

A STRATEGIC FRAMEWORK FOR COST-EFFECTIVE GROUND WATER PROGRAM COMPLIANCE

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ABSTRACT:

The approach is to select strategies that ensure protections of human health and the environment by achieving compliance with US Environmental Protection Agency ground water standards at sites while maximizing cost-effectiveness. The framework is a risk-based decision-making process; each step considers protections of public health and the environment in determining the appropriate strategy to meet ground water protection standards. The framework considers ground water compliance decisions is a step-by-step approach, beginning with consideration of a “no remediation” strategy and proceeding, if necessary, to the passive strategy, such as natural attenuation with compliance monitoring and institutional controls, and then to a more complex, active ground water cleanup method, such as pump and treat or other engineered approaches to cleaning up contaminated ground water. This approach has lowered projected program compliance costs by an order of magnitude and elements of this approach may be applicable to other ground water compliance programs.

BACKGROUND:

On November 8, 1978, Congress enacted the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, Public Law, codified at 42 USC § 7901 et seq. Congress found that uranium mill tailings “... may pose a potential and significant radiation health hazard to the public, and that every reasonable effort should be made to provide for stabilization, disposal, and control in a safe, and environmentally sound manner of such tailings in order to prevent or minimize other environmental hazards from such tailings.” Congress authorized the Secretary of Energy to designate inactive uranium processing sites for remedial action by the U.S. Department of Energy (DOE). Congress also directed the U.S. Environmental Protection Agency (EPA) to set the standards to be followed by the DOE for this process of stabilization, disposal, and control.

On January 5, 1983, EPA published standards (40 CFR Part 192) for the disposal and cleanup of residual radioactive materials. On September 3, 1985, the U.S. Court of Appeals for the Tenth Circuit set aside and remanded to EPA the ground water provisions of the standards. The EPA proposed new standards to replace remanded sections and changed other sections of 40 CFR Part 192. These proposed standards were published in the *Federal Register* on September 24, 1987 (52 FR 36000). Section 108 of the UMTRCA requires that DOE comply with EPA’s proposed standards in the absence of final standards. The Ground Water Project was planned under the proposed standards. On January 11, 1995, EPA published the final rule, with which the DOE must now comply. The PEIS and the Ground Water Project are in accordance with the final standards. The EPA reserves the right to modify the ground water standards, if necessary, based on changes in EPA drinking water standards. Appendix A contains a copy of the 1983 EPA ground water compliance standards, the 1987 proposed changes to the standards, and the 1995 final rule.

Under UMTRA, DOE is responsible for bringing the designated processing sites (Figure 1) into compliance with the EPA ground water standards and complying with all other applicable standards and requirements. The U.S. Nuclear Regulatory Commission (NRC) must concur with DOE's actions. States are full participants in the process. The DOE also must consult with any affected Indian tribes and the Bureau of Indian Affairs.

Uranium processing activities at most of the inactive mill sites resulted in the contamination of ground water beneath and, in some cases, downgradient of the sites. This contaminated ground water often has elevated levels of constituents such as but not limited to uranium and nitrates. The purpose of the UMTRA Ground Water Project is to eliminate or reduce to acceptable levels the potential health and environmental consequences of milling activities by meeting the EPA ground water standards.

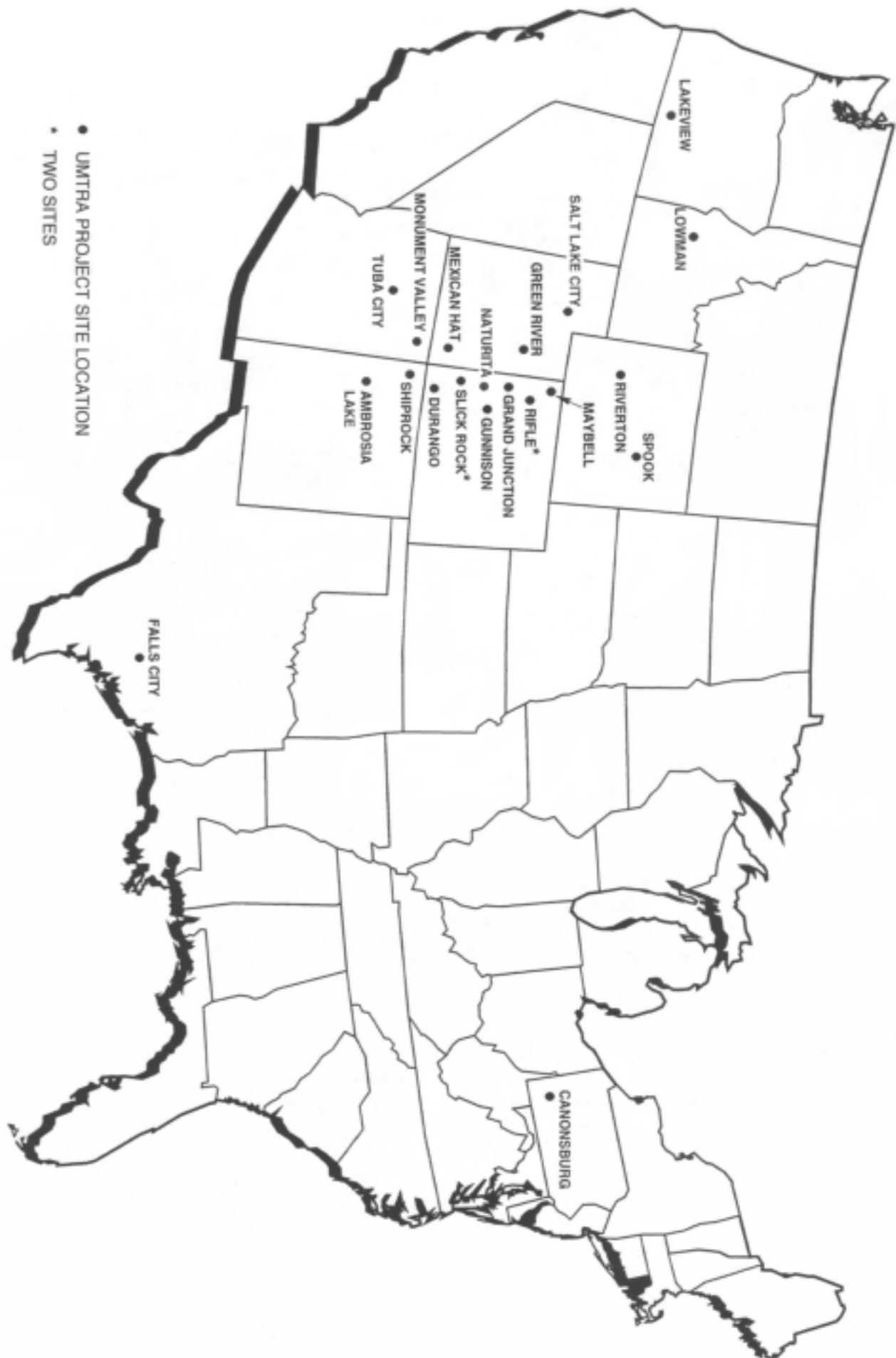


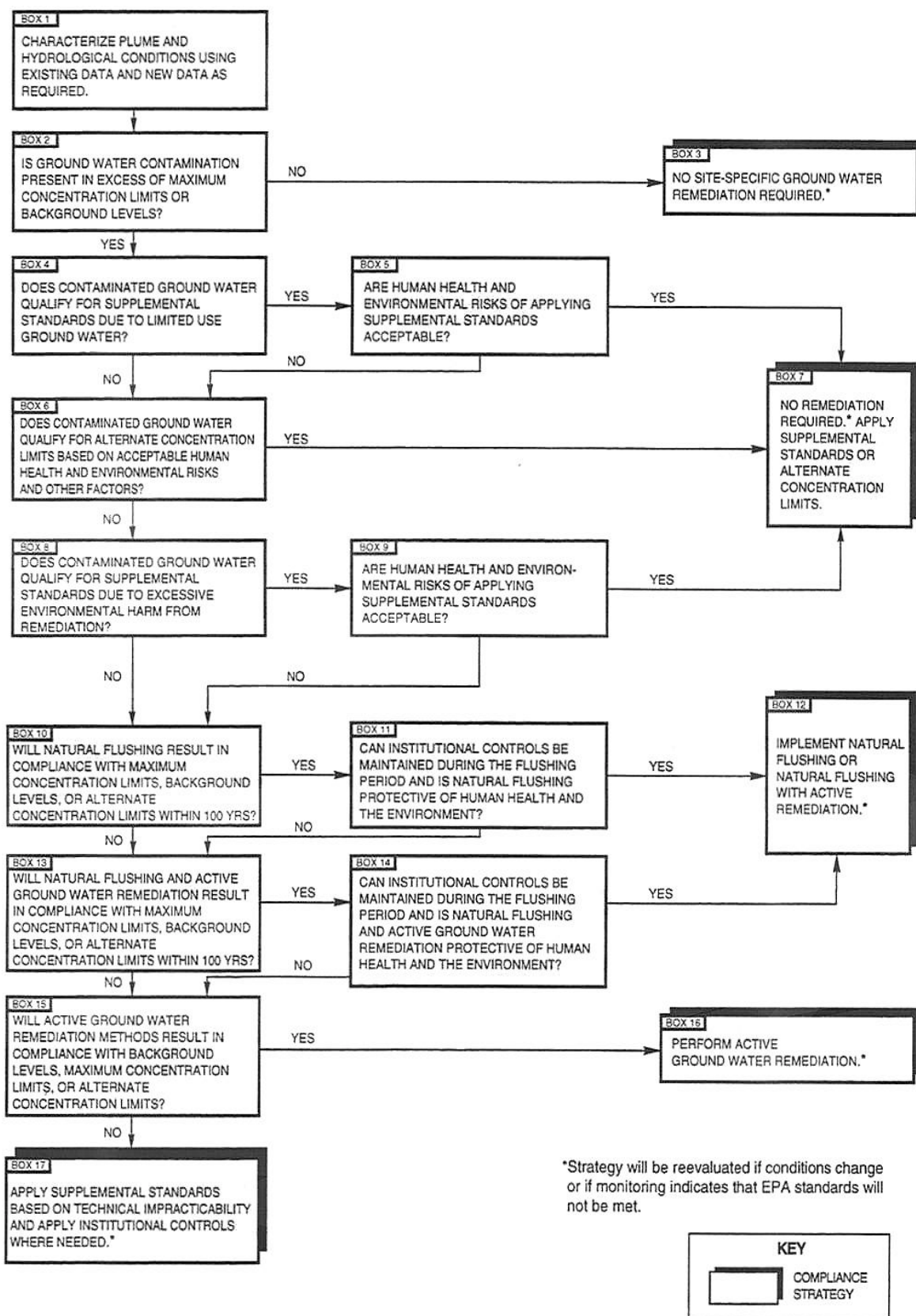
FIGURE 1

APPROACH:

Application of this approach results in the selection of a ground water compliance strategy tailored for each site to achieve conditions that are protective of human health and the environment. The approach considers the full range of ground water compliance strategies in a step-by-step approach, beginning with consideration of the “no remediation” strategy and proceeding, if necessary, to natural flushing with compliance monitoring and institutional controls, and to a more complex, active ground water cleanup methods, such as pump and treat or other engineered approaches to cleaning up contaminated ground water. For example, if a site risk assessment and site observational work plan indicate that the strategy of “no remediation” would be in compliance with the EPA standards and be protective of human health and the environment, a more complex strategy involving active cleanup methods would not be necessary.

The approach is intended to establish a consistent risk-based framework for implementing the UMTRA Ground Water Project and determining appropriate ground water compliance strategies at the UMTRA Project former processing sites. The determination of site-specific ground water compliance strategies would take into account site-specific ground water conditions; human and environmental risks, participation of the tribes, states, and local communities; and cost. This approach is sufficiently flexible to allow for interim actions, such as an alternate water supply system, should these activities be necessary in order to reduce risk and/or support institutional controls. The approach also allow the consideration of new ground water cleanup methods that become available.

The approach uses a logic framework to identify the appropriate ground water compliance strategy or strategies for a site (figure 2). Each step in the decision process considers meeting the EPA standards and the protection of public health and the environment in determining the appropriate ground water compliance strategy.



The first step in the decision process would be to determine if the uranium processing activities at a specific site have resulted in ground water contamination exceeding background levels or maximum concentration limits. If ground water contamination has not exceeded these standards and is not expected to, remediation would not be required.

If ground water has been contaminated by uranium processing activities and the contamination exceeds background levels or maximum concentration limits, the next step would be to determine if compliance with the EPA ground water standards could be achieved by applying supplemental standards based on the existence of limited use ground water. (Refer to Appendix A for a discussion of supplemental standards.) If limited use ground water were shown to exist and if supplemental standards were protective of human health and the environment, so site-specific remediation would be required. If supplemental standards based on limited use were not protective, the next step would be to determine whether alternate concentration limits would apply. (Refer to Appendix A for a discussion of alternate concentration limits.) If alternate concentration limits were protective of human health and the environment, alternate concentration limits would be applied. If not, it would be necessary to determine whether the contaminated ground water plume would qualify for supplemental standards based on the criterion that remediation would cause more environmental harm than benefit. At some sites where supplemental standards or alternate concentration limits may be applied, ground water monitoring and institutional controls may be required to ensure that the application of alternate concentration limits or supplemental standards would continue to be protective of human health and the environment. In addition, when limited use ground water applies, supplemental standards “shall ensure that current and reasonably projected use of the affected ground water are preserved” (60 FR 2854). The use of supplemental standards would be determined on a site-by-site basis and the DOE would abide by the EPA ground water standards when proposing the use of supplemental standards. All proposed supplemental standards would require NRC concurrence.

If supplemental standards would not be protective, the next step would be to determine whether natural flushing would bring the contaminated ground water into compliance (i.e., within maximum concentration limits, background levels, or alternate concentration limits) within 100 years. Natural flushing is a ground water remediation strategy by which natural ground water processes result in compliance with the EPA ground water standards. (Refer to Appendix A for a discussion of EPA standards related to natural flushing.) Natural flushing could be used if it were determined that institutional controls could be implemented, maintained, and enforced during the natural flushing period; that this strategy was protective of human health and the environment; and that all other conditions, as described in Appendix A are met.

If natural flushing would not be protective, it would be necessary to determine whether natural flushing combined with active remediation methods would meet the EPA ground water standards and would be protective of human health and the environment. If so, this two-part strategy would be implemented. When combined with natural flushing, active remediation methods could be used for a short time to remove the most contaminated ground water that may occur in a restricted area; then natural flushing would be applied. Another option would be to use low-

operation and low-maintenance active methods, such as gradient manipulation or geochemical barriers, in conjunction with natural flushing.

Site characterization data may show that natural flushing combined with active remediation would not result in ground water quality that is protective of human health and the environment. That being the case, the next step in the framework would be to determine if active ground water remediation techniques would meet the EPA ground water standards and, if so, to implement these techniques. Several methods of active ground water remediation could be used, including gradient manipulation, ground water extraction, and *in situ* ground water treatment. The active remediation methods could be used individually or in combination with other cleanup methods. If active remediation resulted in compliance with the EPA standards, remedial action would be complete. If these methods did not result in compliance, supplemental standards based on technical impracticability of remediation would be applied, along with institutional controls where necessary.

APPENDIX A

The UMTRCA requires that EPA promulgate standards for protecting public health, safety, and the environment from radiological hazardous constituents associated with the processing, possession, transfer, and disposal of residual radioactive materials. The UMTRCA and EPA define residual radioactive materials as tailings and other wastes that DOE determines to be radioactive that have resulted from uranium ores processing. These wastes may be in the form of tailings or other materials such as demolition debris and nonradiological hazards associated with residual radioactive materials. EPA has interpreted this definition to include sludges and captured contaminated water from the processing sites (60 FR 2854).

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The EPA standards have three subparts that apply to the UMTRA Project: Subpart A, Subpart B, and Subpart C.

Subpart A - Standards for residual radioactive materials

Subpart A, "Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites," addresses control or disposal of the residual radioactive materials at processing or disposal sites. Compliance with Subpart A is being met under the UMTRA Surface Project. This subpart is not discussed further in the PEIS.

Subpart B - Background levels, maximum concentration limits, alternate concentration limits, monitoring, natural flushing

Subpart B, "Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites," requires conducting remedial action at processing sites to ensure that the amounts of residual radioactive materials and associated hazardous constituents in ground water do not exceed any one of the following three standards in 60 FR 2854:

Background levels for these constituents

Maximum concentration limits--EPA's maximum concentration of certain hazardous constituents for ground water protection. Hazardous constituents with maximum concentration limits that may be present in contaminated ground water at UMTRA Project

sites include arsenic, barium, cadmium, chromium lead, mercury, molybdenum, nitrate, radium, selenium, silver, and uranium.

Alternate concentration limits--concentrations of contaminants that may exceed the maximum concentration limits; or, limits for those constituents without maximum concentration limits. If DOE determines, and NRC concurs, that human health and the environment would not be adversely affected, DOE may meet an alternate concentration limit.

Subpart B also defines limited use ground water. Ground water may be classified as limited use if the total dissolved solids exceed 10,000 milligrams per liter (mg/L); there is widespread surrounding contamination that cannot be cleaned up using treatment methods reasonably employed in public water supply systems; or the quantity of ground water available is less than 150 gallons (gal) (570 liters[L]) per day.

Subpart B also has provisions that allow natural flushing as a way to meet the EPA ground water standards. Natural flushing means letting natural ground water processes reduce the contamination in ground water to background levels, below the maximum concentration limits, or to alternate concentration limits. The following conditions must be met before natural flushing can be implemented:

Natural flushing must allow standards (background levels, maximum concentration limits, or alternate concentration limits) to be met within 100 years.

Institutional controls with a high degree of permanence that will effectively protect public health and the environment, and satisfy beneficial uses of ground water must be viable and enforceable (a description of institutional controls is provided below).

Ground water must not be a current or projected source for a public water system during the period of natural flushing. A public water system is defined in 40 CFR § 125.58 as a “system for the provision to the public of piped water for human consumption, if such system has at least fifteen (15) service connections or regularly serves at least twenty-five (25) individuals. This term (public water system) includes 1) any collection, treatment, storage, and distribution facilities under the control of the operator of the system and used primarily in connection with the system; and 2) any collection of pretreatment storage facilities not under the control of the operator of the system which are used primarily in connection with the system.”

Subpart B also requires that DOE monitor the ground water contamination for compliance with Subpart B standards and define the extent of ground water contamination so that measures can be taken, if necessary, to protect human health and the environment.

The EPA standards specify a point of compliance for disposal of the surface contamination but indicate that this does not suffice for the cleanup of contaminated ground water. For the Ground Water Project, “compliance must be achieved anywhere contamination above the levels

established by these standards is found or projected to be found in ground water outside the disposal area and its cover” (60 FR 2854).

Subpart C - Implementation

Subpart C, Implementation, provides guidance for implementing methods and procedures that will reasonably assure the public that the provisions of Subparts A and B are satisfied. The conditions of Subpart B should be met on a site-specific basis, using information gathered from site characterization and monitoring. The plan to meet the conditions of Subpart B should be stated in the compliance strategy document or remedial action plan. This plan should also consider future ground water plume movement. If natural flushing is the selected compliance strategy, Subpart C requires compliance monitoring to verify anticipated plume movement and the associated reduction in plume contamination. Finally, the plan should specify details of the method to be used to meet the standards and, if necessary, the remedial action.

Supplemental standards

Subpart C specifies eight conditions for which DOE may apply supplemental standards to contaminated ground water. These standards are supplemental to background levels, maximum concentration limits, or alternate concentration limits. Supplemental standards as cited below in 40 CFR § 192.21 may be applied if any one of the following conditions is met:

- a) Remedial actions required to satisfy Subpart A or B of the standards would pose a clear and present risk of injury to workers or to members of the public, notwithstanding reasonable measures to avoid or reduce risk.
- b) Remedial actions to satisfy the cleanup standards for land and ground water, notwithstanding reasonable measures to limit damage, would directly produce health and environmental harm that is clearly excessive compared to the health and environmental benefits, now or in the future. A clear excess of health and environmental harm is harm that is long-term, manifest, and grossly disproportionate to health and environmental benefits that may reasonably be anticipated.
- c) The estimated cost of remedial action to meet the standards at a “vicinity site is unreasonably high relative to the long-term benefits, and the residual radioactive materials do not pose a clear present or future hazard. The likelihood that buildings will be erected or that people will spend long periods of time at such a vicinity site should be considered in evaluating this hazard. Remedial action will generally not be necessary where residual radioactive materials have been placed semi-permanently in a location where minor quantities of residual radioactive materials are involved. Examples are residual radioactive materials under hard surface public roads and sidewalks, around public sewer lines, or in fence post foundations. Supplemental standards should not be applied at such sites, however, unless individuals are likely to be exposed for long periods of time to radiation from such materials at levels above those that would prevail under the standards.
- d) The cost of a remedial action for cleanup of a building under the standards is clearly unreasonably high relative to the benefits. Factors that should be included in this judgment

are the anticipated period of occupancy, the incremental radiation level that would be affected by the remedial action, the residual useful lifetime of the building, the potential for future construction at the site, and the applicability of less costly remedial methods than removal of residual radioactive materials.

- e) There is no known remedial action.
- f) The restoration of ground water quality at any designated processing site is technically impracticable from an engineering perspective.
- g) The ground water is not a current or potential source of drinking water, in the absence of contamination from residual radioactive materials, due to the following:

the concentration of total dissolved solids is in excess of 10,000 mg/L or,

widespread, ambient contamination not due to activities involving residual radioactive materials from a designated processing site exists that cannot be cleaned up using treatment methods reasonably employed in public water systems. Ambient conditions caused by natural or human-induced conditions exclude contributions from residual radioactive materials or,

the quantity of water reasonably available for sustained continuous use is less than 150 gal (570L) per day. The parameters for determining the quantity of water reasonably available shall be determined by the DOE with the concurrence of the NRC.

- h) Radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials.

The standards that most likely would apply to the Ground Water project are b, e, f, and g above.

The EPA final rule states that if supplemental standards are applied, DOE must select and perform remedial action that comes as close to meeting the otherwise applicable standard as reasonably achievable. Supplemental standards must also ensure that current and projected uses of the affected ground water are preserved.

Institutional controls

Institutional controls are controls that effectively protect public health and the environment. They typically depend on some social order to ensure that protection is effective. On the UMTRA Ground Water Project, institutional controls would reduce exposure to or mitigate health risks by 1) preventing intrusion into contaminated ground water, or 2) restricting access to or use of contaminated ground water for unacceptable purposes. As a last resort, institutional controls could limit human access to the land above the contaminated ground water. The EPA standards allow the use of institutional controls in place of remediation only if their effectiveness can be verified and maintained. The EPA standards permit the use of institutional controls at

sites where remediation can occur through natural flushing of the aquifer within 100 years. However, the standards do not limit the use of institutional controls to the sites that can meet the standards through natural flushing. Institutional controls may also be used to protect public health or the environment when DOE finds them necessary and appropriate prior to commencing active remedial action, during active remedial action, or during implementation of other compliance strategies.

The EPA standards require that institutional controls

- have a high degree of permanence.

- protect public health and the environment.

- satisfy beneficial uses of ground water.

- are enforceable by administrative or judicial branches of government entities.

- can be effectively maintained and verified.

An example of acceptable institutional controls cited in the EPA standards is deed restriction that can be enforced by a unit of government (either administratively or through judicial processes). Another example is federal or state ownership of land containing contaminated ground water. EPA recognizes that a combination of controls may be needed to adequately protect public health and safety. Measures such as signs, health advisories, or other measures that require voluntary cooperation of private parties can be used to complement other enforceable institutional controls but cannot be considered as primary protective measures. In addition, the use of an alternate water supply in conjunction with institutional controls that would prevent human contact with contaminated ground water would be a viable institutional control.

Key to identifying, implementing, and enforcing institutional controls is participation by tribal, state, and local governments. While DOE is responsible for compliance with the EPA standards at UMTRA sites, its authority to implement and enforce institutional controls may be limited, particularly where tailings are disposed of off the processing site and land is privately owned or is owned or controlled by tribal, state, or other public agencies. Similarly, ground water contamination from uranium processing may have moved beyond the processing site to areas that are not within the DOE jurisdiction.

The need for and duration of institutional controls depends on the compliance strategy selected for a site, the type and level of risk, and existing site conditions. As risks decrease over time, so should the restrictiveness of institutional controls. Contaminated plume movement might require applying the restrictions to an extended area over time. Therefore, to ensure extended protection of public health, the environment, and beneficial uses the water could have satisfied, it is important that the effectiveness of institutional controls can be verified and modified as necessary.

Institutional controls, if any, will be selected in cooperation with the Indian tribes, states, and local governments. DOE will verify that the institutional controls are effective. Site-specific institutional controls will not be selected and implemented without DOE and NRC concurrence.