Section 2

Applicability and Review of Remedy Technologies

This section describes the approach used for evaluating potential response actions at the GWP site, the RAOs and PRGs established for the site, and the ARARs. An evaluation of presumptive remedy technologies, along with selected more recent widely-accepted technologies or design variations of presumptive technologies, developed since the presumptive remedy guidance was released in 1996, is presented in terms of their applicability to the identified contamination.

Contaminated ground water exists at over 85 percent of the sites on the NPL. The goal of ground water remediation at Superfund sites is to protect human health and the environment through a combination of short-term measures (e.g., provision of alternate water supplies, blending programs) and long-term measures to restore ground water quality, as appropriate, for beneficial use. A RA for contaminated ground water generally is warranted when EPA determines, based on the results of a BHHRA such as that performed for the GWP site, that the contamination poses a current or potential threat to human health or the environment (CERCLA §104(a)(1), §104(b)(1)).

In addition, where the ground water is designated a drinking water supply, exceedances of MCLs and non-zero Maximum Contaminant Level Goals (MCLGs) established under the SDWA also may be used as the basis for taking a RA. The goals of the long-term ground water cleanup program are summarized in the NCP as follows:

> "*EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site. When restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction*" (40 CFR §300.430(a)(1)(iii)(F))."

Ground Water Response Actions. For ground water response actions, alternatives address not only cleanup levels but also the time frame within which the alternatives might be achieved. Depending on specific site conditions and the aquifer characteristics, alternatives are selected and identified as those that will achieve ARARs or other health based levels determined to be protective within varying time frames using different methodologies.

For aquifers such as at the GWP site where the ground water is currently used as a drinking water source, alternatives are configured in a manner that would achieve ARARs or risk-based levels as rapidly as possible.

Developing Ground Water Remedial Alternatives. A RA for contaminated ground water generally is warranted when EPA determines, based on the results of the BHHRA, the contamination poses a current or potential threat to human health or the environment (**EPA, 1997b**).

2.1 Approach for the Identification of Technologies and Development of Alternatives

The presumptive remedy strategy and presumptive remedy technologies for contaminated ground water sites are outlined in the EPA guidance document *Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites* (**EPA, 1996**). Certain categories of sites have similar characteristics, such as the types of contamination present, the types of past industrial use, or the types of environmental media that are affected. The use of a "presumptive remedy strategy and technologies" streamlines site characterization and the selection of RAs. In addition, it improves consistency, reduces costs, and increases the speed at which sites are remediated.

PCE, the primary COC at the GWP site based on its concentration and extent, has been treated in contaminated ground water at many sites. Technologies for treating PCE are widely available and understood. In addition, there is a lack of demonstrated risk from the unsaturated zone contamination at the GWP site (**CH2M HILL, 2006a**). For the GWP site, therefore, the presumptive remedy approach was deemed appropriate, and was used to streamline the identification and screening of remedial technologies applicable to the site. The presumptive remedy technologies were reviewed, in keeping with the guidance, along with selected more recent widely-accepted technologies or design variations of presumptive technologies developed since the presumptive remedy guidance was released in 1996.

The phased implementation of a remedy can often be beneficial even for relatively simple ground water actions. Phased implementation is included in the presumptive remedy approach for contaminated ground water (**EPA, 1996**). In a phased approach, the remedy is implemented in a sequence of steps such that information gained from earlier phases is used to refine subsequent actions.

For the GWP site, site characterization data available in the RI (**CH2M HILL, 2006a**) are sufficient to determine that the likelihood of attaining the RAOs is relatively high. For this reason, the phased approach described in the presumptive remedy approach for contaminated ground water (**EPA, 1996)** is being evaluated for implementation at this site. The ground water will be the focus of the remedial effort in the first phase. If it is determined, based on review of the efficiency of the selected remedy, including, but not limited to, ground water data, system operational data, and modeling, that the RAOs are not attainable, a second phase will be designed and implemented. A contingency remedy, or second phase, may include, but would not be limited to, further ground water remediation (e.g., adding pumping wells or treatment system wells) or remediation of soil vapor. **Figure 2-1** (**EPA, 1996**) depicts the decision logic used to evaluate the phased approach to a long-term remedy implementation.

Implementing investigations and actions in phases provides the following major benefits (**EPA, 1996**):

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

A FS for sites where the phased-approach and presumptive remedy evaluation and selection process are used differs from a conventional FS in that it allows for the following:

- The use of a phased-approach to remediation where initial and contingency remediation alternatives are considered. This FS will propose implementation of the contingency remedy only if performance data from the initial remedy phase indicate that the long-term RAOs are not attainable by the initial remedy alone. Provisions are made for assessing the attainability of long-term objectives using performance data during the initial remedy phase.
- Identification of the presumed or likely treatment technologies up front, thereby allowing for a more focused technology evaluation.

- Elimination of the need for the initial step of screening alternatives during the FS. After an analysis of similar FSs and RODs, EPA found that certain technologies were appropriately and consistently screened from further consideration based on the criteria of effectiveness, implementability, and cost. Therefore, the initial step of identifying and screening technologies may be eliminated in the instances where the presumptive remedy process is deemed appropriate. Instead, the FS may proceed directly from identification of alternatives to the detailed analysis, focusing on the technologies recommended in the presumptive remedy guidance for contaminated ground water sites (**EPA, 1996**). As previously indicated, however, technologies that have become widely used since the presumptive remedy guidance was released have been considered also.

2.2 Remedial Action Objectives

The first step of the process is to identify the RAOs for the site. The RAOs and PRGs should reflect current and potential future uses of the ground water and exposure scenarios that are consistent with these uses. Generally, drinking water standards (federal MCLs, non-zero MCLGs, or more stringent state drinking water standards) are relevant and appropriate as PRGs, and ultimately as final cleanup levels, for ground water determined to be a current or potential future source of drinking water (40 CFR §300.430(e)(2)(i)(B and C)) (**EPA, 1997b**). The MCLG for PCE is zero; therefore, the MCL is relevant and appropriate for consideration as a PRG.

The RAOs for ground water at this site were established in accordance with the *Presumptive Response Strategy and Ex Situ Treatment Technologies for Contaminated Ground water at CERCLA Sites* (**EPA, 1996**), and are provided as follows:

- Prevent human exposure to contaminated ground water above the MCL (5 µg/L) for PCE.
- Maintain capture of the PCE-contaminated ground water plume above the MCL (5 µg/L) for PCE.
- Restore ground water to its expected beneficial use as a drinking water supply with PCE concentrations no greater than the MCL (5 µg/L).

As described in **Section 1**, based on a comparison between ground water concentrations and MCLs in monitor wells, PCE was identified as the COC for ground water. Concentrations of PCE were measured below the MCLs at current ground water exposure points, primarily as a result of the blending program enacted by the CLC to meet drinking water regulations. Nonetheless, a potential for future unacceptable exposure above the MCL exists if (1) PCE is not maintained below the MCL in the municipal water supply; (2) if private wells are completed in the plume; or (3) if the ground water plume expands beyond the current site boundary.

In addition to PCE, VOCs benzene, toluene, MTBE, and PCE degradation products TCE, and 1,2 cis- and 1,2 trans-DCE have been detected in the ground water within the footprint of the PCE plume at the site. Of these, only benzene has been detected in site monitor wells above its corresponding MCL, although it has not been detected in samples from the municipal supply wells. The benzene, toluene, and MTBE are addressed under the New Mexico Petroleum Storage Tank Regulations (NMAC 20.5). VOCs other than PCE located within the footprint of the PCE plume will also be addressed by the treatment and hydraulic containment aspects of the alternative described in this FS because, as VOCs, they are similar in nature to PCE, and because they are co-mingled with the PCE plume. VOCs detected in site monitor wells will be sampled as part of the long-term monitoring (LTM) program to be selected for the site. Annual evaluations of ground water data collected at the site will be performed to monitor trends in these contaminants and provide information for future decision-making.

It is important that coordination between all environmental programs occur to provide effective management of co-mingled contaminants, and to prevent further co-mingling and expansion of contaminated areas within and outside the boundaries of the GWP site PCE plume.

As noted previously, uranium also exceeds its corresponding MCL in seven municipal supply wells. However, elevated concentrations of uranium are naturally occurring, and the CLC is addressing the elevated uranium concentrations in the drinking water supply as part of compliance with the SDWA.

2.2.1 Applicable or Relevant and Appropriate Requirements (ARARs)

The NCP requires a selected response action to attain ARARs under Federal and State environmental laws 40 CFR 300.430(e)(2)(i)(A). RAOs and PRGs established for a site must consider ARARs.

Under CERCLA, a requirement may be either “applicable” or “relevant and appropriate” to a specific response action, but not both. The NCP (40 CFR Section 300.5) defines “applicable” and “relevant and appropriate” requirements as follows:

- **Applicable requirements** are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Only those state standards that are more stringent than federal requirements may be applicable.

- **Relevant and appropriate requirements** are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site so that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

Typically, ARARs are compiled in the following three categories:

- Chemical-specific
- Action-specific
- Location-specific

The primary factor that influenced selection of the ARARs for the GWP site was the elevated contaminant levels of PCE found in CLC municipal water supply wells.

Tables 2-1 and **2-2** (included at the end of this section) present the federal and State of New Mexico ARARs, respectively. The ARARs listed on the tables are grouped by type of regulation (i.e., air, water, solid and hazardous waste, transportation). A summary of the ARARs is provided below. Although not considered ARARs, City and County requirements and regulations were also investigated as presented on **Table 2-3.**

2.2.1.1 Chemical-Specific ARARs

Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies used to determine acceptable concentrations of chemicals that may be found in or discharged to the environment, for example, MCLs that establish safe levels in drinking water.

The chemical-specific ARARs most pertinent to the GWP site are the federal SDWA MCLs, the State of New Mexico drinking water standards (NMAC 20.7), and the New Mexico Water Quality Control Commission Regulations (NMAC 20.6.2). These standards are important in establishing remediation goals for ground water.

2.2.1.2 Action-Specific ARARs

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions or conditions involving specific substances. The action-specific ARARs presented in this document for the GWP site have been selected based on potential remedial action alternatives. The following potential action-specific requirements may be applicable or relevant and appropriate: (1) design standards affecting the construction of a remedy; (2) performance standards affecting operation of a remedy, specifically, treatment requirements and management of residuals; and (3) discharge standards for a particular process.

The action-specific ARARs most pertinent to the response actions discussed later in this report are the federal and state laws pertaining to the management of solid and hazardous waste, and those pertaining to air emissions, including the New Mexico Air Pollution Control Regulations (NMAC 20.2). For all CERCLA remedies, the remedial action is exempt from having to obtain permits. However, any substantial requirements of applicable permits, such as discharge limitations, must be met in the remedy. Any improvements to the system must comply with all applicable state rules and regulations. Such requirements are usually set by the state, if the state is authorized to administer the federal program.

2.2.1.3 Location-Specific ARARs

Location-specific ARARs restrict actions or contaminant concentrations in certain environmentally sensitive areas. Examples of areas regulated under various federal laws include floodplains, wetlands, and locations where endangered species or historically significant cultural resources are present.

No location-specific ARARs were identified for the GWP site.

2.2.1.4 To-Be-Considered Criteria

To-be-considered (TBC) criteria are nonpromulgated, nonenforceable guidelines, or criteria that may be useful for developing a remedial action or that are necessary for evaluating what is protective to human health and/or the environment. Examples of TBC criteria include EPA drinking water health advisories, reference doses, and cancer slope factors.

2.2.2 Preliminary Remediation Goals

The target contaminant defined for ground water at the GWP site is PCE. The New Mexico Water Quality Control Commission Regulations (20.6.2.3103 of the New Mexico Administrative Code [NMAC]) include ground water standards for PCE based on human health (0.02 mg/L). The MCL for PCE established under the SDWA is lower (0.005 mg/L) and therefore the MCL will be used as the PRG.

Benzene has also been detected in site monitor wells above its MCL of 5 µg/L, although it has not been detected in samples from municipal supply wells. Because benzene is addressed under the New Mexico Petroleum Storage Tank regulations (NMAC 20.5), a PRG will not be established for benzene at the GWP site. It will be monitored as part of the LTM program to be selected for the site, however, and annual evaluations of ground water data collected at the site will be performed to monitor trends and provide information for future decision-making.

Uranium is also present in the ground water at levels above its MCL, but it is considered naturally occurring, and, as such, it is not directly regulated under CERCLA. If the selected RA includes discharge of extracted ground water to the municipal water supply, however, uranium will need to be addressed to comply with drinking water ARARs. For this reason, potential treatment technologies for the removal of uranium are discussed briefly in **Section 2.4**. The CLC is required to address uranium to comply with SDWA requirements, however, and uranium removal is not included, therefore, in the alternatives or associated costs developed for this FS.

2.2.3 Occurrence and Volume of Affected Media above PRGs

Another step in the FS process is to identify the occurrence of affected media above the PRGs, determine which RAOs must be applied to each media, and determine the approximate volume of ground water to be remediated. This process defines the target treatment zones and supports sizing and costing of treatment technologies and alternatives.

PCE contamination is observed in ground water in the UHZ, the upper portion of the LHZ, and the lower portion of the LHZ, as shown in **Figures 1-10 through 1-12**. The approximate volume of contaminated ground water at the GWP site was estimated by the JSP as part of the ground water modeling activity. The estimated volume was estimated by the JSP at between 1,928 and 2,892 acre-feet (6.82 and 9.42 billion gallons). The approximate volume of ground water to be remediated, i.e. with PCE concentrations greater than 5 µg/L, was estimated at between 735 and 1,102 acre-feet (2.39 and 3.59 billion gallons).

The total contaminant mass of PCE at the GWP site was estimated by the JSP (based on the volume of contaminated ground water provided above) at between 150 and 225 kilograms (between 330 and 496 pounds). The contaminant mass of PCE to be remediated, i.e. with PCE concentrations greater than 5 µg/L, was estimated at between 110 and 160 kilograms (between 242 and 357 pounds).

2.3 Evaluation of Remedial Technologies

As described in **Section 2.1**, the use of the presumptive remedy approach for sites with contaminated ground water outlined in the EPA guidance document (**EPA, 1996**) has been considered to be appropriate for the GWP site. This section describes the presumptive remedy technology options available under the guidance and reviews their applicability in light of the specific conditions documented at the site and the RAOs/PRGs established for the site, along with selected more recent widely-accepted technologies or design variations of presumptive technologies developed since the presumptive remedy guidance was released in 1996.

2.3.1 Description of Remedial Technologies

The following is a list of the presumptive remedy treatment options defined by EPA for sites contaminated with organics (**EPA, 1996**). Practical presumptive technologies for treatment of extracted ground water with dissolved organic contaminants, volatiles, and semivolatiles are as follows:

- Air stripping
- Granular activated carbon (GAC)
- Chemical/UV oxidation
- Aerobic biological reactors

These presumptive remedies are well-understood methods that have been used for many years in the treatment of drinking water and/or municipal or industrial wastewater (**EPA, 1996**).

Examples of in-situ ground water treatment technologies are also provided in the presumptive remedy guidance (**EPA, 1996**). These technologies, as well as more recent commonly used, cost effective, and practical treatment technologies, are as follows:

- Recirculation/flooding (water, steam, chemical, nutrient)
- Thermal Enhanced Recovery (radio frequency, electrical resistance)
- Electromigration
- Physical/Chemical Treatment (volatilization, oxygen enhancement, chemical oxidation/reduction, solvent flushing)
- Biological Treatment (aerobic, anaerobic, reductive dehalogenation)

In addition to these technologies, the EPA guidance document also states that natural attenuation may be an appropriate remedial approach for portions of the contaminant plume when combined with other remedial measures needed to control sources and/or remediate "hot spots" (**EPA, 1996**). The

NCP defines natural attenuation as "biodegradation, dispersion, dilution, and adsorption" of contaminants in ground water (Federal Register, 1990a, Preamble at 8734). The NCP also states that natural attenuation may be a useful remedial approach if site-specific data indicate that these processes "will effectively reduce contaminants in the ground water to concentrations protective of human health and the environment in a timeframe comparable to that which could be achieved through active restoration."

Selection of technologies for long-term treatment of extracted ground water requires an understanding of the types of technologies that will be needed and how they will be used in the treatment system, as well as site-specific information for determining the most appropriate and cost-effective technologies. The presumptive technologies presented above are the technologies retained for further consideration in **Section 3** and **Section 4**, the development and detailed analysis of remedial alternatives for the GWP site . The presumptive remedy guidance (**EPA, 1996**) and its associated Administrative Record supports the identification and screening of technologies portion of this FS.

Institutional controls (ICs) can be used as a component of a presumptive remedy to minimize or prevent exposure to contaminated media that remain at a given site. The NCP emphasizes that ICs, such as water use restrictions, are meant to supplement engineering controls during all phases of cleanup and may be a necessary component of the completed remedy.

2.3.2 Site Specific Evaluation of Remedial Technologies

Table 2-4 summarizes the screened technologies separated by response action type. This table includes the presumptive technologies, or categories of technologies, listed in EPA's presumptive remedyguidance (as described in **Section 2.3.1**), and, in keeping with the guidance, selected new technologies that have become widely used since the issuance of the EPA guidance. Each is described in the following paragraphs in more detail.

No Action. "No action" is considered a response action. According to the NCP and EPA guidance (**EPA, 1988**), a No Action alternative must be considered. The No Action alternative is used as a baseline to compare other alternatives. Although a No Action alternative may include some type of environmental monitoring, action taken to reduce the potential for exposure (e.g., well abandonment, wellhead treatment [including blending], site fencing, or deed restrictions) should not be included as a component of the No Action alternative. This alternative is retained as a basis for comparison of risk-reduction using remediation technologies.

Institutional Controls. ICs are a category of response actions. ICs are non-engineered instruments such as administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land or resource use; are generally to be used in conjunction with, rather than in lieu of, engineering measures such as waste treatment or containment; can be used during all stages of the cleanup process to accomplish various cleanup-related objectives; and, should be "layered" (i.e., use multiple ICs) or implemented in a series to provide overlapping assurances of protection from contamination. Some examples of ICs include easements, covenants, well drilling prohibitions, zoning restrictions, and special building permit requirements (**EPA, 2000**). Because the prevention of exposure to site contamination is an RAO, ICs will be given further consideration. Although this option alone will not meet the RAOs, it is considered in conjunction with all alternatives.

Monitoring. Monitoring is a response action. Ground water monitoring alone will not meet the RAOs, but is likely to be a component of the selected alternative. Monitoring will be used to document site conditions prior to implementation of a remedy and evaluate the effectiveness of the implemented remedy. Monitoring includes sampling according to a prescribed plan and can include site contaminants, as well as water quality parameters (e.g., alkalinity, hardness, TOC, TDS, etc.), and natural attenuation indicator parameters (e.g., molecular hydrogen, chloride, methane, etc.).

Containment. Containment is a response action that includes many technologies that inhibit the vertical or horizontal migration of contaminants. Examples of physical barriers include sheet piling, bentonite slurry walls, ground freezing, and grouting. Examples of hydraulic containment include pumping wells and trenched drains. Treatment can also be combined with containment technologies with the use of permeable reactive barriers. At this site, the ground water is too deep (i.e., greater than 200 ft bgs) and the vertical extent of contamination is too thick (i.e., greater than 400 ft) to make physical containment cost effective. However, hydraulic containment using vertical pumping wells is a technology option that may be cost effective and is retained for further consideration. Containment alone will not meet the RAOs; however, vertical pumping wells are retained as it may be considered in conjunction with another technology.

Removal. Removal is a response action that includes many technologies. The removal of ground water for treatment can be performed in many ways. Because of the depth to ground water and thickness of contamination as previously described, ground water extraction methods such as horizontal wells, drain lines, and one-pass trenching are technically infeasible and/or cost prohibitive. As with containment technologies, vertical pumping wells are technically feasible and can be cost effective. For this site, there is the potential to use existing municipal supply wells for ground water extraction. Vertical pumping wells are retained for further consideration.

Ex-situ Treatment. Ex-situ treatment is a group of technologies under the response action category of Treatment. Once extracted from the subsurface and treated, the ground water must be discharged. This can mean that the extracted water is delivered to an approved discharge facility or discharged on site to a ground water reinjection well, to a surface water body, to the municipal sewer system, or to the stormwater system. Discharge can also mean provided to the CLC as a drinking water supply. In the case of most of the discharge options (with the possible exception of the municipal sewer system), the contamination above the PRGs needs to be removed from the ground water, and permits and/or agreements with the appropriate parties need to be approved prior to discharge. Because the site ground water is the drinking water supply for the CLC, supplying the water to the City is the preferable option (i.e., beneficial use) and the other discharge methods will only be investigated for use as repair/emergency discharge options. Ex-situ presumptive remedy treatment methods include air stripping, GAC, chemical/UV oxidation, and aerobic biological reactors. Each of these four technologies is described below.

Air Stripping –Air stripping is a technology in which VOCs are transferred from extracted water to air. Air stripping can take place in a packed tower or sieve tray (known as an “air stripper”) or an aeration tank. The packed tower “air stripper” typically includes a spray nozzle at the top of the tower. It sprays ground water that has been pumped to the treatment system over the packing in the column. As the water descends, air is forced up through the packing in the column, stripping off the volatile compounds. Packing or baffles within the tower increase the surface area of the contaminated water that is exposed to air, thus maximizing the amount of volatilization. A basin at the bottom of the tower collects decontaminated water. Auxiliary equipment may include an air heater to improve removal efficiency and air emission “scrubbers” to remove contaminants from the exhaust prior to atmospheric discharge.

Another air stripping design is known as the low-profile tray air stripper. These units have a number of trays that are set almost horizontally. In a counter-current manner, water cascades down over the trays while air is blown up through many small holes in the trays to maximize air-water contact while minimizing vertical space. Multiple trays can be stacked on top of each other to achieve higher removal efficiencies. Because they are more compact, they have become the more prominent type of air stripper used for the removal of volatile compounds from ground water.

As noted above, controls to remove contaminants from the vapor phase may be required, depending on the concentration of contaminants in the emissions and local requirements. Las Cruces is an attainment area under the CAA. In accordance with the OSWER Directive 9355.0-28 “Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites” (**EPA, 1989**), the air stripping alternatives developed in this FS include preliminary calculations of air emission rates associated with air stripping of PCE and consideration of potential air emissions under the remedy selection criteria evaluation. These preliminary calculations indicate it is unlikely that air emission controls will be required (see **Section 4**). The alternatives that include air stripping also include air monitoring to confirm emissions are in compliance.

Air stripping is technically feasible for this site and can be cost effective. This technology is retained for further consideration.

GAC – GAC is a material used to filter harmful chemicals from contaminated water. As contaminated water flows through a GAC filter, chemicals stick, or adsorb, to the surface and within the pores of the granules. GAC generally consists of one or more containers or columns of granules. It is designed to sorb specific contaminants found at a site. The water is usually pumped through a GAC column from the top down, but upward flow is also possible. The water that exits the column is cleaner than the water that entered it. If the water is not clean enough, it is pumped into another column for "polishing."

GAC is technically feasible for this site and can be cost effective. This technology is retained for further consideration.

Chemical/UV Oxidation – This technology uses specific chemicals, called oxidants, and/or UV light to destroy organic contamination in ground water. The extracted ground water is mixed with oxidants and/or exposed to UV light, causing the contaminants to break down into less harmful chemicals, such as water and carbon dioxide.

Chemical/UV oxidation is technically feasible for this site and can be cost effective. This technology is retained for further consideration.

Aerobic Biological Reactors – This technology uses microorganisms to break down contamination. Ground water is pumped through a vessel that contains microorganisms and a growth substrate. The microorganisms use the contaminants as part of their metabolic processes (e.g., as a food source, or nutrient) and can completely metabolize them to produce carbon dioxide and water. Aerobic microorganisms need oxygen to break down contaminants. In this case, oxygen is pumped into the container and mixed with the microorganisms and contaminated ground water. Anaerobic microorganisms use nutrients such as methane, sulfate, nitrate, and iron instead of oxygen to break down contaminants.

PCE is more readily degraded using anaerobic processes and therefore an anaerobic biological reactor would be needed for this site (if this technology is selected). If the appropriate microbes are not used, however, this degradation pathway may cause a build up of vinyl chloride, which is not as easily broken down anaerobically. A sequential anaerobic-aerobic reactor can be used to complete the degradation of vinyl chloride to innocuous by-products. For the low levels of contaminants at this site, this technology is much less effective than other ex-situ technologies and therefore is not considered further.

In-situ Physical/Chemical Treatment. In-situ physical/chemical treatment is a second group of technologies under the response action category of Treatment. In-situ technologies treat the ground water in place and therefore do not require ground water extraction. Most in-situ technologies inject air and/or chemicals into the ground water to assist in physical removal, chemical breakdown, or biological breakdown of the contaminants. At this site, the injection of most in-situ treatment chemicals is not desired because of the proximity to municipal supply wells and the potential taste and odor effects. In addition, the thickness of the ground water contamination and the heterogeneity of the subsurface matrix make the delivery of chemicals within the subsurface very difficult. Specific details about each in-situ treatment technology are presented in **Table 2-4**. In-well air stripping and recirculation are in-situ treatment technologies that do not use chemical injection. They are described below.

In-Well Air Stripping – The principal of in-well air stripping is the same as that in air stripping described above except that the treatment occurs within a single well casing. In this case, a ground water circulation pattern is established at the same time as the ground water is aerated within the well to volatilize the contaminants. Air-lift pumping is typically used to lift ground water and strip it of contaminants. The vapors produced may be allowed to biodegrade in the soil or can be drawn off for aboveground treatment. Since biodegradation has not been shown to be significant at the GWP site, vapors will be drawn off for treatment, if necessary. Partially treated ground water is forced out of the well into the soil where it infiltrates back down to the water table. Untreated ground water enters the well at its base, replacing the water lifted through pumping. Eventually, the partially treated water is cycled back through the wells through this process until the concentration goals are met.

As noted above for air stripping, controls to remove contaminants from the vapor phase may be required, depending on the concentration of contaminants in the emissions and local requirements. Las Cruces is an attainment area under the CAA. In accordance with the OSWER Directive 9355.0-28 “Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites” (**EPA, 1989**), the air stripping alternatives developed in this FS include preliminary calculations of air emission rates associated with air stripping of PCE and consideration of potential air emissions under the remedy selection criteria evaluation. These preliminary calculations indicate it is unlikely that air emission controls will be required (see **Section 4**). The alternatives that include air stripping also include air monitoring to confirm emissions are in compliance.

In-well air stripping is technically feasible for this site and may be cost effective. This technology is retained for further consideration.

Recirculation – Recirculation is used in conjunction with ground water extraction and an ex-situ treatment technology. The treated ground water is reinjected into the subsurface at locations away from the extraction points. When properly designed, this reinjected ground water causes a circulation pattern that pushes ground water towards the extraction wells and can enhance the efficiency of ground water contaminant extraction.

Recirculation is technically feasible for this site and may be cost effective by reducing the overall cleanup time. This technology is retained for further consideration.

In-situ Biological Treatment. In-situ biological treatment is another group of technologies under the response action category of Treatment. The PCE degradation mechanism is called reductive dechlorination. A hydrogen source is necessary to provide electrons to complete this reaction. Typically, additives include, but are not limited to, lactate, methanol, hydrogen, and molasses. Where the subsurface is heterogeneous, it is very difficult to deliver the additives throughout every portion of the contaminated zone. A ground water circulation system must typically be created so that contaminants do not escape from zones of active biodegradation. The thickness of ground water contamination (60 to 350 ft thick) at the site would require very large quantities of additives. In addition, this degradation mechanism produces a more toxic daughter product, vinyl chloride, which might not be easily biodegraded to non-toxic ethane under anaerobic conditions. The possibility of the build-up of vinyl chloride would require bench-scale and/or pilot-scale testing to determine if bioaugmentation would be necessary.

Because of the difficulty in the delivery efficiency of the biological enhancement chemicals, this technology is not considered further.

Monitored Natural Attenuation. The term “monitored natural attenuation” (MNA) refers to the reliance on natural attenuation processes to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The processes that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants. 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. The preamble of the NCP states:

> *Natural attenuation is generally recommended only when active restoration is not practicable, cost-effective or warranted because of site-specific conditions (e.g., Class III ground water or ground water which is unlikely to be used in the foreseeable future and therefore can be remediated over an extended period of time) or where natural attenuation is expected to reduce the concentration of contaminants in the ground water to the remediation goals -- levels determined to be protective of human health and sensitive ecological environments -- in a reasonable timeframe. Further, in situations where there would be little likelihood of exposure due to the remoteness of the site, alternate points of compliance may be considered, provided contamination in the aquifer is controlled from further migration. The selection of natural attenuation by EPA does not mean that the ground water has been written off and not cleaned up but rather that biodegradation, dispersion, dilution, and adsorption will effectively reduce contaminants in the ground water to concentrations protective of human health in a timeframe comparable to that which could be achieved through active restoration. Institutional controls may be necessary to ensure that such ground waters are not used before levels protective of human health are reached.*

Natural attenuation processes are typically occurring at all sites, but to varying degrees of effectiveness depending on the types and concentrations of contaminants present and the physical, chemical, and biological characteristics of the soil and ground water. At the GWP site, natural attenuation occurs primarily through the physical processes of advection, diffusion, and dispersion. Processes that degrade or destroy PCE in ground water at this site have not been observed. Therefore, an implemented MNA remedy with no other treatments would not meet RAOs at the GWP site. Also, MNA would not be necessary in a RA that provides complete plume capture. MNA might be a useful contingency where plume capture is not achieved or if pumping to attain plume capture is considered technically impractical. MNA may also be deemed applicable and acceptable to be used after cessation of active remediation, for example, if active remediation becomes ineffective and contaminant concentrations have been reduced to levels close to the MCLs. MNA is retained, therefore, for future consideration.

2.4 Evaluation of Uranium Removal Technologies

As discussed in **Section 2.2.2**, uranium is present in the ground water at levels above its MCL, but it is considered naturally occurring, and, as such, it is not specifically regulated under CERCLA. If the selected RA includes discharge of extracted ground water to the municipal water supply, however, uranium will need to be addressed to comply with drinking water ARARs. The CLC is required to address uranium exceedances to maintain compliance with SDWA requirements, and has been evaluating uranium treatment technologies.

The technologies being evaluated by the CLC are as follows:

- Enhanced Coagulation/Filtration
- Ion Exchange
- Reverse Osmosis
- Lime Softening
- Granular Ferric Hydroxide
- Alternative Media - Brimac 002060

Each of these technologies, along with additional details on the CLC's evaluation, is discussed in *Technical Memorandum – Uranium and PCE Treatment – Phase 1 Evaluation of Treatment Technologies* (**CH2M HILL, 2006b**). The Phase 1 evaluation indicates that enhanced coagulation/filtration, non-regenerating ion exchange and reverse osmosis are the technologies listed as Best Available Technologies (BAT) by the EPA. However, ion exchange is the only technology that appears to have been implemented at full-scale operating plants specifically designed for uranium removal. The CLC document recommends that an ion exchange pilot test be conducted to determine its effectiveness at this site for uranium removal.

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Table 2-1
Federal Applicable or Relevant and Appropriate Requirements for Remedial Action
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Citation	Requirement/Purpose	Applicability	ARAR Category
AIR REGULATIONS			
40 CFR 50-National Primary and Secondary Ambient Air Quality Standards	Established Ambient Air Quality Standards	Compliance is achieved through compliance with state and local rules established pursuant to a State Implementation Plan (SIP).	Chemical-specific
40 CFR 61 Subpart J – National Emission Standard for Equipment Leaks (Fugitive Emission Sources) of Benzene	Establishes requirements for controlling fugitive emissions of benzene from designated equipment.	Potentially applicable if remedial alternative includes regulated equipment and benzene (at least 10% by weight).	Chemical-specific
40 CFR 63 Subpart H - National Emission Standards for Organic Hazardous Air Pollutants for Equipment Leaks (Source Categories)	Establishes requirements for controlling emissions of organic hazardous air pollutants from designated equipment. Identifies emission standards for hazardous air pollutants that originate from specific source categories.	Potentially applicable if remedial alternative includes regulated compounds and equipment. Applicable if the identified hazardous air pollutants are emitted from a specific source category that has been identified.	Action-specific, Chemical-specific
40 CFR 89 – Control of Emissions from New and In-use Non-road Compression-Ignition Engines.	Establishes requirements for controlling emissions of non-road compression-ignition engines.	Potentially applicable if remedial alternative includes regulated engines. Most applicable during the construction phase.	Action-specific
40 CFR 90 – Control of Emissions from Non-road Spark-Ignition Engines at or below 19 kilowatts	Establishes requirements for controlling emissions of non-road spark-ignition engines at or below 19 kilowatts.	Potentially applicable if remedial alternative includes regulated engines. Most applicable during the construction phase.	Action-specific
40 CFR 1039 – Control of Emissions from New and In-Use Non-road Compression-Ignition Engines	Establishes requirements for controlling emissions of non-road compression-ignition engines.	Potentially applicable if remedial alternative includes regulated engines.	Action-specific
40 CFR 1068 – General Compliance Provisions for Non-road Programs	Establishes compliance provisions for regulated non-road engines.	Potentially applicable if remedial alternative includes regulated engines.	Action-specific

Table 2-1
Federal Applicable or Relevant and Appropriate Requirements for Remedial Action
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Citation	Requirement/Purpose	Applicability	ARAR Category
WATER REGULATIONS			
40 CFR 122.26 - EPA Administered Permit Programs: The National Pollutant Discharge Elimination System; Storm Water Discharges	Requires obtaining an NPDES permit for discharge of storm water from specified industrial and construction activities, developing a storm water pollution prevention plan, implementing best management practices to prevent discharge of pollutants to storm water, and monitoring storm water discharges.	Although NPDES permit coverage is not required for on-site discharges of storm water, substantive requirements, including implementing best management practices to prevent discharge of pollutants to storm water, are applicable to construction activities disturbing one acre or more. These requirements may be applicable to construction of a central groundwater treatment plant.	Action-specific
40 CFR 141.61–National Primary Drinking Water Regulations; Maximum Contaminant Levels for Organic Compounds; 40 CFR 141.66–National Primary Drinking Water Regulations; Maximum Contaminant Levels for Radionuclides	Establishes maximum contaminant levels (MCLs) for specific chemicals to protect drinking water quality.	MCLs for benzene, PCE and uranium are applicable if the water will be supplied directly to a drinking water distribution system with a specified number of consumers or connections. MCLs are relevant and appropriate if the water could be used for drinking.	Chemical-specific
Reference Doses (RfDs), EPA Office of Research and Development	Presents non-enforceable toxicity data for specific chemicals for use in public health assessments.	”To be considered” criterion used to assess risk associated with soil and groundwater; not an ARAR.	Chemical-specific TBC

Table 2-1
Federal Applicable or Relevant and Appropriate Requirements for Remedial Action
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Citation	Requirement/Purpose	Applicability	ARAR Category
Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Methyl Tertiary-Butyl Ether (MtBE) (*EPA-822-F-97-009)*; EPA Office of Water Risk-Specific Doses (RSDs), EPA Carcinogen Assessment Group and EPA Environmental Criteria and Assessment Office	Presents non-enforceable guidance for drinking water suppliers recommending a level of contamination for MTBE in drinking water to protect consumer acceptance of the water resource and provide a margin of safety from toxic effects. Represents the dose of a chemical in mg per kg of body weight per day associated with a specific risk level (i.e., 10^{-6}). RSDs are determined by dividing the selected risk level by the cancer potency factor (slope factor).	"To be considered" criterion used in setting an acceptable MTBE level in drinking water; not an ARAR. Applicable standard used to assess risk associated with soil and groundwater.	Chemical-specific TBC
Risk-Specific Doses (RSDs), EPA Carcinogen Assessment Group and EPA Environmental Criteria and Assessment Office	Represents the dose of a chemical in mg per kg of body weight per day associated with a specific risk level (i.e., 10^{-6}). RSDs are determined by dividing the selected risk level by the cancer potency factor (slope factor).	Applicable standard used to assess risk associated with soil and groundwater; not an ARAR.	Chemical-specific TBC
SOLID AND HAZARDOUS WASTE REGULATIONS			
40 CFR Part 261–Identification and Listing of Hazardous Waste	Identifies those wastes subject to regulation as hazardous wastes	Applicable for determining which wastes are hazardous and potentially subject to the hazardous waste management requirements in Parts 262-268. Potential hazardous wastes include spent GAC produced by groundwater treatment activities.	Chemical-specific
40 CFR Part 262-Standards Applicable to Generators of Hazardous Waste	Specifies standards for management of hazardous waste by hazardous waste generators, including management in tanks and containers.	Substantive management standards are applicable to hazardous waste generated during remedial activities Potential hazardous wastes include spent GAC produced by groundwater treatment activities.	Action-specific

Table 2-1
Federal Applicable or Relevant and Appropriate Requirements for Remedial Action
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Citation	Requirement/Purpose	Applicability	ARAR Category
40 CFR Part 265 Subpart C-Preparedness and Prevention Requirements	Specified preparedness and prevention requirements applicable to hazardous waste generators, including requirements for specified spill control, fire control, communication equipment and aisle space in hazardous waste accumulation areas.	Applicable if hazardous waste accumulation areas are utilized at the groundwater treatment plant or other locations.	Action-specific
40 CFR 265.16-Hazardous Waste Training Requirements	Specifies training for employees whose job duties include managing hazardous waste.	Applicable if hazardous waste is generated by remedial activities.	Action-specific
40 CFR Part 265 Subpart I-Hazardous Waste Container Requirements	Specifies requirements for managing hazardous waste in containers, including keeping containers closed when not in use and transferring waste from leaking or damaged containers.	Applicable if hazardous waste generated by remedial activities is managed in containers.	Action-specific
40 CFR Part 265 Subpart J-Hazardous Waste Tank Requirements	Specifies requirements for managing hazardous waste in tanks, including secondary containment and daily inspections.	Applicable if hazardous waste generated by remedial activities is managed in tanks.	Action-specific
40 CFR Part 265 Subpart CC-Hazardous Waste Air Emission Standards for Tanks and Containers	Specifies requirements for minimizing air emissions from hazardous waste tanks and containers.	Potentially applicable if hazardous waste generated by remedial activities contains specified concentration of volatile organic compounds and is managed in tanks or containers.	Action-specific
40 CFR Part 268-Land Disposal Restrictions	The land disposal restrictions prohibit land-based disposal of listed and characteristic hazardous wastes that do not meet specified treatment standards.	Applicable to off-site land disposal of listed or characteristic hazardous wastes, and to on-site remedies that include placement of these wastes in previously uncontaminated site areas.	Action-specific, chemical-specific

Table 2-1
Federal Applicable or Relevant and Appropriate Requirements for Remedial Action
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Citation	Requirement/Purpose	Applicability	ARAR Category
U.S. EPA REGULATIONS ON TRANSPORT OF HAZARDOUS WASTE			
40 CFR 263 - Standards Applicable to Transporters of Hazardous Waste	Establishes responsibilities for transporters of hazardous waste in handling, transportation, and management of the waste. Sets requirements for manifesting, recordkeeping, and emergency response action in case of a spill.	Applicable to transportation of material classified as RCRA hazardous waste	Action-specific, chemical-specific
HISTORICAL PRESERVATION REGULATIONS			
Archaeological and Historic Preservation Act of 1974 16 U.S.C. Section 469 et seq. 43 CFR Part 7, Protection of Archaeological Resources	Provides for the preservation of historical or archaeological data that might be destroyed or lost as the result of 1) flooding, building of access roads, relocation of railroads and highways, and other alterations of terrain caused by the construction of a dam by government or persons, or 2) alteration of terrain caused by Federal construction projects or federally licensed activity or program.	Applicable if construction projects or alteration of terrain at a site have the potential to destroy historical or archaeological materials.	Location-specific
National Historical Preservation Act 16 USC Section 431-433 - Antiquities Act of 1906 16 U.S.C. Section 470 et seq. 16 USC Section 470aa-470ll - Archaeological Resources Protection Act of 1979 36 CFR Part 65 – National Historic Landmarks Program 36 CFR Part 800 –Protection of Historic Properties 40 CFR 6.301 (c) - Landmarks, Historical, and Archaeological Sites (Historic, prehistoric and archeological data)	Establishes procedures for the preservation of scientific, historical, and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or federally licensed activity or program. If scientific, historical, and archaeological artifacts are discovered at the site, work in the area of the site affected by such discovery will be halted pending the completion of any data recovery and preservation activities required pursuant to the act and its implementing regulations.	Will be applicable during remedial activities if scientific, historical, and archaeological artifacts are identified during the implementation of the remedy.	Location-specific

Table 2-1
Federal Applicable or Relevant and Appropriate Requirements for Remedial Action
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Citation	Requirement/Purpose	Applicability	ARAR Category
WILDLIFE PROTECTION REGULATIONS			
Endangered Species Act of 1973 7 U.S.C. Section 136 16 U.S.C. Section 460 et seq	Provides a program for conservation of threatened and endangered plants and animals and the habitats in which they are found.	Applicable if threatened or endangered species or their habitats are present at or near the site.	Location-specific
Fish and Wildlife Conservation Act 16 U.S.C. Sections 2901 to 2911	Action to conserve fish and wildlife, particularly those species which are indigenous to the state.	Applicable is significant populations are present at a site or are affected by site activities.	Location-specific
Fish and Wildlife Coordination Act 16 U.S.C. Sections 661 to 667e	The Act allows the Department of Agriculture and Commerce to assist Federal and State agencies to study the effects of domestic sewage, trade wastes, and other polluting substances on wildlife.	Applicable is significant populations are present at a site or are affected by site activities.	Location-specific
FLOOD PLAIN REGULATIONS			
Flood Control Act of 1944 16 U.S.C. Section 460	Provides the public with knowledge of flood hazards and promotes prudent use and management of flood plains.	Applicable if the site is located on a designated flood plain.	Location-specific

Table 2-2
New Mexico Applicable or Relevant and Appropriate Requirements for Remedial Action
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Citation	Requirement/Purpose	Applicability	ARAR Category
20.2 NMAC – Air Quality	Establishes ambient air quality standards, performance standards for specific sources of air pollutants, and specifies monitoring methods.	Potentially applicable if remedial activities involve sources subject to regulation.	Action-specific
20.6.2 NMAC – New Mexico Water Quality Control Regulations	Establishes the New Mexico Water Quality Control Commission Regulations regarding the re-injection of water into the subsurface. Establishes the New Mexico Water Quality Control Commission Regulations regarding discharges to ground water.	The substantive provisions of these regulations apply to reinjection programs. These regulations are ARARs if the NM standards are less than EPA MCLs.	Action-specific
19.25.9 NMAC – Prohibitions on Use of Surface and Ground Water in Designated Areas	Places restrictions on wells and transfers of either surface water or ground water within the boundaries of certain areas as determined by the state engineer in the interest of safety and the protection of life and property within the state of New Mexico.	Applies to new ground water wells. May apply to certain remedial actions.	Action-specific
20.7 NMAC - New Mexico Regulations for Public Drinking Water Systems	Provides the state primary drinking water regulations based on MCLs for public water systems.	These requirements are applicable. When the MCLGs are zero, groundwater will be treated to meet MCLs. The MCLs PCE is 5 ppb.	Chemical-specific
20.4 NMAC – Hazardous Waste Management	Establishes criteria for the classification of hazardous waste and for the treatment, storage, and disposal or hazardous waste.	Applies to actions involving treatment, storage, and disposal of hazardous waste. Incorporates Federal Hazardous Waste Regulations by reference, with specified exceptions.	Action-specific
20.3.3 NMAC – Licensing of Radioactive Material 20.3.16 NMAC – Fees for Licensure of Radioactive Materials	Establishes licensing requirements for radioactive material. Establishes fees for licensure of radioactive material licenses, and provides for methods of payment for such fees.	Applies to the receipt, transfer, and disposal of radioactive material. Only technical and not administrative aspects of this rule are ARARs.	Action-specific
20.3.4 NMAC – Standards for Protection Against Radiation	Establishes standards for protection against ionizing radiation resulting from activities conducted pursuant to licenses or registrations issued by the Department.	Applies to persons licensed to receive, possess, use, transfer, or dispose of sources of radiation.	Chemical-specific

Table 2-2
New Mexico Applicable or Relevant and Appropriate Requirements for Remedial Action
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Citation	Requirement/Purpose	Applicability	ARAR Category
20.3.10 NMAC – Notices, Instructions, and Reports to Workers: Inspections	Establishes requirements for notices, instructions and reports by licenses or registrants to individuals engage in activities under a license or registration and options available to such individuals in connection with Department inspections of licensees or registrants to ascertain compliance with the provisions of the Act and regulations, orders and licenses issued thereunder regarding radiological working conditions.	Applies to persons licensed to receive, possess, use, transfer, or dispose of sources of radiation. Only technical and not administrative aspects of this rule are ARARs.	Action-specific
New Mexico Cultural Properties Act (NMSA 1978)	Requires the identification of cultural resources, assessment of impact on those resources that may be caused by the proposed remedy, and consultation with the State Historic Preservation Officer.	This requirement may become applicable if cultural resources are identified during remedial activities.	Location-specific
New Mexico Prehistoric and Historic Sites Preservation Act 18-8 et seq. (NMSA 1989)	The purpose of the New Mexico Prehistoric and Historic Sites Preservation Act is the acquisition, stabilization, restoration or protection of significant prehistoric and historic sites by the state of New Mexico and corporations.	This requirement may become applicable if prehistoric or historic sites are identified during and affected by remedial activities.	Location-specific

Table 2-3
City and County Regulations and Requirements
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

Citation	Requirement/Purpose	Applicability	ARAR Category
CITY REGULATIONS [a]			
None	None	None	None
COUNTY REGULATIONS [b]			
None	None	None	None

[a] Based on review of City of Las Cruces, New Mexico, http://www.las-cruces.org/utilities/
[b] Based on review of Dona Ana County, New Mexico, http://www.co.dona-ana.nm.us/

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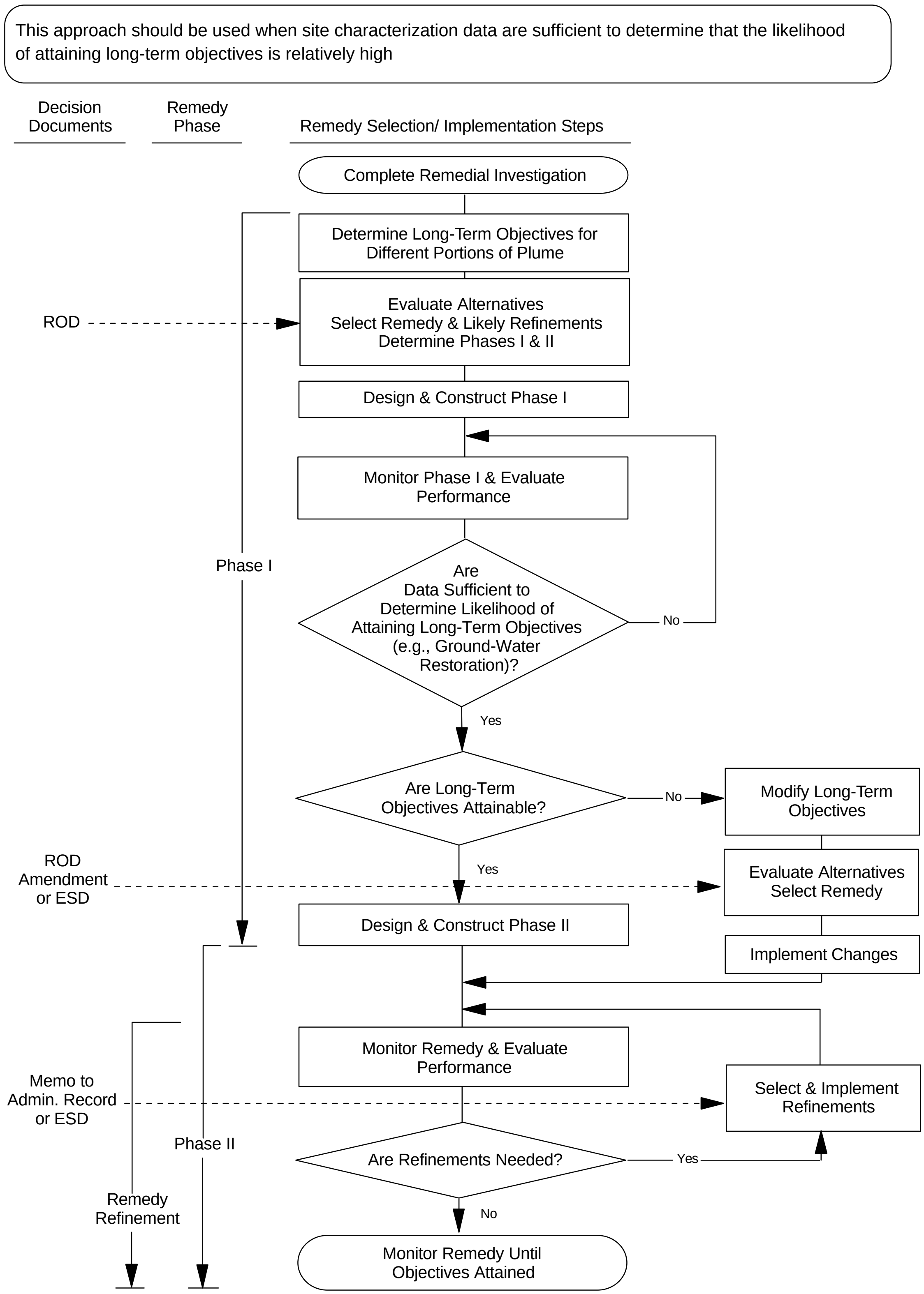
Table 2-4
Review of Technologies for Ground Water Remediation Alternatives
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

NOTE: Technologies retained for further consideration for the GWP site are shown in bold text in gray-shaded cells.				
General Response Action	**Remedial Technology Type**	**Option**	**Comments**	**Retained?**
No Action	**None**	**None**	**The no action alternative is evaluated for every site according to EPA guidance. *"Although a no-action alternative should include some type of environmental monitoring, action taken to reduce the potential for exposure (e.g., site fencing, deed restrictions) should not be included as a component of the no-action alternative."* (EPA, 1988). The City of Las Cruces blending program is considered an interim action and would not be considered as a part of the no action alternative.**	**Yes**
Institutional Controls	**Access and Use Restrictions**	**Land, Groundwater, Soil Use Restrictions/Controls, Drilling Controls (i.e., State Engineer approvals)**	**Institutional controls will likely be a component of each alternative. Potential controls to consider include drilling restrictions within or in the vicinity of the plume, ground water monitoring requirements to supplement those required under the SDWA for supply wells located within or in the vicinity of the plume, and water use restrictions for wells located within or in the vicinity of the plume.**	**Yes**
Monitoring	**Ground water Monitoring**	**Sampling**	**Ground water monitoring is likely to be a component of each alternative. Monitoring will be used to evaluate the effectiveness of the implemented remedy whether active treatment (e.g., pump and treat), natural attenuation or a combination of remedies.**	**Yes**
Containment	**Hydraulic or Physical Barriers**	**Hydraulic Containment**	**Hydraulic containment using vertical extraction and /or injection wells is likely an effective containment technology for use at the site.**	**Yes**
		Cement-Bentonite Slurry Wall	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site.	No
		Vibrating Beam Barrier Installation	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site.	No
		Soil-Bentonite Slurry Wall	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site.	No
		Injected Curtains	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site.	No
		Sheet Piling	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site.	No
		Permeable Reactive Barriers	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site.	No
		Deep Soil Mixing	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site.	No
		Ground Freezing	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site.	No
Removal	**Groundwater Extraction**	**Vertical Well Pumping**	**Use of existing municipal wells for extraction of contaminated ground water is likely an effective removal option for the site. Additional extraction wells may be required depending on the effectiveness of plume capture demonstrated using existing municipal wells. Ground water flow and transport modeling being conducted by the City of Las Cruces and will be used to evaluate capture and optimal extraction well placement.**	**Yes**
		Multi-phase Extraction	Technology is applicable for NAPL; but no NAPL has been observed to-date at the site.	No
		Horizontal Wells	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site.	No
		One-Pass Trenching	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site. The practical depth of application is approximately 190 feet bgs.	No
		Interceptor Trench – Drain Line	Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site. Below depths of 50 feet, accurate placement of drain line is considered innovative.	No

Table 2-4
Review of Technologies for Ground Water Remediation Alternatives
Griggs and Walnut Ground Water Plume
Las Cruces, New Mexico

NOTE: TECHNOLOGIES RETAINED FOR FURTHER CONSIDERATION FOR THE GWP SITE ARE SHOWN IN BOLD TEXT IN GRAY-SHADED CELLS.				
General Response Action	**Remedial Technology Type**	**Option**	**Comments**	**Retained?**
Treatment	**Ex-Situ Treatment**	**Air Stripping**	**Effective for the removal of dissolved organic contaminants, as discussed in the *Presumptive Response Strategy and Ex-Situ treatment Technologies for Contaminated Groundwater at CERLCA Sites* (EPA, Oct. 1996).**	**Yes**
		Granular activated carbon (GAC)	**Effective for the removal of dissolved organic contaminants, as discussed in the *Presumptive Response Strategy and Ex-Situ treatment Technologies for Contaminated Groundwater at CERLCA Sites* (EPA, Oct. 1996).**	**Yes**
		Chemical/UV oxidation	**Effective for the removal of dissolved organic contaminants, as discussed in the *Presumptive Response Strategy and Ex-Situ treatment Technologies for Contaminated Groundwater at CERLCA Sites* (EPA, Oct. 1996).**	**Yes**
		Aerobic biological reactors	**Effective for the removal of dissolved organic contaminants, as discussed in the *Presumptive Response Strategy and Ex-Situ treatment Technologies for Contaminated Groundwater at CERLCA Sites* (EPA, Oct. 1996).**	**Yes**
	In-Situ Physical/Chemical Treatment	**In-Well Air Stripping**	**Effective for removal of VOCs. Based on site lithology, contamination crosses a silt clay layer that might be continuous in the area of concern. Therefore, two stripping zones would likely be needed.**	**Yes**
		Recirculation (re-injection of treated water)	**Effective for removal of VOCs. This technology could enhance ground water extraction capture with ex-situ treatment. Based on discussions with the City of Las Cruces, all ground water extracted and treated as part of an implemented remedy is expected to be discharged to the drinking water distribution system; however, re-injection into the aquifer of a portion of the treated water could reduce cleanup time by flushing contaminants toward the extraction wells. The potential use of this technology will be evaluated using the ground water flow and transport model currently being developed.**	**Yes**
		Air Sparging	Effective for removal of VOCs. Technology prohibited by depth to ground water (> 200 ft bgs) and the thickness of ground water contamination (between 60 to 350 feet thick) at the site..	No
		Electrokinetic Treatment	This technology is only in the research stage with few field-scale applications. Extensive pilot study would be required to refine the design of a full-scale system.	No
		Surfactant/Cosolvent Flushing	Surfactant-enhanced recovery is most applicable for contaminated sites with DNAPLs which have not been found at this site. Subsurface heterogeneities, as with most ground water remediation technologies, present challenges to the successful implementation of surfactant-enhanced recovery. There are potential toxic effects of residual surfactants in the subsurface. The potential exists for the migration of contaminants because of the increased solubility achieved with surfactant injection. The injection of surfactants into the aquifer within close proximity to municipal supply wells is not desirable.	No
		In-situ Chemical Oxidation	The injection of the typical oxidizing chemicals (e.g., permanganate, ozone, hydrogen peroxide, persulfate, hypochlorites, chlorine, chlorine dioxide) into the aquifer within close proximity of municipal supply wells is not desirable. Incomplete oxidation or formation of intermediate contaminants could occur (e.g., trihalomethanes) and wellhead treatment would likely be required prior to potable use. Safety precautions must be used when handling oxidizing chemicals.	No
		In-situ Chemical Reduction	The injection of the typical reducing chemicals (e.g., ferrous iron, sodium dithionite) into the aquifer within close proximity of municipal supply wells is not desirable because of the formation of reduced conditions and associated taste and odor problems. The formation of intermediate contaminants can occur and wellhead treatment would likely be required prior to potable use.	No
		Emulsified Zero Valent Iron	Typically used for sites with identified DNAPL source zones which have not been found at this site. Utilizes the injection of solution (zero valent iron particles in a surfactant-stabilized biodegradable oil-in-water emulsion) into the aquifer. The addition of iron into the aquifer within close proximity to municipal supply wells is not desirable because of long-lasting residual effects on taste and odor. The formation of intermediate contaminants can occur and wellhead treatment would likely be required prior to potable use.	No
	Natural Attenuation	**Monitored Natural Attenuation**	**Natural attenuation has been demonstrated at the site through the mechanisms of dispersion and diffusion, but not biodegradation. Because the process is naturally occurring, it will be an inherent part of any remedy that is selected.**	**Yes**
	In-Situ Biological Treatment	Enhanced Biodegradation	The PCE degradation mechanism is called reductive dechlorination. A hydrogen source is necessary to provide electron donors to complete this reaction. Typically additives include, but are not limited to, lactate, methanol, hydrogen, and molasses. Where the subsurface is heterogeneous, it is very difficult to deliver the additives throughout every portion of the contaminated zone. A ground water circulation system must typically be created so that contaminants do not escape from zones of active biodegradation. The thickness of ground water contamination (between 60 to 350 feet thick) at the site will require very large quantities of additives. In addition, this degradation mechanism produces a more toxic by-product, vinyl chloride, which might not be easily biodegraded under anaerobic conditions present at the GWP site.	No

FIGURE 2-1: Phased Ground-Water Actions: Long-Term Remedy Implemented in Phases



Source: U. S. Environmental Protection Agency (EPA), 1996a. Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites. EPA 540/R-96/023. OSWER Directive 9283.1-12. October 1996.

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