EPA Superfund Groundwater Policy and Federal Facilities Overview

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FEDERAL FACILITIES RESTORATION AND REUSE OFFICE

OFFICE OF SCIENCE, REMEDIATION, TECHNOLOGY, AND INNOVATION

The purpose of this course is to discuss U.S. Environmental Protection Agency Superfund Groundwater Policy Overview as applied to federal facility sites on the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

Agenda

Review EPA groundwater policy as applied at federal facility sites on the NPL under CERCLA:

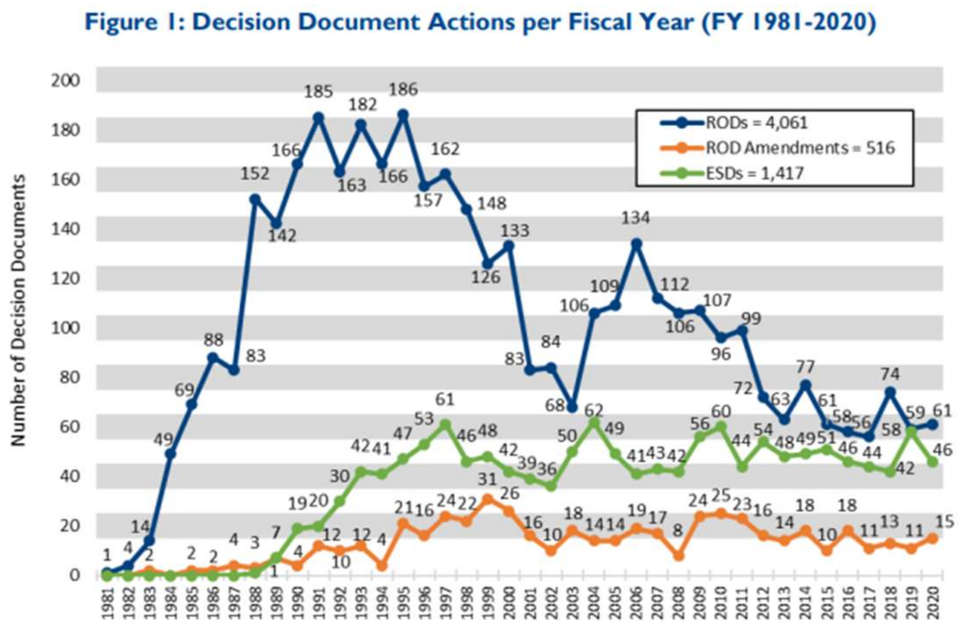
- ❑Groundwater Classification, Institutional Controls (ICs)
- ❑Groundwater Response Actions
- ❑Monitored Natural Attenuation (MNA), and Technical Impracticability (TI) Waivers
- ❑Remedy Optimization
- ❑Adaptive Management at Groundwater Sites

This presentation provides an overview of EPA groundwater policy as applied to federal facility sites on the NPL under CERCLA. The objectives of this presentation is to become familiar with groundwater classification and how it is useful for restoration objectives; understand the nature and extent considerations for groundwater contaminant plumes; learn about the ARARs commonly associated with groundwater remedies, such as SDWA and MCLs; learn about groundwater considerations for MNA, ICs, and TI Waivers; understand what goes into groundwater remedy selection; and be introduced to major groundwater policies from other federal agencies, such as DOD and DOE.

Group Poll

What has been your biggest challenge when it comes to dealing with groundwater remedies at a Superfund site?

Decision Documents
- 5,994 total
- 4,061 RODs
- 516 RODAs
- 1,417 ESDs
- >35% of decision documents are for federal facilities



Source: 2023 Superfund Remedy Report

EPA prepares the Superfund Remedy Report to provide information and analyses on remedies EPA selected to address contamination at Superfund National Priorities List and Superfund Alternative Approach sites. This report is the latest in a series, prepared since 1991, on Superfund remedy selection. A total of 5,994 decision documents, consisting of 4,061 RODs, 516 ROD amendments, and 1,417 ESDs have been issued through FY 2020 (Figure 1). More than 35 percent of decision documents are for federal facilities.

https://www.epa.gov/remedytech/superfund-remedy-report

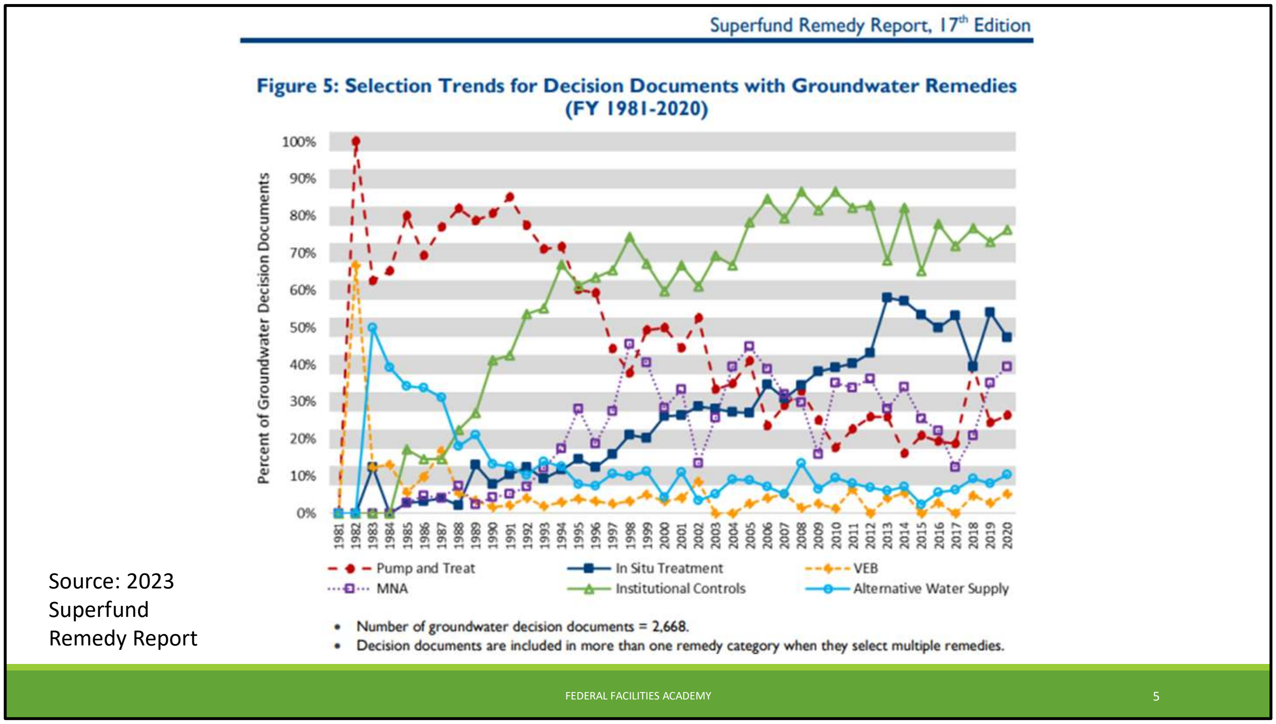


Figure 5 shows in situ treatment was selected in 47 percent of groundwater decision documents in the most recent three years, down slightly from 51 percent in FYs 2015 to 2017. The selection of P&T remains low, at an average of 31 percent, but has increased from an average of 20 percent in FYs 2015 through 2017. Approximately 30 percent of recent decision documents for groundwater selected MNA, which is up from 20 percent during the previous three years (FYs 2015 to 2017). Approximately three quarters of recent groundwater decision documents continue to include ICs. Additionally, EPA determined that sites with recent groundwater decision documents that did not include ICs typically had selected ICs for the groundwater in a previous or subsequent decision document. Overall, 55 percent of decision documents with groundwater remedies select multiple remedial approaches, including various combinations of treatment, VEBs, MNA, and ICs.

Source: U.S. EPA, 2023, Superfund Remedy Report, Office of Land and Emergency Management, 17th Edition.

Table 6: Groundwater Remedies Selected Most Frequently in Recent Decision Documents (FY 2018-2020)

Selected Remedy	Number	Percent
Treatment	**79**	**67%**
In Situ Treatment	55	47%
Bioremediation	29	25%
Chemical Treatment	19	16%
Thermal Treatment	11	9%
Air Sparging	5	4%
Permeable Reactive Barrier	3	3%
Multi-phase Extraction	3	3%
Solidification/Stabilization	2	2%
Vapor Extraction	2	2%
Ex Situ Treatment (P&T)	36	31%
Vertical Engineered Barrier	**5**	**4%**
Monitored Natural Attenuation	**37**	**31%**
Institutional Controls	**89**	**75%**
Alternative Water Supply	**11**	**9%**
Other	**6**	**5%**

- Percentages based on 118 groundwater decision documents issued in FYs 2018 through 2020.

Source: 2023 Superfund Remedy Report

During FYs 2018 to 2020, 118 of the 278 total decision documents (42 percent) address groundwater contamination at 102 sites. As shown in Table 6, sixty-seven percent (79 documents) selected treatment remedies.

In situ treatment was selected in 47 percent of the 118 groundwater decision documents with bioremediation (25 percent) and chemical treatment (16 percent) selected most frequently. For decision documents that selected bioremediation, 22 (76 percent) specified anaerobic bioremediation, 13 (45 percent) indicated bioaugmentation, and 6 (21 percent) specified aerobic bioremediation. When documents selected chemical treatment, 16 (nearly 85 percent) specified ISCO, while 4 (21 percent) selected ISCR. One document selected both ISCO and ISCR. P&T and MNA are the next most frequently selected remedies in recent groundwater decision documents at 31 percent each.

Groundwater Classification

Groundwater Use Designations

- Federal Guidelines
  - Classification System (EPA Guidelines for Ground-Water Classification, Draft Final 1986)
- Class I: Special Groundwater
- Class II: Actual or Potential Drinking Water Source
  - Class IIA: Current source
  - Class IIB: Potential source of drinking water, agricultural or other beneficial use
- Class III: Not a Potential Source of Drinking Water and of Limited Beneficial Use
- State Guidelines
  - Approved Comprehensive State Groundwater Protection Program

Land use is not identified as a consideration in making groundwater classifications

Source: U.S. EPA, 1986, Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy

Superfund and other EPA remediation programs should generally defer to a State's determination of current and future groundwater uses when based on criteria or methodology that 1) are specified in an EPA-endorsed Core Comprehensive State Groundwater Protection Program (CSGWPP), and 2) can be applied at specific sites or facilities. For States that do not have an EPA-endorsed CSGWPP, or for CSGWPPs that do not have provisions for making site-specific determinations of groundwater use (or resource value, priority or vulnerability), the Superfund program will continue to follow guidance provided in the National Contingency Plan (NCP) Preamble.

Many states have already developed groundwater protection approaches tailored to their particular land use and hydrogeologic conditions. State agencies responsible for managing groundwater will not be required by EPA to adopt the classification system for general program use. However, state agencies carrying out delegated or authorized EPA programs may need to use these guidelines as they are implemented by those programs. The following slides will further discuss the EPA Groundwater Classification System.

Source: U.S. EPA, 1986, Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy, Web, https://semspub.epa.gov/work/HQ/175205.pdf

Comprehensive State Groundwater Protection Program (CSGWPP)

- 13 States have an EPA-endorsed CSGWPP (CT, MA, NH, RI, VT, DE, AL, GA, IL, WI, OK, NV, WA), but DE and WA excluded for SF.
  - Current EPA-Endorsed Comprehensive State Groundwater Protection Programs (CSGWPPs)
- 1997 EPA Guidance clarified that EPA Regions generally should:
  - *Defer to State determinations of current and future ground-water uses, when based on an EPA-endorsed CSGWPP that has provisions for site-specific decisions;*
  - *Participate in EPA's review and endorsement of CSGWPPs; and*
  - *Use other CSGWPP provisions, as appropriate, for more effective or efficient program implementation (e.g., increased program emphasis in geographic areas identified in a CSGWPP as having higher resource value or priority).*

Source: U.S. EPA, 1997 Guidance, *The Role of CSGWPPs in EPA Remediation Programs*

Current and potential future beneficial use determinations should generally consider state and tribal groundwater classifications or similar designations. Several states have developed groundwater use or priority designations as part of an EPA-endorsed Comprehensive State Groundwater Protection Program (CSGWPP). Currently, twelve states (Connecticut, Massachusetts, Vermont, New Hampshire, Rhode Island, Delaware, Alabama, Georgia, Illinois, Wisconsin, Oklahoma, Nevada and Washington) and no tribes have gone through the process and received EPA endorsed CSGWPPs. EPA clarified CSGWPP utilization in the 1997 guidance, *The Role of CSGWPPs in EPA Remediation Programs* (OSWER Directive 9283.1-09; April 1997).

EPA Groundwater Classification

Class I: Special Groundwater

- Resources of unusually high value that are highly vulnerable to contamination
- Irreplaceable source of drinking water – serves a substantial population, or the alternative sources in the area are economically infeasible
- Ecologically vital - supplies a sensitive ecological system that supports a unique habitat

Photo: https://www.desertusa.com/colorado/intro/du_introcr.html

Source: U.S. EPA, 1986, Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy

Groundwater may be considered “irreplaceable” if it serves a substantial population and if delivery of comparable quality and quantity of water from alternative sources in the area would be economically infeasible or precluded by institutional constraints (i.e., it serves at least 2500 people, and the annual cost to a typical user of replacing the source exceeds 0.7 to 1.0 percent of the mean household income in the area).

Groundwater may be considered ecologically vital if it supplies a sensitive ecological system located in a groundwater discharge area that supports a unique habitat. A unique habitat is defined to include habitats for endangered or threatened species listed or proposed for listing on the Endangered Species Act, as well as certain types of Federally managed and protected lands.

Source: U.S. EPA, 1986, Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy, Web, https://semspub.epa.gov/work/HQ/175205.pdf

EPA Groundwater Classification (cont.)

Class II: Actual or Potential Drinking Water Source

- Class IIA: Current source of drinking water
  - Presence of one or more drinking water wells or springs (in operation)
  - Presence of a water-supply reservoir watershed (or a portion) designated for water quality protection
- Class IIB: Potential source of drinking water, agricultural or other beneficial use

Potential Source Criteria

- Yields at last 150 gallons/day
- TDS less than 10,000 mg/L
- Can be used without treatment or treated with methods found in a public water system

Source: U.S. EPA, 1986, Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy

All non-Class I groundwater currently used or potentially available for drinking water and other beneficial use is included in this category, whether or not it is particularly vulnerable to contamination. Groundwater is considered a current source of drinking water under two conditions. One is the presence of one or more drinking water wells or springs in operation in the Classification Review Area, and the second requires the presence of a water supply reservoir watershed designated by either state or local government for water quality protection.

Groundwater is considered a potential source of drinking water if it is capable of yielding a quantity of drinking water to a well or spring sufficient for the needs of an average family. The sufficient yield criterion has been established at 150 gallons per day. Drinking water is water with a total dissolve solids (TDS) concentration of less than 10,000 mg/L that can be used without treatment or treated using methods reasonably implemented in a public water supply system.

It is assumed that all groundwater units are capable of supplying a yield sufficient to meet the minimum needs of an average family, unless an insufficient yield can be demonstrated as part of a Class III determination.

Source: U.S. EPA, 1986, Guidelines for Groundwater Classification Under the EPA

Groundwater Protection Strategy.

EPA Groundwater Classification (cont.)

Class III: Not a Potential Source of Drinking Water and of Limited Beneficial Use

- TDS greater than or equal to 10,000 mg/L
- Contamination by naturally occurring conditions or by broad-scale human activity (unrelated to specific pollution incident) that they cannot be treated by public water system
- Insufficient yield for an average-size household (150 gpd)
- Two subcategories based on interconnection to adjacent units and surface water:
    1. Class IIIA – high-to-intermediate degree of interconnection
    2. Class IIIB – low degree of interconnection

Source: U.S. EPA, 1986, Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy

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Class III is reserved for groundwater that has virtually no potential as a source of drinking water.
Because of the very low likelihood that Class III groundwater would be used as a drinking water source and thus pose a risk to humans, it may be appropriate in some situations to manage existing contamination differently or take different preventative measures than would be taken for Class I and II groundwaters. Groundwater will not be considered Class III when contamination is due to an action or in-action on the part of the facility in question.

Class IIIA includes groundwaters in settings where yields are insufficient from any depth within the Classification Review Area to meet the needs of an average size family.

Class IIIB groundwaters are naturally isolated from sources of drinking water in such a way that there is little potential for producing additional adverse effects on human health and the environment.

Source: U.S. EPA, 1986, Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy.

Groundwater Use and Classification

- "…to the degree that the state or local government have classified their groundwater, EPA will consider those classifications and their applicability to the selection of an appropriate remedy." [55 FR 8733]

- "If a state classification would lead to a less stringent solution than the EPA classification scheme, then the remediation goals will generally be based on EPA classification...If the use of a state classification would result in the selection of a nonprotective remedy, EPA will not follow the state scheme." [55 FR 8733]

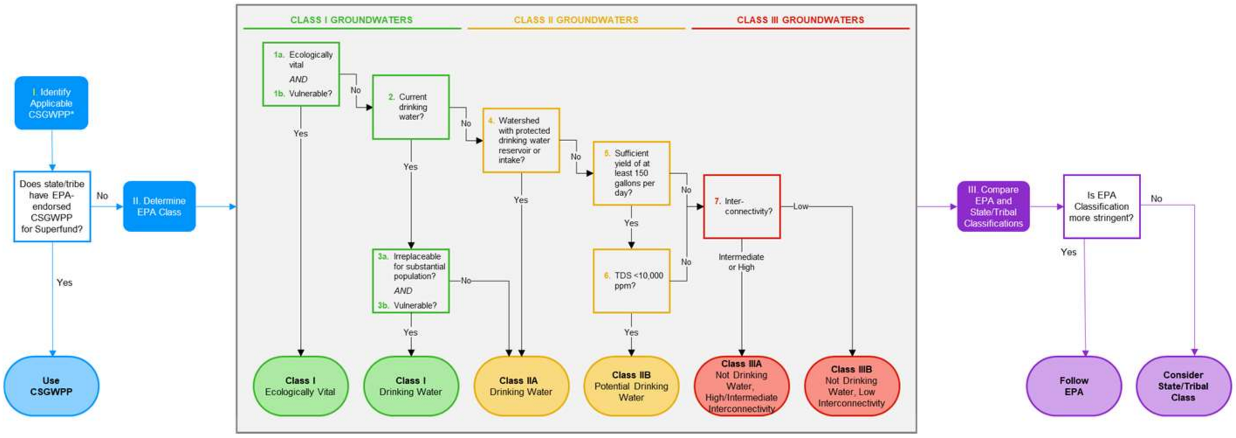
Source: U.S. EPA, 1990, Final National Oil and Hazardous Substances Pollution Contingency Plan 55 FR 8733.

55 FR 8733 of the NCP states that groundwater is a valuable resource and should be protected and restored if necessary and practicable. It also states that when EPA must classify groundwater for a Superfund action, that classification is only used to determine the scope of site-specific remedial actions.

Source: U.S. EPA, 1990, Final National Oil and Hazardous Substances Pollution Contingency Plan 55 FR 8733.
Citations from Final NCP 55 FR 8733 (March 8, 1990).

Beneficial Use Designation for Groundwater at Superfund Sites

Attachment 1: Procedural Groundwater Classification Flowchart



Link: Beneficial Use Designation for Groundwater at Superfund Sites

Apply Your Understanding

A State, without an EPA-endorsed Comprehensive State Groundwater Protection Program (CSGWPP), has designated an aquifer as not a potential source of drinking water (Class III). EPA classified the aquifer as a potential source of drinking water(Class IIB). How should the aquifer be considered during remedy selection?

A) Current source of Drinking water
B) Special Groundwater
C) Potential source of Drinking water
D) Not Drinking Water

The Answer is: C – Potential source of drinking water.

If a state classification would lead to a less stringent solution than the EPA classification scheme, then the remediation goals will generally be based on EPA classification

Institutional Controls

Role of Institutional Controls (ICs)

- ICs generally are not to be included when evaluating whether a CERCLA remedial action is appropriate (55 FR 8710-8711).
- ICs related to groundwater or surface use may be used as part of a response action.
- ICs do not actively address contamination and are considered to be limited action alternatives

Source: U.S. EPA, 2009, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration

NCP preamble states that "The baseline assessment is essentially an evaluation of the no-action alternative. Institutional controls, while not actively cleaning up the contamination at the site, can control exposure, and therefore, are considered to be limited action alternatives."

Source: U.S. EPA, 2009, OSWER Directive 9283.1, 1-33, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration.

Role of ICs

- ICs shall not substitute for active response measures as the sole remedy unless such active measures are determined not to be practicable

- Institutional controls will usually be used as supplementary protective measures during implementation of groundwater remedies (55 FR 8732).

Source: U.S. EPA, 2009, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration

40 CFR § 300.430(a)(iii)(D) states that "The use of institutional controls shall not substitute for active response measures (e.g., treatment and/or containment of source material, restoration of groundwaters to their beneficial uses) as the sole remedy unless such active measures are determined not to be practicable, based on the balancing of trade-offs among alternatives that is conducted during the selection of remedy.“

While there may be limited circumstances where an IC-only final remedy is appropriate, generally, an IC-only ROD would follow selection of other remedial action elements in previous decision documents. For example, previous decision documents may have selected active remediation that included removal of sources contributing to groundwater contamination, may have addressed groundwaters to the extent practicable, and may have invoked a TI waiver of ARARs for specific contaminants in one part of an aquifer. Where the cleanup under previous decision documents has not ensured protection of human health for that part of the groundwater that will not achieve MCLs, a separate decision document would generally be issued to select one or more ICs to prevent current or future exposure to contaminated groundwater.

Mention it is passive, same with monitoring. It is not an active remediation. Consultation with HQ is required for a IC – Only remedy.

Source: U.S. EPA, 2009, OSWER Directive 9283.1, 1-33, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration.

Groundwater Response Actions

Groundwater Response Actions

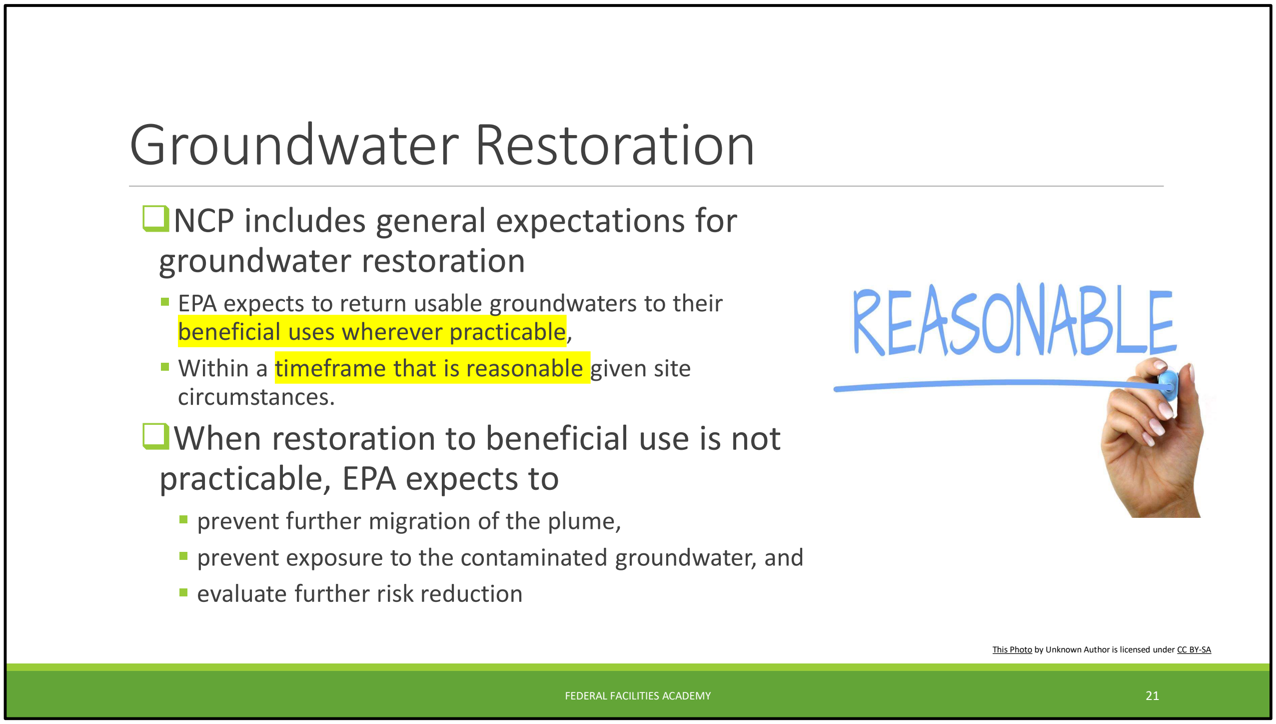
- Under CERCLA Section 121(d)(2)(A) and congressional mandate for groundwater response actions
- Such Remedial action shall require a level or standard of control which
  - At least attains Maximum Contaminant Level Goals established under the Safe Drinking Water Act; and,
  - Water quality criteria established under section 304 or 303 of the Clean Water Act
  - Where such goals or criteria are relevant and appropriate for the release

Photo: https://epa.ohio.gov/ddagw/gw_support

Source: U.S. EPA, 1980, Superfund Law (CERCLA – Comprehensive Environmental Response, Compensation and Liability Act of 1980)

Under CERCLA 121(d)(2)(A), groundwater response actions are governed in part by the following mandate established by Congress: *"…Such remedial action shall require a level or standard of control which at least attains Maximum Contaminant Level Goals established under the Safe Drinking Water Act and water quality criteria established under section 304 or 303 of the Clean Water Act, where such goals or criteria are relevant and appropriate under the circumstances of the release or potential release"*

Source: U.S. EPA, 1980, Superfund Law (CERCLA – Comprehensive Environmental Response, Compensation and Liability Act of 1980)



Recognizing that groundwaters of the United States are valued natural resources, the Agency carries out CERCLA response actions in a manner that ensures Superfund remedies are protective by, among other things, restoring contaminated groundwater to beneficial uses. Generally, these response actions attain MCLs (and non-zero maximum contaminant level goals [MCLGs], where appropriate) for current or potential drinking water aquifers.

NCP includes general expectations for purposes of groundwater restoration as follows:

> *"EPA expects to return usable groundwaters to their beneficial uses wherever practicable, within a timeframe*

that is reasonable given the particular circumstances of the site. When restoration of groundwater to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction"

EPA groundwater policies are often based on the language included in CERCLA, as amended. In some cases, EPA may have limited or no flexibility in the way groundwater policy is interpreted since the policy is in effect the language included in the law.

Principles for Groundwater Restoration

1) *If groundwater that is a current or potential source of drinking water is contaminated above protective levels, a remedial action under CERCLA should seek to restore that aquifer to beneficial use wherever practicable.*
2) *Groundwater contamination should not be allowed to migrate and further contaminate the aquifer or other media*
3) *Technical impracticability waivers and other waivers may be considered and granted under appropriate circumstances if the statutory criteria are met when groundwater cleanup is impracticable*

U.S. EPA, 2009, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration.

When addressing groundwater contamination at CERCLA sites, Regions should carefully consider these 5 principles:

1. If groundwater that is a current or potential source of drinking water is contaminated above protective levels (e.g., for drinking water aquifers, contamination exceeds Federal or State MCLs or non-zero MCLGs), a remedial action under CERCLA should seek to restore that aquifer to beneficial use (e.g., drinking water standards) wherever practicable.
2. Groundwater contamination should not be allowed to migrate and further contaminate the aquifer or other media (e.g., vapor intrusion into buildings, sediment, surface water, or wetland).
   - When a site is listed, it is necessary to define the release (or releases) encompassed within the listing. The approach generally used is to delineate a geographical area (usually the area within the installation or plant boundaries) and define the site by reference to that area. As a legal matter, the site is not coextensive with that area, and the boundaries of the installation or plant are not the "boundaries" of the site. Rather, the site

consists of all contaminated areas within the area used to define the site, and any other location to which contamination from that area has come to be located.

3. Technical impracticability waivers and other waivers may be considered and, under appropriate circumstances, granted if the statutory criteria are met when groundwater clean up is impracticable; the waiver decision should be scientifically supported and clearly documented.
4. Early actions (such as source removal, plume containment, or provision of an alternative water supply) should be considered as soon as possible. ICs related to groundwater use, or even surface use, may be useful to protect the public in the short-term, as well as in the long-term.
5. ICs should not be relied upon as the only response to contaminated groundwater or as justification for not taking action under CERCLA. To ensure protective remedies, CERCLA response action cleanup levels for contaminated groundwater should generally address all pathways of exposure that pose an actual or potential risk to human health and the environment.

Sources: U.S. EPA, 2009, OSWER Directive 9283.1, 1-33, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration.
U.S. EPA, 1995, Clarification of NPL Listing Policy, Web, https://www.epa.gov/sites/production/files/documents/clarfctn_npl_list_plcy.pdf

Principles for Groundwater Restoration

4) *Early actions should be considered as soon as possible. ICs related to groundwater use, or even surface use, may be useful to protect the public*
5) *ICs should not be relied upon as the only response to contaminated groundwater or as a justification for not taking action under CERCLA.*
   - *Cleanup levels should address all pathways of exposure that pose an actual or potential risk to human health and the environment*

In working with other Federal agencies to make groundwater clean up decisions at sites where the other Federal agency is lead for cleanup, EPA Regions should use the principles highlighted in this document to the same extent as at non-federal facility sites.

U.S. EPA, 2009, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration.

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Source: U.S. EPA, 2009, OSWER Directive 9283.1, 1-33, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration.

In working with other Federal agencies to make groundwater clean up decisions at sites where the other Federal agency is lead for cleanup, EPA Regions should use the principles highlighted in this document to the same extent as at non-federal facility sites. CERCLA Section 120(e)(4)(A) provides a role for EPA in the selection of remedies at Federal facilities on the National Priorities List.

NCP Expectations in DoD Guidance

- DoD DERP Manual acknowledges NCP expectations for groundwater:
  - If remedial action for groundwater is necessary to protect human health or the environment, the DoD Component should consider the NCP expectation that useable groundwaters will be returned to their beneficial uses whenever practicable, within a timeframe that is reasonable given the particular circumstances of the site, when establishing remedial action objectives in accordance with subpart 300.430(a)(1)(iii)(F) of NCP.
  - When restoration to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction, pursuant to subpart 300.430(a)(1)(iii)(F) of NCP.
    - If ARARs cannot be met, the DoD should appropriately justify an ARAR waiver in accordance with subpart 300.430(f)(1)(ii)(C) of NCP.

Source: Section 4 of DoD DERP Manual, DoD Environmental Restoration Program

Excerpts from Section 4 of DoD DERP Manual, DoD Environmental Restoration Program:

7. If remedial action for groundwater is necessary to protect human health or the environment, the DoD Component should consider the NCP expectation that useable groundwaters will be returned to their beneficial uses whenever practicable, within a timeframe that is reasonable given the particular circumstances of the site, when establishing remedial action objectives in accordance with subpart 300.430(a)(1)(iii)(F) of NCP. (Page 35)

c. Some States have groundwater non-degradation laws that they may propose as an ARAR. The DoD Component shall consult with their legal counsel on the ARAR analysis. (See subparagraph b.(8)(d) of this section for ARAR information that shall be included in the DD.) (Page 36)

8. When restoration to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction, pursuant to subpart 300.430(a)(1)(iii)(F) of NCP. If ARARs cannot be met, the DoD should appropriately justify an ARAR waiver in accordance with subpart 300.430(f)(1)(ii)(C) of NCP. (Page 36)

Source: U.S. DOD, 2012, Defense Environmental Restoration Program (DERP) Manual, Web, https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/471520m.pdf

Groundwater Remediation Phased Approach

- Site response activities are implemented in a sequence of steps so information gained from earlier phases refines subsequent investigations, objectives or actions.
  - Includes early and interim actions
- Considerations for the use of interim actions:
  - More data to assess restoration potential
  - Attainable objectives can be set for each response phase
  - Flexibility in response to unexpected site conditions
  - Increased remedy performance (decreased timeframes and cost)

Source: U.S. EPA, 1996, Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites.

Implementing investigations and actions in phases provides the following major **benefits**:

- Data from earlier response actions are used to further characterize the site and assess restoration potential;
- Attainable objectives can be set for each response phase;
- Flexibility is provided to adjust the remedy in response to unexpected site conditions;
- Remedy performance is increased,

decreasing remediation timeframe and cost; and

- Likely remedy refinements are built into the selected remedy, better defining the potential scope and minimizing the need for additional decision documents”

Phased remedy approaches may include the implementation of early and interim actions. For early actions, “*early refers to the timing of the start of an action with respect to other response”* actions at a given site. For Superfund sites, early actions could include removal actions, interim remedial actions, or early final remedial actions. An interim action is limited in scope and only addresses areas/media that also will be addressed by a final site/operable unit Record of Decision (ROD). Both source [such as soil] and groundwater actions may be implemented as either early or interim actions. These actions generally may address exposure to contaminated groundwater, or prevent further migration of groundwater, or prevent further migration of contaminants from sources.

Source: U.S. EPA, 1996, Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites. OSWER Directive No. 9283.1-12, Web, www.epa.gov/superfund/health/conmedia/gwdocs/gwguide/index.htm.

Basis for CERCLA Action

- The NCP preamble states, "The results of the baseline risk assessment are used to determine whether remediation is necessary, to help provide justification for performing remedial action, and to assist in determining what exposure pathways need to be remediated."
- "Under existing EPA policy, groundwaters that are current or potential sources of drinking water that exceed risk-based standards (e.g., MCLs) or pose an unacceptable risk generally warrant a remedial action under CERCLA."
- "Other routes of exposure, such as vapor intrusion, or current or potential threat to sediment quality, surface water quality, wetlands, or critical habitats for protected species, also may be the basis for remedial action under CERCLA."

Source: U.S. EPA, 2009, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration

Source: U.S. EPA, 2009, OSWER Directive 9283.1, 1-33, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration.

Current or potential threats to sediment quality, surface water quality, wetlands, or critical habitats for protected species may be justified in the ecological risk component of the baseline risk assessment.

Extent of Contamination

- A site consists of all contaminated areas within the site and any other location to which contamination from that area has come to be located
- Groundwater contamination should not be allowed to migrate and further contaminate the aquifer or other media

Photo: https://www.circleofblue.org/2019/world/epa-says-it-will-regulate-two-pfas-chemicals-in-drinking-water/

Source: U.S. EPA, 2009, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration

Groundwater contamination should not be allowed to migrate (i.e., beyond the “fenceline” or established land site boundaries) and further contaminate the aquifer or other media (e.g., vapor intrusion into buildings, sediment, surface water, or wetland).

When a site is listed, it is necessary to define the release (or releases) encompassed within the listing. The approach generally used is to delineate a geographical area (usually the area within the installation or plant boundaries) and define the site by reference to that area. As a legal matter, the site is not coextensive with that area, and the boundaries of the installation or plant are not the "boundaries" of the site. Rather, the site consists of all contaminated areas within the area used to define the site and any other location to which contamination from that area has come to be located.

Sources: U.S. EPA, 2009, OSWER Directive 9283.1, 1-33, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration.
U.S. EPA, 1995, Clarification of NPL Listing Policy, Web, https://www.epa.gov/sites/production/files/documents/clarfctn_npl_list_plcy.pdf

Groundwater ARARs to Consider

- Maximum contaminant level goals (MCLGs), established under the Safe Drinking Water Act, that are set at levels above zero shall be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release based on the factors in 300.400(g)(2).

- If an MCLG is determined not to be relevant and appropriate, the corresponding maximum contaminant level (MCL) shall be attained where relevant and appropriate to the circumstances of the release. (40 CFR 300.430(eX2)(i)(B))

Source: U.S. EPA, 2009, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration

Source: U.S. EPA, 2009, OSWER Directive 9283.1, 1-33, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration.

Groundwater ARARs to Consider (cont.)

- The NCP Preamble further clarifies: EPA's policy is that MCLs or MCLGs above zero should generally be the relevant and appropriate requirement for groundwater that is or may be used for drinking, and that a waiver is generally needed in situations where a relevant and appropriate MCL or nonzero MCLG cannot be attained.

- Where groundwaters may impact surface water quality, "water quality criteria established under section 304 or 303 of the Clean Water Act" may be relevant and appropriate standards consistent with CERCLA §121 (d)(2)(A)(ii).

Source: U.S. EPA, 2009, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration

This slide is specific to MCLs and water quality criteria, but keep in mind that there are other ARARs to consider (e.g., State, location-specific, etc.).

Source: U.S. EPA, 2009, OSWER Directive 9283.1, 1-33, Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration.

Apply Your Understanding

Which is NOT true when addressing groundwater contamination at CERCLA sites?

A) Early actions should be considered as soon as possible.

B) Groundwater contamination migrating beyond the "fenceline", or established land site boundaries should be considered.

C) Technical impracticability waivers and other waivers may be considered.

D) Institutional Controls can be relied upon as the only response to contaminated groundwater or as justification for not taking action under CERCLA.

Answer: D

ICs should not be relied upon as the only response to contaminated groundwater or as justification for not taking action under CERCLA. To ensure protective remedies, CERCLA response action cleanup levels for contaminated groundwater should generally address all pathways of exposure that pose an actual or potential risk to human health and the environment.

Alternate Concentration Limits (ACLs)

- Section 121(d)(2)(B)(ii) addresses ACLs and limitations concerning their use
- ACLs may not be used if the process assumes a point of human exposure beyond the boundary of the facility, except where:
  - there are known and projected points of entry of such groundwater into surface water;
  - there is or will be no statistically significant increase of constituents in surface water or at any point downstream; and
  - the remedial action includes enforceable measures that will preclude human exposure to the contaminated groundwater.

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Section 121(b)(1) requires that remedial actions be protective of human health and the environment. In addition to that independent requirement, Section 121(d) generally provides that remedial actions shall meet applicable or relevant and appropriate requirements (ARARs), unless those requirements are waived pursuant to section §121(d)(4) under appropriate site-specific circumstances. Section 121(d)(2)(B)(ii) also addresses ACLs and limitations concerning their use, as follows:

> (ii) For the purposes of this section, a process for establishing alternate concentration limits to those otherwise applicable for hazardous constituents in groundwater under subparagraph (A) may not be used to establish applicable standards under this paragraph if the process assumes a point of human exposure beyond the boundary of the facility, as defined at the conclusion of the remedial investigation and feasibility study, except where-
> (I) there are known and projected points of entry of such groundwater into surface water; and
> (II) on the basis of measurements or projections, there is or will be no statistically significant increase of such constituents from such groundwater in such surface water at the point of entry or at any point where there is reason to believe accumulation of constituents may occur downstream; and
> (III) the remedial action includes enforceable measures that will preclude human exposure to the contaminated groundwater at any point between the facility boundary and all known and projected points of entry of such groundwater into surface water then the assumed point of human exposure may be at such known and projected points of entry.

In general, Regions should consider the factors discussed in the 2005 guidance in evaluating whether use of CERCLA ACLs may be appropriate under site-specific circumstances. Where CERCLA ACLs are established as part of a remedy, the Superfund Record of Decision (ROD) should identify the applicable standards for which the CERCLA ACLs have been substituted and should document specifically how the site meets the specific conditions required by the statute (e.g., point of entry, no statistically significant increase of constituents, enforceable measures that will preclude human exposure). The ROD also should explain the process used to establish the CERCLA ACLs and their numeric values. Finally, the ROD should explain how the ACL meets the independent requirement in CERCLA section 121 that CERCLA response actions be protective of human health and the environment (e.g., selected engineering measures; institutional controls). For sites not meeting the statutory conditions for use of CERCLA ACLs, Regions should consider other flexibilities provided for in CERCLA and the NCP that may be appropriate. (Source: U.S. EPA, 2005, Use of Alternate Concentration Limits in Superfund Cleanups)

2005 EPA HQ Memo on ACLs

- Purpose: To provide guidance on the proper use of ACLs in Superfund remedies under the authority of CERCLA Section 121
- Expands on the factors/criteria for guiding the use of ACLs in CERCLA section 121
  - Seven additional site-specific factors added to the three original factors in CERCLA section 121
- Two additional clarifications were noted on the use of ACLs
  - ACLs are directed to substitute for standards that are "applicable" and meet specific criteria
  - ACLs cannot be used when a "relevant and appropriate" standards exist (e.g. MCLs or WQC under the CWA)

Source: US EPA, 2005 Use of Alternate Concentration Limits (CLs) in Superfund Cleanups

Examples of applicable standards are state requirements for groundwater cleanup, state requirement to clean up groundwater to background levels (i.e. antidegradation)

Source: US EPA, 2005 Use of Alternate Concentration Limits (CLs) in Superfund Cleanups, OSWER 9200.4-39,
https://semspub.epa.gov/work/HQ/176388.pdf

CERCLA Degree of Cleanup

- Under Section 121(d) remedial actions shall attain a degree of cleanup which assures protection of human health and the environment.
- Remedial action shall obtain ARARs unless in limited circumstances it is determined that one of the six waivers specified in Section 121(d)(4) can be invoked.
- "SDWA MCLs are generally considered 'relevant and appropriate' to determining acceptable exposure for groundwater that is or may be used for drinking." [55 FR 8750]

40 CFR 300.340(f)(1)(1)(A)

Overall protection of human health and the environment compliance with ARARs are threshold requirements that each remedial alternative must meet in order to be eligible for selection. [Ref. 40 CFR 300.340(f)(1)(1)(A)]

Remediation Timeframe

- For groundwater, timeframes will be developed based on the site-specific contaminants, hydrogeological conditions, and size of the plume. [55 FR 8732]
- "EPA's preference is for rapid restoration, when practicable, of Class I groundwater and groundwaters that are currently, or likely in the near-term to be, the source of a drinking water supply." [55 FR 8713]

Restoration to beneficial uses is the ultimate objective for groundwater remediation. An extended remediation timeframe is generally appropriate where contaminated groundwaters are not expected to be used in the near term and where alternative sources are available. A state's groundwater regulation may provide useful information on priority and/or value of groundwater resources that can affect timeframe.

Evaluating Completion of Groundwater Restoration Remedial Actions

- Recommends evaluating contaminant of concern (COC) concentration levels on a well-by-well basis for:
  - Remediation monitoring
  - Attainment monitoring
- Well-specific conclusions used with conceptual site model to demonstrate that:
  - The contaminant cleanup level for each COC has been achieved
  - Groundwater will continue to meet cleanup levels for all COCs in the future

Source: U.S. EPA, 2013, Guidance for Evaluating Completion of Groundwater Restoration Remedial Actions

EPA generally will consider whether a groundwater restoration remedial action is complete by evaluating groundwater data and information gathered during the following two phases at each monitoring well: I) the remediation monitoring phase; and 2) the attainment monitoring phase.

The remediation monitoring phase refers to the phase of the remedy where remedial activities are being implemented to reach groundwater cleanup levels selected in a remedy decision document. During this phase, groundwater sampling and monitoring data typically are collected to evaluate contaminant migration and changes in COC concentrations over time.

The attainment monitoring phase typically occurs after EPA makes a determination that the remediation monitoring phase is complete. When the attainment phase begins, data typically are collected to evaluate if the well has reached post remediation conditions (i.e., steady state conditions) where remediation activities, if employed, are no longer influencing the groundwater in the well. In general, once the groundwater is observed to have reached post remediation conditions, data are collected and evaluated to confirm completion of the attainment monitoring phase.

The completion of the attainment monitoring phase at a monitoring well typically occurs when contaminant-specific data provide a technical and scientific basis that: 1) The contaminant cleanup level for each COC has been met; and 2) The groundwater will continue to meet the contaminant cleanup level for each COC in the future.

Source: U.S. EPA, 2013, Guidance for Evaluating Completion of Groundwater Restoration Remedial Actions, Web, https://semspub.epa.gov/work/11/175206.pdf. OSWER 9355.0-129\

Monitored Natural Attenuation (MNA)

(transition slide)

Use of MNA

- Not considered as a "no action" approach, but as an alternative means of achieving remediation objectives
- Should be selected only where it meets all relevant remedy selection criteria and where it will meet site remediation objectives within a timeframe that is reasonable compared to that offered by other methods.
- Does **not** imply that active remediation measures are infeasible or are "technically impracticable" from an engineering perspective.
- Can be used for many classes of contaminants (e.g., organics, inorganics and radioactive)

Source: U.S. EPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites.

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While MNA is often dubbed "passive" remediation because natural attenuation processes occur without human intervention, its use at a site does **not** preclude the use of "active" remediation or the application of enhancers of biological activity (e.g., electron acceptors, nutrients, and electron donors). However, by definition, a remedy that includes the introduction of an enhancer of any type is no longer considered to be "natural" attenuation.

Use of MNA does not imply that activities (and costs) associated with investigating the site or selecting the remedy (e.g., site characterization, risk assessment, comparison of remedial alternatives, performance monitoring, and contingency measures) have been eliminated.

Technical impracticability (TI) determinations are used to justify a departure from cleanup levels that would otherwise be required at a Superfund site or Resource Conservation and Recovery Act (RCRA) facility based on the inability to achieve such cleanup levels using available remedial technologies. Such a TI determination does not imply that there will be no active remediation at the site, nor that MNA will be used at the site. Rather, such a TI determination simply indicates that the cleanup levels and objectives which would otherwise be required cannot practicably be attained using available remediation technologies. MNA should **not** be viewed as a direct or presumptive outcome of a technical impracticability determination.

Source: U.S. EPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites.

Use of MNA (cont.)

- Use of MNA may be appropriate as one component of the total remedy, either in conjunction with active remediation or as a follow-up measure.
  - Source control measures must be evaluated
- MNA in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants.
  - EPA prefers processes that degrade or destroy contaminants

Source: U.S. EPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites.

When relying on natural attenuation processes for site remediation, EPA prefers those processes that degrade or destroy contaminants. Also, EPA generally expects that MNA will only be appropriate for sites that have a low potential for contaminant migration.

Source: U.S. EPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites.

MNA Pros and Cons

PROS	CONS
• Less remediation waste generated • Reduced potential for cross-media transfer of contaminants • Reduced risk of human exposure to contaminants • May result in in-situ destruction of contaminants • Less surface intrusion • Potential for application to all or part of a site • Can be used in conjunction with active remedy • Potentially lower remediation costs	• Longer timeframes to achieve remediation objectives • More complex/costly site characterization • Toxicity/mobility of transformation products may exceed parent compound • Long-term performance monitoring required • Long-term ICs may be needed • Potential for continued migration • Environmental conditions may change and increase migration • More outreach/education may be needed to gain public acceptance

Source: U.S. EPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites.

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In general, the level of site characterization necessary to support a comprehensive evaluation of MNA is more detailed than that needed to support active remediation. Site characterizations for natural attenuation generally warrant a quantitative understanding of source mass; groundwater flow (including preferential pathways); contaminant phase distribution and partitioning between soil, groundwater, and soil gas; rates of biological and non-biological transformation; and, an understanding of how all of these factors are likely to vary with time.

MNA may not be appropriate as a remedial option at many sites for technological or economic reasons. For example, in some complex geologic systems, technological limitations may preclude adequate monitoring of a natural attenuation remedy to ensure with a high degree of confidence that potential receptors will not be impacted. This situation typically occurs in many karstic, structured, and/or fractured rock aquifers where groundwater moves preferentially through discrete pathways (e.g., solution channels, fractures, joints, foliations).

EPA or other regulatory authorities should consider a number of factors when evaluating reasonable timeframes for MNA at a given site. These factors, on the whole, should allow the overseeing regulatory authority to determine whether a natural attenuation remedy
(including ICs where applicable) will fully protect potential human and environmental receptors and whether the site remediation objectives, and the time needed to meet them, are consistent with the regulatory expectation that contaminated groundwaters will be restored to beneficial uses within a reasonable timeframe. When these conditions cannot be met using MNA, a remedial alternative that more likely would meet these expectations should be selected.

Source: U.S. EPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites.

MNA Lines of Evidence

1. Data that demonstrate decreasing trend of contaminant mass and/or concentration over time
   - Statistically significant decreases in concentrations within individual wells along flow paths over time
2. Data that demonstrate **indirectly** the type(s) of natural attenuation processes active at the site and their rates
3. Data from field or microcosm studies which **directly** demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the COCs
   - Typically used for biological degradation processes only

Three-Tiered Approach where more information is collected as necessary

Source: U.S. EPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites.

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Source: U.S. EPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites.

A three-tiered approach to such an evaluation is becoming more widely practiced and accepted. In this approach, successively more detailed information is collected as necessary to provide a specified level of confidence on the estimates of attenuation rates and remediation timeframe.

Unless EPA or the overseeing regulatory authority determines that historical data (Number 1 above) are of sufficient quality and duration to support a decision to use MNA, data characterizing the nature and rates of natural attenuation processes at the site (Number 2 above) should be provided. Where the latter are also inadequate or inconclusive, data from microcosm studies (Number 3 above) may also be necessary.

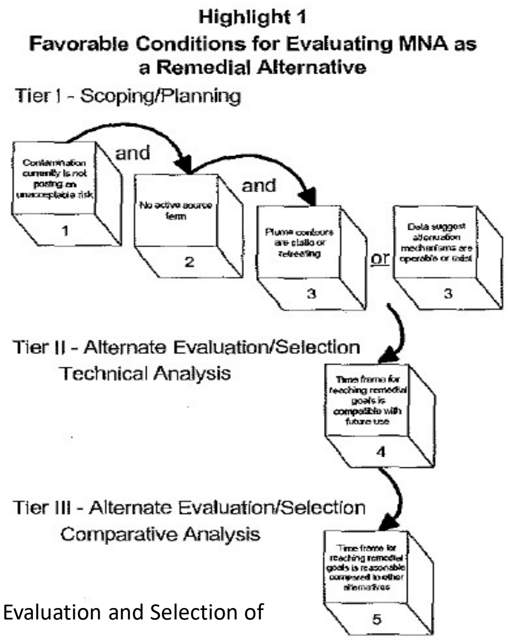
1) Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. (In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration. In the case of inorganic contaminants, the primary attenuating mechanism should also be understood.)
(2) Hydrogeologic and geochemical data that can be used to demonstrate **indirectly** the type(s) of natural attenuation processes active at the site and the rate at which such processes will reduce contaminant concentrations to required levels. For example, characterization data may be used to quantify the rates of contaminant sorption, dilution, or volatilization, or to demonstrate and quantify the rates of biological degradation processes occurring at the site.
(3) Data from field or microcosm studies (conducted in or with actual contaminated site media) which **directly** demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern.

In general, more supporting information may be required to demonstrate the efficacy of MNA at those sites with contaminants which do not readily degrade through biological processes (e.g., most non-petroleum compounds, inorganics), or that transform into more toxic and/or mobile forms than the parent contaminant, or where monitoring has been performed for a relatively short period of time.

Sites where the contaminant plumes are no longer increasing in extent or are shrinking would be the most appropriate candidates for MNA remedies.

DOE Guidance on MNA

- DOE advocates the use of a "tiered" decision-making approach.
- Tiers are structured to streamline the MNA evaluation process while ensuring site resources are expended wisely.
- Data collection and modeling to support MNA are initiated only in those situations where MNA appears sufficiently promising.



Source: U.S. DOE, 1999, Decision-Making Framework Guide for Evaluation and Selection of Monitored Natural Attenuation Remedies at DOE Sites.

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Source: U.S. DOE, 1999, Decision-Making Framework Guide for Evaluation and Selection of Monitored Natural Attenuation Remedies at DOE Sites.

The Department supports the principles set forth in EPA' s directive and has used these principles as a foundation to develop this guide. DOE advocates the use of a "tiered" decision-making approach to assess whether MNA is a viable remedial alternative. This tiered framework utilizes a set of favorable conditions based on the expectations and guidelines contained in the OSWER Directive to guide the evaluation process.

Key Considerations from DOE MNA Guidance

Tier I – Scoping/Planning
- Contamination currently not posing risk
- No active source term (releases to the plume/increasing plume mass)
- Plume perimeter is static or retreating
- Attenuation mechanisms are operable or exist

Tier II – Technical Analysis
- Determine time frame needed for MNA to attain remediation objectives
- DOE considers anticipated future land and groundwater use
- Protection during implementation
- Distance to potential receptors

Tier III – Risk Management Considerations
- Effectiveness (timeframe)
- Implementability (monitoring network)
- Cost (lifecycle)

Source: U.S. DOE, 1999, Decision-Making Framework Guide for Evaluation and Selection of Monitored Natural Attenuation Remedies at DOE Sites.

MNA may be considered as a remedial option under a variety of state and federal regulations, each with their own specific requirements for evaluating and selecting response measures. Therefore, the successful implementation of an MNA alternative ultimately will depend on rigorous, technically defensible analyses and management strategies. The tiered decision-making framework outlined in this guide is designed to ensure such defensible analyses are generated and only in those situations where MNA truly represents a viable remedial strategy.

Source: U.S. DOE, 1999, Decision-Making Framework Guide for Evaluation and Selection of Monitored Natural Attenuation Remedies at DOE Sites.

Technical Impracticability (TI) Waivers

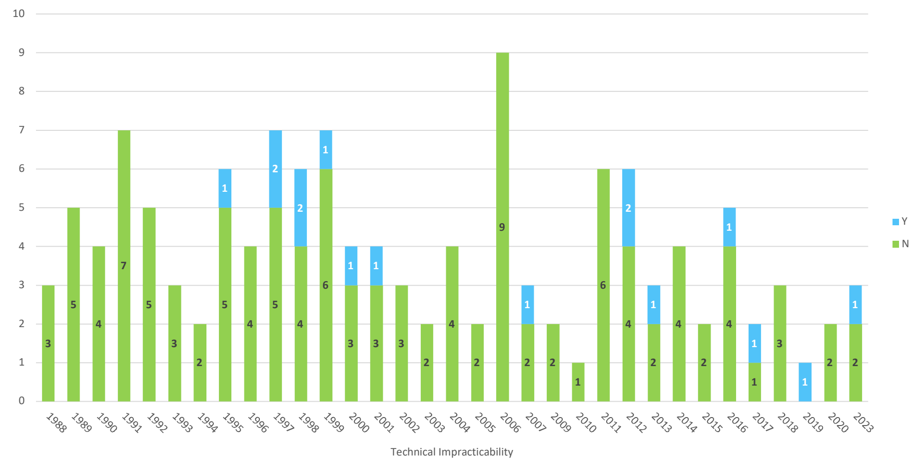
Technical Impracticability (TI) Waivers

- Superfund law allows for waivers of ARARs in limited circumstances
- TI just one of six waivers - most used
- TI waiver may be appropriate when compliance with an ARAR "is technically impracticable from an engineering perspective" (40 CFR 300.430(f)(2)(ii)(C)(3))
- Remedy must still be protective of human health and the environment

TI Waivers (cont.)

- 130 TI waivers granted to date
- Most TI waivers are for groundwater (a few for surface water)
- Waivers typically based on:
  - Inability to treat, remove or contain contaminants:
    - Contaminant chemical and physical properties
    - Complex subsurface geology/hydrogeology
    - Ineffective remedial technologies
  - Long remedial timeframe

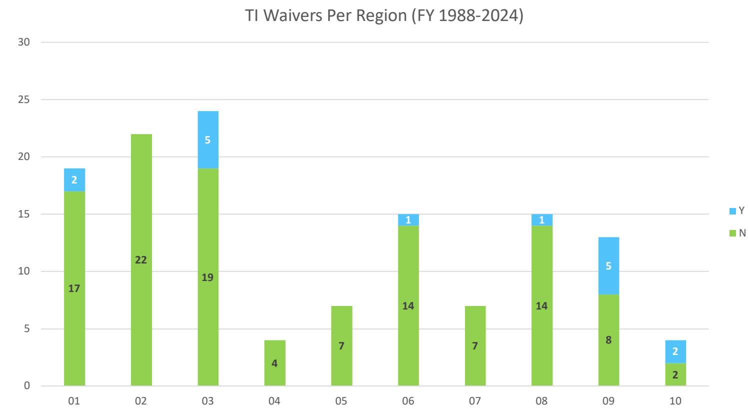
TI Waivers per Fiscal Year (FY 1988-2024)



Total Number of TI Waivers = 130*

*16 TI waivers at 13 sites are for federal facilities.

TI Waivers per Region (FY 1988-2024)



Total Number of TI Waivers = 130*

*16 of the 130 TI waivers are for federal facilities.

Adapted from: U.S. EPA, 2012, Summary of Technical Impracticability Waivers at National Priorities List Sites

The total TI Waivers are the number of draft TI waiver profiles for groundwater based on decision documents through FY 2020.

15 of the 125 TI waivers for groundwater are at Federal Facilities (11 FF sites).

Source: U.S. EPA, 2012, Adapted from Summary of Technical Impracticability Waivers at National Priorities List Sites, Web, https://semspub.epa.gov/work/HQ/175391.pdf.

Technical Impracticability (TI) Waivers

- TI and other waivers may be considered, and under appropriate circumstances granted if the statutory criteria are met, when groundwater cleanup is impracticable; the waiver decision should be scientifically supported and clearly documented.
- Requires review process with regional EPA offices and Headquarters/OLEM.
- TI Evaluation should address these elements to help reviewers decide whether a TI waiver is appropriate based on the site-specific circumstances

Source: U.S. EPA, 2016, Clarification of the Consultation Process for Evaluating the Technical Impracticability of Groundwater Restoration at CERCLA Site

Complex geology (e.g., fractured bedrock) and non-aqueous phase liquids have been the contributing factors in the vast majority of the TI waivers.

Source: U.S. EPA, 2016, Clarification of the Consultation Process for Evaluating the Technical Impracticability of Groundwater Restoration at CERCLA Sites.

Evaluating Technical Impracticability of Groundwater Restoration - Checklist

Source: U.S. EPA, 2016, Clarification of the Consultation Process for Evaluating the Technical Impracticability of Groundwater Restoration at CERCLA Sites.

- ❑ Specific ARARs or Media Cleanup Standards
  - Specific ARARs for which TI waiver is sought
  - Technical feasibility of restoring some of the groundwater contaminants
- ❑ Spatial Extent of TI Decisions
  - Spatial (vertical and horizontal) contaminant distribution in saturated and saturated zones
  - Spatial extent of TI zone as small as possible
- ❑ Development and Purpose of the Conceptual Site Model (CSM)
  - Geologic and Hydrologic information
  - Contaminant distribution, transport, and fate parameters

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Source: U.S. EPA, 2016, Clarification of the Consultation Process for Evaluating the Technical Impracticability of Groundwater Restoration at CERCLA Sites.

TI Evaluation Checklist

- ❑ Evaluation of Restoration Potential
  - Source control measures
  - Remedial action performance analysis
  - Restoration timeframe analysis
  - Other applicable technologies
- ❑ Cost Estimates
  - Estimates for potentially viable remedial alternatives
- ❑ Alternate Remedial Strategies
  - Strategy that is technically practicable, protective, and meets ARARs
- ❑ Additional Remedy Selection Considerations
  - Consider shorter timeframes to reduce exposures

Source: U.S. EPA, 2016, Clarification of the Consultation Process for Evaluating the Technical Impracticability of Groundwater Restoration at CERCLA Sites.

This guidance and attachments provides more details on the process for consulting with EPA headquarters on a TI Evaluation and how to conduct the evaluation.

Remedy Optimization

EPA Remediation Optimization (2013)

- Efforts at any phase of the remedial response to
  - improve the effectiveness and
  - cost-efficiency
- May also improve
  - remedy's protectiveness and
  - long-term implementation which may facilitate progress towards site completion.
- Groundwater remedies may benefit from optimization efforts due to the long-term nature of the response and potential for changes to the conceptual site model

Source: U.S. EPA, 2013, Remediation Optimization: Definition, Scope and Approach

The EPA's Strategy defines optimization as:
"Efforts at any phase of the removal or remedial response to identify and implement specific actions that improve the effectiveness and cost-efficiency of that phase. Such actions may also improve the remedy's protectiveness and long-term implementation which may facilitate progress towards site completion. To identify these opportunities, regions may use a systematic site review by a team of independent technical experts, apply techniques or principles from Green Remediation or Triad, or apply other approaches to identify opportunities for greater efficiency and effectiveness."

Source: U.S. EPA, 2013, Remediation Optimization: Definition, Scope and Approach, Web, https://www.epa.gov/sites/production/files/2015-08/documents/optimizationprimer_final_june2013.pdf

Remediation Optimization (2013) (cont.)

- Review considers
  - the goals of the remedy,
  - available site data,
  - conceptual site model (CSM),
  - remedy performance, and
  - exit strategy.
- Activities include:
  - Examining site documents
  - Interviewing site stakeholders
  - Evaluating site data
  - Developing findings and recommendations
  - Compiling a report for the purposes of project documentation and technology transfer

Source: U.S. EPA, 2013, Remediation Optimization: Definition, Scope and Approach

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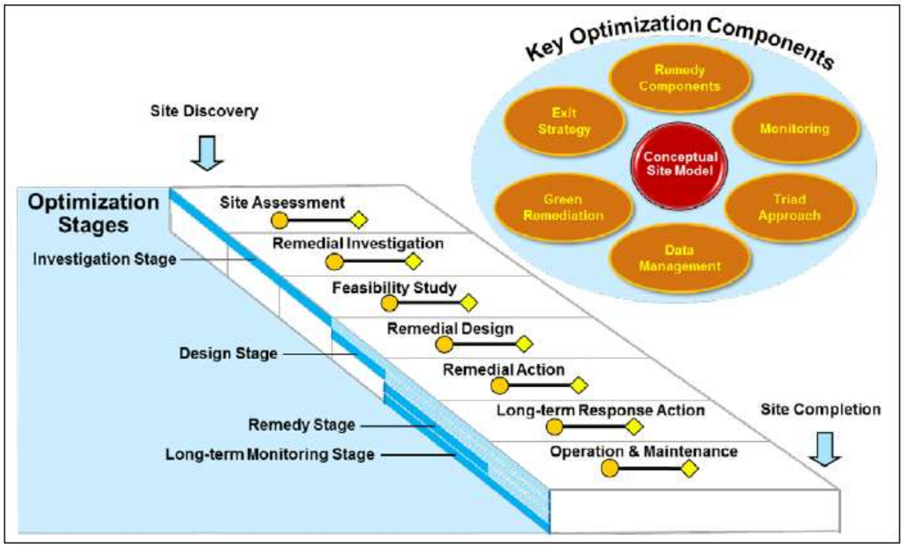
Focuses on protectiveness, effectiveness, cost efficiency, technical improvement, progress toward site completion, site closure, and environmental footprint reduction (qualitative or quantitative). Optimization review considers the goals of the remedy, available site data, the conceptual site model (CSM), remedy performance, and exit strategy.

Source: U.S. EPA, 2013, Remediation Optimization: Definition, Scope and Approach, Web, https://www.epa.gov/sites/production/files/2015-08/documents/optimizationprimer_final_june2013.pdf

Figure 1 - Optimization Applied to Cleanup Activities from Site Assessment to Site Completion



Source: U.S. EPA, 2013, Remediation Optimization: Definition, Scope and Approach

Source: U.S. EPA, 2013, Remediation Optimization: Definition, Scope and Approach, Web, https://www.epa.gov/sites/production/files/2015-08/documents/optimizationprimer_final_june2013.pdf

Optimization Review Report Outline

- A typical draft optimization review report or memorandum includes the following information:
  - Executive summary
  - General site background
  - Summary of the characterization or remediation objectives
  - Findings from document reviews, data analysis and interviews
  - Recommendations (including expected costs/savings implications) that address critical data gaps, remedy implementation, protectiveness, cost, and progress to site closure

Source: U.S. EPA, 2013, Remediation Optimization: Definition, Scope and Approach

Source: U.S. EPA, 2013, Remediation Optimization: Definition, Scope and Approach, Web, https://www.epa.gov/sites/production/files/2015-08/documents/optimizationprimer_final_june2013.pdf

Apply Your Understanding

During which parts of the CERCLA process can optimization be considered?

A. RI/FS

B. Remedy design

C. Remedy construction

D. Remedy operation and maintenance

E. At any time of the process

Answer is E.

Optimization includes efforts at any phase of the removal or remedial response to identify and implement specific actions that improve the effectiveness and cost-efficiency of that phase. Such actions may also improve the remedy's protectiveness and long-term implementation which may facilitate progress towards site completion.

DOE Guidance for Optimizing Groundwater Response Actions at DOE Sites

- Designing optimal response strategies includes:
  - Planning Response Priorities
  - Addressing Current or Imminent Risk
  - Groundwater Restoration Evaluation
  - Evaluation of Source Control Measures
  - Evaluation of Mass Reduction Measures
  - Monitoring
- Other consideration include:
  - Technical Impracticability
  - Transition and Exit Strategies
  - Communicating Groundwater Response Strategies

Source: Guidance for Optimizing Groundwater Response Actions at DOE Sites, DOE, 2002

Source: Guidance for Optimizing Groundwater Response Actions at DOE Sites, DOE, 2002

Per DOE guidance: Groundwater contamination is addressed under a "·resource-based" approach. As a result, the initial field of remedial action objectives (RAOs) is narrowed to restoration. However, the actual restoration of groundwater is often a long-term proposition that may not address more immediate exposure concerns at a given site. Therefore, both risk and resource considerations are used to identify the optimal manner in which to respond to groundwater contamination.

Since the order in which actions are taken should be determined on the basis of risk rather than the broader resource protection framework through which ultimate programmatic objectives are selected, the first and foremost consideration is whether any current or imminent exposures exist that need to be expeditiously addressed.

Once provisions have been made to address a current or imminent risk, the focus shifts to the evaluation of viable measures for restoring contaminated groundwater to its highest beneficial use.

Given the above considerations and the low cleanup criteria associated with many contaminants, restoration may be impracticable more frequently than originally anticipated. However, a conclusion that restoration is impracticable is simply a recognition that currently available technologies are unable to achieve the desired goal in a reasonable time frame, and a different focus is needed to provide the necessary assurances that human health and the environment are adequately protected over time.

DoD Remedial Optimization Policy (2012)

1. The DoD Component shall maximize DERP effectiveness and minimize the DERP financial liabilities and environmental footprint
2. The DoD Component shall, to the maximum extent possible, identify specific environmental restoration objectives
3. Optimization of remedial alternatives begins during the analysis of remedial alternatives when the DoD Component considers means to evaluate and improve the remedy over time
   - Optimization process continues through the operating life of the remedy to the end state condition

Source: DoD Manual 4715.2

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DoD Manual 4715.20 (available at
https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/471520m.pdf
)states the following:
e. Remedy Optimization
(1) The DoD Component shall maximize DERP effectiveness and minimize the DERP financial liabilities and environmental footprint.
(2) The DoD Component shall, to the maximum extent possible, identify specific environmental restoration objectives (e.g., site-specific and appropriate residual concentrations for each contaminant of concern) in a DD that selects the response action. Changes to the remedy requiring modification of the DD shall be in accordance with subparts 300.430(f)(3)(ii) and 300.435(c)(2) of NCP.
(3) Optimization of remedial alternatives begins during the analysis of remedial alternatives when the DoD Component considers means to evaluate and improve the remedy over time. The optimization process continues through the operating life of the remedy to the end state condition that was defined as the final environmental restoration objectives. The DoD Component shall develop and implement ways to continue to evaluate the response action throughout the remedy lifecycle. Such an evaluation can be a part of required reviews, such as the statutorily required 5-year review. During this continued evaluation of implemented remedies the DoD Component may examine factors including:
(a) Means for optimizing the overall performance and effectiveness of the remedy.

(b) Means for controlling the operational, maintenance, and monitoring cost(s) of remedies in the RA-O phase.
(c) Assessing the adequacy and concurrence of the exit strategy (i.e., environmental restoration objectives and RAWP) with the DD.
(d) Assessing if the environmental restoration objectives specified in the DD are consistent with planned and future resource use.
(e) Assessing if the environmental restoration objectives specified in the DD are achieved and whether the response action is still needed.
(f) Determining if a different remediation goal is needed or if an alternative technology or approach is more appropriate.

Questions