on a generic basis or they could be determined on a site-specific basis.

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