3.0 WABOU Groundwater Remedial Investigation Summary

The primary objectives of the RI were to evaluate the nature and extent of contamination in the WABOU and assess the potential risks to human health and the environment posed by the contamination. Following the RI field activities, the data were evaluated and human health and ecological risk assessments were performed for each site. A quantitative human health risk assessment (HHRA) resulted in the identification of chemicals of concern (COC) for each site. Site-related excess lifetime cancer risks, as well as Hazard Indexes (for non-cancer-causing chemicals) were computed for each COC. Similarly, the ecological risk assessment resulted in the identification of chemicals of ecological concern (COEC) for each site. Hazard Quotients for various ecological receptors (selected indicator species of plants and animals) were computed for each COEC.

3.1 Nature and Extent of Contamination

There are four WABOU sites with groundwater contamination. This section presents a brief description of each groundwater site. Figure 3-1 shows the locations of the WABOU groundwater sites and the extent of groundwater contamination.

Appendix A provides a brief summary of the description of each WABOU groundwater site, the nature and extent of contamination, the alternatives evaluated in the FS, the selected interim groundwater action, and the conceptual design for the selected interim remedy.

Reservoir Facilities 1514/1518 is a WABOU site that did not continue into the WABOU FS. This active facility has fluoride contamination in groundwater as a result of an aboveground fluoridation tank leak. Because the leak occurred after the IRP funding eligibility date (1 January 1984), the site was transferred to the Compliance Branch of the Travis AFB Environmental Management Office. A description of this site is found in Section 4.17 of the *West/Annexes/ Basewide Operable Unit Remedial Investigation Report (Volumes 1-4), 60th Air Mobility Wing, Travis Air Force Base, California* (WABOU RI) (CH2M HILL, 1997).

3.1.1 Building 755 (DP039)

Building 755 is the Travis AFB Battery and Electric Shop. The site consists of Building 755 and a former battery neutralization sump. Past operations have included the recharging and dismantling of lead-acid and nickel-cadmium batteries. Before 1978, lead-acid solutions were discharged into a sink inside Building 755. The pipeline from the sink led to a rock-filled sump approximately 65 feet northwest of the building. This practice was discontinued in 1978 when the pipeline was dismantled and reconnected to the sanitary sewer system. The sump was removed in 1993.

Electrical equipment maintenance also took place in this building, and it is apparent that industrial solvents used in the maintenance, such as TCE, were discharged into the sump. The highest VOC concentrations were found in samples from beneath the former sump and suggest the presence of undissolved TCE beneath the water table. Subsequent groundwater sampling was used to determine the extent of the VOC plume. The plume has migrated 1,400 feet to the southeast, consistent with the local groundwater flow direction, and is 800 feet wide. TCE is the contaminant that poses the greatest potential risk at this site. Figure A-1 of Appendix A presents the Building 755 site and a conceptual diagram of the TCE plume.

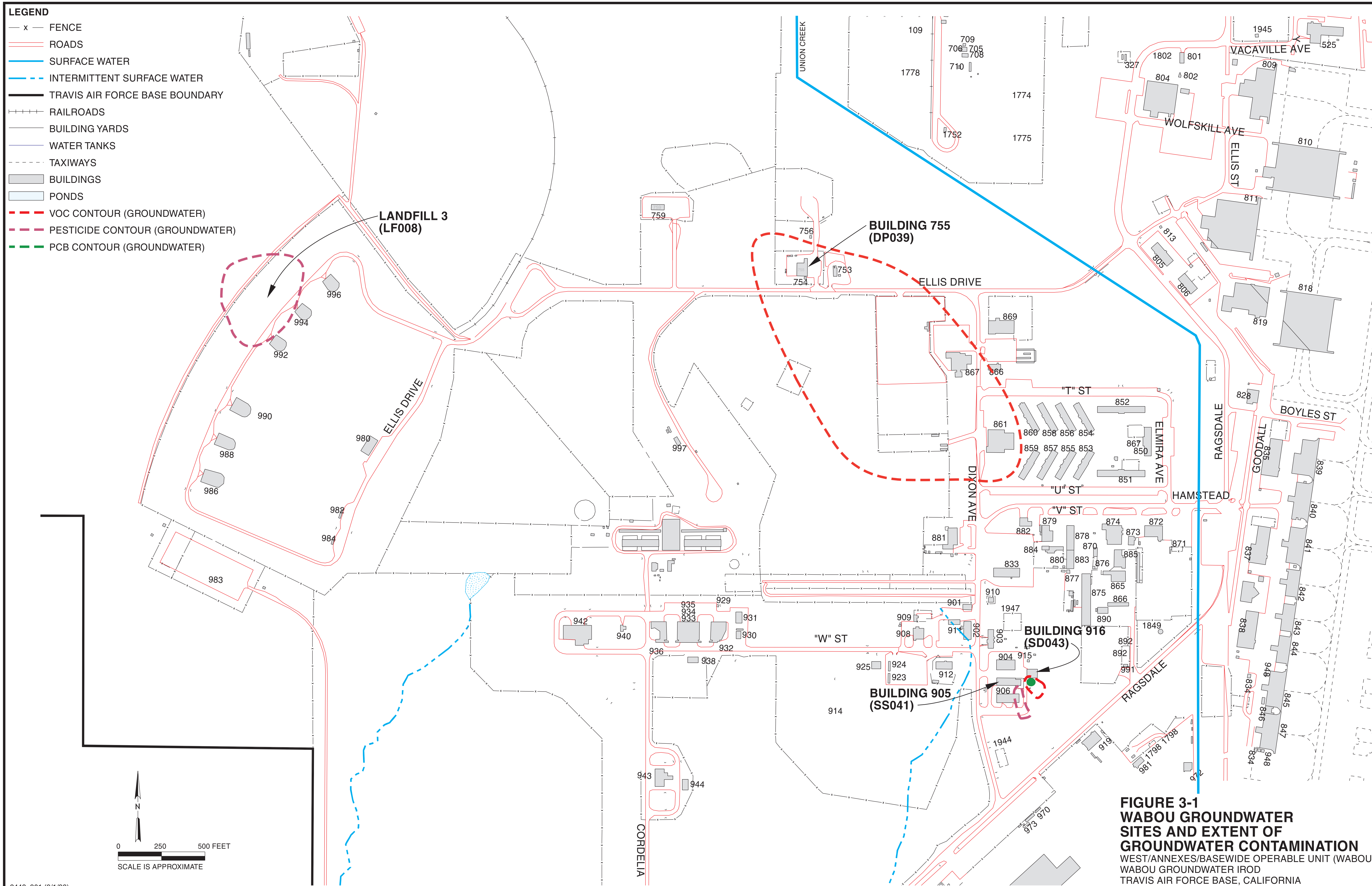


FIGURE 3-1
WABOU GROUNDWATER SITES AND EXTENT OF GROUNDWATER CONTAMINATION
WEST/ANNEXES/BASEWIDE OPERABLE UNIT (WABOU)
WABOU GROUNDWATER IROD
TRAVIS AIR FORCE BASE, CALIFORNIA

CH2MHILL

There are no discrete surface water drainage pathways at this site. A sanitary sewer line runs in an east-west direction just south of Ellis Drive. This 8-inch vitrified clay line is located 4 feet below ground surface (bgs). Based on the depth of the water table in the vicinity of this sewer line (>15 feet bgs), there is no interaction between the groundwater and the sewer line.

3.1.2 Landfill 3 (LF008)

Landfill 3 consists of trenches used in the 1970s for the disposal of rinsed pesticide containers, bags, and possibly pesticide container rinsewater (JEG, 1994b). Landfill 3 is located within the Weapons Storage Area (Bunker A) in the western portion of the WABOU. Bunker A is a secured area and is surrounded by fences. The LF03 site comprises about 1 acre of land, based on the trenches excavated during the WABOU RI. The trenches are currently covered with fill material. There are no storm or sanitary sewer lines in the vicinity of this site.

Approximately 30 cubic yards of materials were reportedly buried in trenches with varying dimensions. Geophysical surveys were used to identify the locations of these trenches. Six out of nine exploration trenches encountered buried debris during the RI. The depth of waste observed was from 5 to 8 feet, and no lining was visible beneath the waste. Materials excavated during the RI included 1- and 5-gallon metal containers, plastic and paper bags, other paper and plastic debris, 1-gallon glass bottles, and two 55-gallon drums. Labels found on some of the containers indicated that the containers originally held pesticides and herbicides. No evidence that other contaminants were disposed of at the landfill was discovered.

The results of groundwater sampling indicated that pesticides have migrated from the disposal trenches to the groundwater. Figure A-2 of Appendix A presents a conceptual diagram of the pesticide plume. Because the trenches are located on a topographic high, the plume has migrated slowly in a radial direction around the source area.

3.1.3 Building 905 (SS041)

Building 905 is the Travis AFB Entomology Shop that was used to prepare pesticide and herbicide mixtures from 1983 to 1992. A 3,000-square-foot fenced enclosure outside on the east side of the building contains a washrack and a storage area. The washrack was formerly used to wash down tractors used for towing bowsers filled with pesticides and herbicides. The washrack consisted of a concrete pad with a perimeter berm (i.e., curb) and a drain that discharged to a tank. The surface soil appears to have received pesticide residue from spray generated during the washing of pesticide applicator vehicles under windy conditions. The results of groundwater sampling indicated that pesticides have migrated from the surface soil to the groundwater. There are no storm or sanitary sewer lines in the vicinity of the groundwater contamination at Building 905. The sanitary sewer line that supports Building 905 is upgradient of the contaminant plume and is not considered a preferential pathway. Figure A-3 of Appendix A presents a conceptual diagram of the pesticide plume.

3.1.4 Building 916 (SD043)

Building 916 was constructed in 1953 to provide emergency electrical power. The diesel-powered generators inside the building are located in a cellar, or sump area, that also houses sump pumps. Prior to 1991, diesel fuel that had spilled from the generators was washed down with water and pumped out of the building through one of four pipes. The pipes discharged onto small concrete spillways constructed for erosion control on the side slope of the trapezoidal drainage channel that lies east of the building. From the spillways, wastewater flowed down the side-slope and into the drainage channel. This method of sump water disposal was discontinued in 1991.

A TCE plume has been identified beneath the drainage channel adjacent to the building. The source of this plume appears to be the spillway that was used to drain the sump within the building, although this possibility has not been confirmed. In addition, leaks at a former transformer pad resulted in deposition of a PCB isomer (PCB-1254) in the nearby soil and migration to the local groundwater. There are no storm or sanitary sewer lines in the vicinity of the groundwater contamination at Building 916. The sanitary sewer line that supports Building 916 is upgradient of the contaminant plume and is not considered a preferential pathway. Figure A-3 of Appendix A presents a conceptual diagram of the TCE and PCB plumes.

3.2 Risk Assessments

An HHRA and an ecological risk assessment were conducted using the data collected during the WABOU RI. The objective of a risk assessment is to evaluate the potential risks resulting from exposure to chemicals detected in environmental media. Since there is no exposure pathway of the contaminated groundwater at the four WABOU sites to ecological habitats, these sites pose no ecological risk to the local habitats. Therefore, this section will address the results of the WABOU HHRA that pertain to groundwater.

The WABOU HHRA was conducted in two phases: a screening risk assessment and a quantitative risk assessment. Each risk assessment follows the following four steps:

- Identification of Chemicals of Potential Concern (COPC)—chemical concentrations were compared to U.S. EPA Preliminary Remediation Goals (PRGs) and WABOU inorganic reference concentrations
- Exposure Assessment—potential pathways by which exposure could occur were identified, potentially exposed populations were characterized, and the magnitude, frequency , and duration of exposure were estimated
- Toxicity Assessment—the toxicity of the COPC and the relationship between magnitude of exposure and adverse health effects were summarized
- Risk Characterization—the toxicity and exposure assessments were integrated to estimate the potential risks to human health from exposure to site chemicals.

The screening HHRA evaluated chemicals detected in groundwater by comparing them to chemical-specific water PRGs developed by U.S. EPA Region IX (EPA, 1995). These water PRGs were developed using default exposure factors for a residential scenario and U.S. EPA or Cal/EPA toxicity values (whichever are more stringent) to estimate concentrations which are protective of humans, including sensitive groups, over a lifetime. This is a very conservative screening assessment because no current or future residential land use is planned for sites within the WABOU. In addition, onsite groundwater is not currently being used for agricultural, industrial, or domestic purposes.

The purpose of the quantitative HHRA was to evaluate site-specific exposure scenarios. Because no current or future residential land use is planned in the WABOU, this is an unlikely future exposure scenario. On the basis of actual current and future planned site uses, the most likely future exposure scenario is a commercial/industrial worker exposure scenario. Therefore, a worker exposure scenario was used in the quantitative HHRA.

Table 3-1 presents the potential human health risks posed by the contaminated groundwater at the four WABOU groundwater sites. The human health risk calculations are presented in Appendix G1 of the WABOU RI.

3.3 Chemicals of Concern

Based on the results of the WABOU HHRA, COCs were identified at each WABOU site. Table 3-1 presents the groundwater COCs at the four WABOU groundwater sites. The general criteria for the identification of groundwater COCs are presented below:

1. The contaminant creates a potential human health risk over 1×10^{-6}; or
2. The contaminant has a Hazard Index (HI) exceeding 1.0.

TABLE 3-1
COC Concentrations and Potential Risks at WABOU Groundwater Sites

Site Name	Groundwater COC	Maximum Concentration (µg/L)	Human Health Risk Value
Building 755	1,1-DCE (1,1-dichloroethene)	7,800	2×10^{-2}
	1,2-DCA (1,2-dichloroethane)	440	1×10^{-4}
	1,1,1-TCA (1,1,1-trichloroethane)	26,000	Hazard Index (HI) = 3
	1,1,2-TCA (1,1,2-trichloroethane)	240	5×10^{-5}
	acetone	45,000	HI = 4
	bromodichloromethane	10	3×10^{-6}
	methylene chloride	200	1×10^{-5}
	PCE (perchloroethene)	20	5×10^{-6}
	TCE	210,000	1×10^{-2}
Landfill 3	aldrin	0.11	7×10^{-6}
	alpha-chlordane	0.27	2×10^{-6}
	heptachlor	0.084	3×10^{-6}
	heptachlor epoxide	0.033	2×10^{-6}
Building 905	heptachlor epoxide	0.023	2×10^{-6}
Building 916	PCB-1254	22	5×10^{-5}
	TCE	71	5×10^{-6}

The approach to evaluating pesticide concentrations in the WABOU is based on comparisons with the concentrations found at other locations on Travis AFB. The WABOU RI used the Inorganic Constituent Evaluation Methodology (Radian, 1996b) to determine whether compounds detected in samples are naturally occurring or are contaminants from past industrial practices. Statistical analysis of the pesticide detections from non-pesticide sites resulted in the establishment of WABOU reference concentrations for pesticides. More detailed discussion of the WABOU pesticide evaluation is provided in Appendix I of the WABOU RI report (CH2M HILL, 1997).

3.4 Summary

Groundwater at four out of 41 WABOU sites is contaminated with VOCs (Building 755 and 916), PCBs (Building 916), and pesticides (Building 905 and Landfill 3). Table 3-1 presents the groundwater contaminants at each site, the maximum concentrations, and the human health risk values associated with each contaminant. No groundwater COECs were identified in the WABOU. One additional groundwater site (Reservoir Facilities 1514/1518) was transferred to the Compliance Branch of the Travis AFB Environmental Office for disposition. The four WABOU sites were evaluated in the WABOU FS.

4.0 Summary of WABOU Groundwater Feasibility Study

Travis AFB conducted an FS in the WABOU to assist in selecting remedial actions for the four contaminated groundwater sites. The primary objectives of this study were to:

1. Identify potential response actions, technologies, and process options to address the potential risks in the WABOU
2. Screen the technologies and process options
3. Assemble feasible and appropriate remedial alternatives
4. Provide detailed evaluations of the remedial alternatives
5. Perform a comparative analysis of the alternatives

The FS can be divided into three main phases:

1. The Initial Screening of Alternatives
2. The Detailed Analysis of Alternatives
3. The Comparative Analysis of Alternatives

4.1 Initial Screening of Alternatives

The Initial Screening of Alternatives (ISA) was used to develop an appropriate range of remedial alternatives that would protect human health and the environment at the four groundwater sites identified in the WABOU RI. This was necessary because of the large number of remedial technologies available to handle a wide variety of contaminants under various site conditions.

With all of the combinations of treatment options available, the evaluation process could easily become too complicated and cumbersome. To prevent this, the ISA removed from consideration those technologies that were not appropriate for the contaminants and site conditions found in the WABOU. Then, it used the remaining technologies to develop the most promising remedial alternatives.

The screening process is divided into the following seven steps:

Step 1: Establish Remedial Action Objectives. Remedial Action Objectives (RAOs) specify the extent of cleanup required to protect human health and the environment. The RAO for a site takes into account the contaminant that poses the potential risk, the exposure routes and receptors, and an acceptable contaminant level or range of levels for each exposure route. This contaminant level or range of levels is called a Preliminary Cleanup Goal.

Step 2: Develop General Response Actions. General response actions describe the broad range of actions that will satisfy the RAOs.

Step 3: Identify Potential Remedial Technologies and Process Options. There are many potentially applicable technology types available to remediate all categories of contaminants under various site conditions. Some technologies have a proven record of performance, while others are promising but have not been tested under all field conditions. General technology types that can be used to implement a general response action are referred to as remedial technologies. Specific technology types within a remedial technology are called process options. An example of a remedial technology for an administrative action is access restrictions; an example of a process option within this remedial technology is fencing. Information on remedial technologies and process options is acquired through data base searches and technical journal reviews. This review of all potentially applicable technologies ensures that the best technologies are not overlooked early in the FS process.

Step 4: Screen Process Options for Technical Implementability. In this step the evaluation of technical implementability reduces the list of technology and process options. Technical implementability refers to the ability of the remedial technology or process option to meet an RAO. The result of this step is a list of technologies and process options that are capable of addressing contaminant types found in the WABOU under existing site conditions.

Step 5: Technology Evaluation and Selection of Representative Process Options. The process options that survived the above screening are evaluated for administrative implementability, effectiveness and cost. Examples of administrative implementability are the ability to obtain the necessary permits and the availability of necessary equipment and workers to implement the process option. This evaluation further reduces the list of process options to those that can be implemented, are effective in treating the contaminants in the WABOU, and are not cost prohibitive.

Even after the above evaluations are completed, there may be a number of process options that could be used to meet the RAOs. From the list of remaining process options within each remedial technology, a representative process option is selected. The representative process option is used to develop the alternatives, but the other equally promising process options are retained.

Step 6: Assemble Remedial Alternatives. The representative process options are used to assemble remedial alternatives that represent a range of general response actions specifically for the WABOU sites.

Step 7: Screen Remedial Alternatives. In this final step of the ISA the remedial alternatives are screened to ensure that they are protective of human health and the environment, implementable and cost-effective. This is to verify that the combined groups of process options meet these three criteria.

The ISA resulted in the development of seven groundwater remedial alternatives. Table 4-1 provides a brief description of these alternatives

4.2 Detailed Analysis of Alternatives

The purpose of the Detailed Analysis of Alternatives (DAA) is to analyze the alternatives identified in the ISA and present the relevant information needed to select the appropriate remedies. This is accomplished by evaluating each alternative against seven of the nine criteria provided under CERCLA. Figure 4-1 defines the nine evaluation criteria. The other two criteria (Community Acceptance and State Acceptance) are addressed in this Interim Groundwater Record of Decision based on the acceptance of the WABOU Groundwater Proposed Plan and the evaluation of comments received during the April 8, 1998 – May 8, 1998 public comment period.

TABLE 4-1
Interim Groundwater Remedial Alternatives

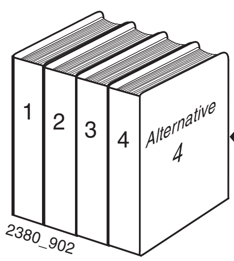
Remedial Alternative	Description
G1 - No Action	This serves as a starting point for comparing the other alternatives. No groundwater treatment takes place.
G2- Monitored Natural Attenuation (MNA)	MNA is a groundwater treatment strategy that relies on naturally occurring processes to prevent the spread of contamination. A major part of this strategy is the destruction of contaminants into harmless by-products by subsurface microorganisms. Groundwater monitoring is used to verify the effectiveness of this strategy.
G3 - Containment/ Treatment/Discharge	This alternative is designed to prevent the migration of the groundwater contamination. Groundwater is pumped from a series of extraction wells that are built near the leading edge of the contaminant plume. The resulting hydraulic barrier removes the contaminated ground-water before it can move past the extraction wells. The removed groundwater is treated using activated carbon and is either discharged to Union Creek or used for irrigation.
G4 - Extraction/ Treatment/Discharge	This alternative uses the extraction wells as described in alternative G3. It also places additional extraction wells in the more highly contaminated part of the plume in order to actively treat the whole plume. The removed groundwater is treated and is either discharged to Union Creek or used for irrigation.
G5 - Source Area and Groundwater Extraction/ Treatment/Monitored Natural Attenuation	This alternative applies only to Building 755 and is divided into three parts. The first part uses a vacuum-enhanced groundwater technology, DPE. A DPE system uses a vacuum to draw contaminated groundwater into an extraction well and at the same time lower the local water table. Exposed pools of solvents would then evaporate, and the vacuum removes the contaminated vapors. The water and vapors are cleansed in a treatment plant. This is designed to remove the source of contamination at this site. The second part uses extraction wells in the center of the plume to remove highly contaminated groundwater. The third part uses MNA to treat the portion of the plume with lower contaminant concentrations. MNA is described in Alternative G2.
G6 - Source Area Extraction/Treatment/ Monitored Natural Attenuation	This alternative also applies only to Building 755 and is divided into three parts. The first part is the DPE system that is described above. The second part uses a reactive wall in the subsurface to treat the contaminated groundwater as it passes through the wall. The third part uses MNA technology to treat the portion of the plume with lower contaminant concentrations. MNA is described in Alternative G2.

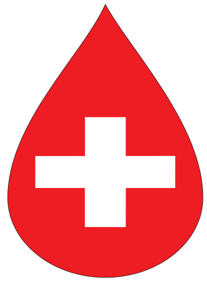
4.3 Comparative Analysis of Alternatives

In this final phase of the FS, the groundwater alternatives were evaluated based on how well they meet the individual CERCLA criteria. This analysis identified the advantages and disadvantages of each alternative, relative to each other, so that key tradeoffs could be used to select the preferred alternatives at each site. A sensitivity analysis was included in the Cost Comparative Analysis to determine how various uncertainties might affect the cost estimates. The following subsections present summaries of the comparison of the strengths and weaknesses of each alternative at each WABOU groundwater site.

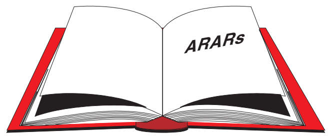
Alternatives G5 and G6 were designed specifically for Building 755, because this is the only WABOU groundwater site where pools of undissolved TCE are likely to be present beneath the local water table. This conclusion is based on the high TCE concentrations detected at the former sump area (source area).

Buildings 905 and 916 are evaluated together, because computer modeling of the ground-water capture zones indicated that a single groundwater extraction well would be capable of hydraulically containing the plumes at both buildings. As a result, Alternatives G1, G2, and G3 are the only alternatives that apply to these buildings.

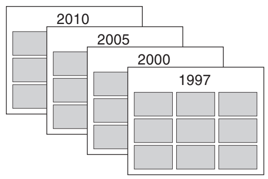




1. Overall Protection of Human Health and the Environment
Addresses whether a remedy provides adequate protection of human health and the environment and describes how risks are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.



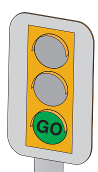
2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)
Addresses whether a remedy will meet all ARARs [federal and state environmental statutes] and/or provide grounds for invoking a waiver.



3. Long-term Effectiveness and Permanence
Refers to the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean up goals have been met.

4. Reduction of Toxicity, Mobility, or Volume (TMV) Through Treatment
Refers to the anticipated ability of a remedy to reduce the TMV of the hazardous components present at the site.

5. Short-term Effectiveness
Addresses the period of time needed to complete the remedy, and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until the clean up goals are achieved.

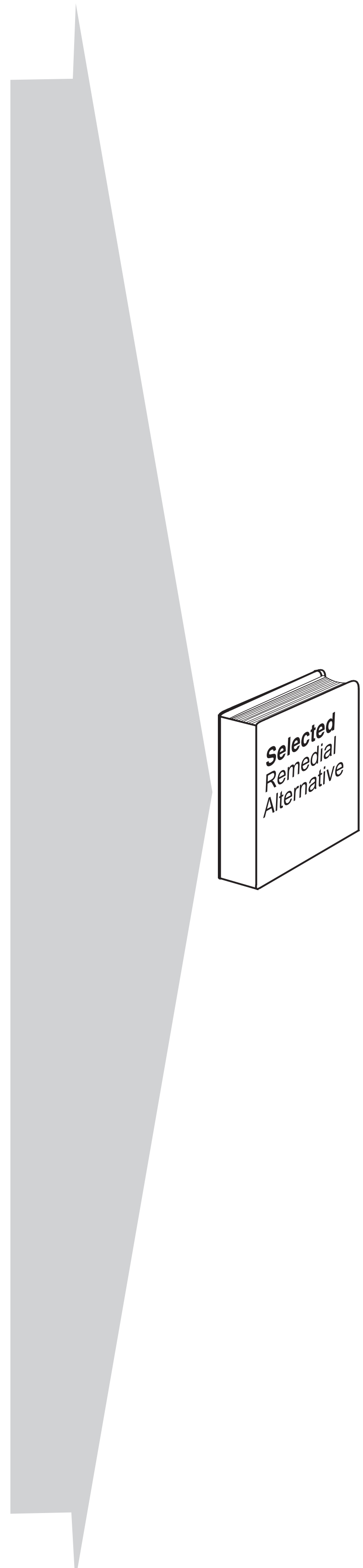


6. Implementability
Refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to carry out a particular option.

7. Cost
Evaluates the estimated capital and operation and maintenance costs of each alternative.

8. State Acceptance
Indicates whether, based on its review of the information, the state concurs with, is opposed to, or has no comment on the preferred alternative.

9. Community Acceptance
Indicates whether community concerns are addressed by the remedy and whether the community has a preference for a remedy. Although public comment is an important part of the final decision, EPA is compelled by law to balance community concerns with all of the previously mentioned criteria.



NOTE
The nine criteria are from the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA, 1988) and provide support for the selected Remedial Alternative.

FIGURE 4-1
NINE EVALUATION CRITERIA
WEST/ANNEXES/BASEWIDE OPERABLE UNIT (WABOU)
WABOU GROUNDWATER IROD
TRAVIS AIR FORCE BASE, CALIFORNIA

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4.3.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment serves as a threshold determination that must be met by any alternative for it to be selected as a remedy. Each of the groundwater alternatives, except for Alternative G1 (No Action), are protective of human health and the environment.

4.3.2 Compliance with ARARs

Compliance with ARARs also serves as a threshold determination that must be met by any alternative for it to be selected as a remedy. Each of the groundwater alternatives, except for Alternative G1 (No Action), will comply with ARARs.

4.3.3 Long-Term Effectiveness and Permanence

The *Long-term Effectiveness and Permanence* criterion is a measure of two principal factors: (1) the magnitude of residual risk; and (2) the adequacy and reliability of controls used to manage treatment residuals. Each of the groundwater alternatives, except for Alternative G1 (No Action), achieve some measure of long-term effectiveness and permanence. However, none of the alternatives as presently constituted achieve a high degree of effectiveness and permanence at Building 755. Table 4-2 provides a summary qualitative evaluation of the performance of each of the groundwater alternatives against this criterion on a site-by-site basis.

4.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Each of the groundwater treatment alternatives, including Alternative G1 (No Action), will achieve varying degrees of contaminant Reduction, Toxicity, Mobility, or Volume. However, Alternative G1 will not achieve reduction through treatment. Table 4-3 provides a summary qualitative evaluation of the performance of each of the groundwater alternatives against this criterion on a site-by-site basis.

TABLE 4-2
Summary of Comparative Analysis of Groundwater Alternatives – by Criterion Long-term Effectiveness and Permanence

	Groundwater Alternative					
Site	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**
Building 755	O	O	•	•	•	•
Landfill 3	O	•	•	●	-	-
Building 905	O	•	●	-	-	-
Building 916	O	O	●	-	-	-

Legend: Relative performance of the alternative at each site.

● Better satisfies criterion

• Moderately satisfies criterion

O Poorly satisfies criterion

\- Alternative not applicable at this site

Alternative G1 – No Action

Alternative G2 – Monitored Natural Attenuation

Alternative G3 – Containment/Treatment/Discharge

Alternative G4 – Extraction/Treatment/Discharge

Alternative G5 – Source Area and Groundwater Extraction/ Treatment/Monitored Natural Attenuation

Alternative G6 – Source Area Extraction/Treatment/ Monitored Natural Attenuation

TABLE 4-3
Summary of Comparative Analysis of Groundwater Alternatives – by Criterion Reduction of Toxicity, Mobility, and Volume through Treatment

	Groundwater Alternative					
Site	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**
Building 755	O	O	•	•	●	●
Landfill 3	O	•	•	●	-	-
Building 905	O	•	●	-	-	-
Building 916	O	•	●	-	-	-

Legend: Relative performance of the alternative at each site.

● Better satisfies criterion

• Moderately satisfies criterion

O Poorly satisfies criterion

\- Alternative not applicable at this site

Alternative G1 – No Action

Alternative G2 – Monitored Natural Attenuation

Alternative G3 – Containment/Treatment/Discharge

Alternative G4 – Extraction/Treatment/Discharge

Alternative G5 – Source Area and Groundwater Extraction/ Treatment/Monitored Natural Attenuation

Alternative G6 – Source Area Extraction/Treatment/ Monitored Natural Attenuation

4.3.5 Short-Term Effectiveness

The *Short-term Effectiveness* criterion is a measure of the protection afforded by each alternative during the construction and implementation process. As such, the time until the remedial action objectives are achieved is an important component of the criterion. Each of the groundwater alternatives, except for Alternative G1 (No Action), is effective in the short term to some degree. Table 4-4 provides a summary qualitative evaluation of the groundwater alternatives against this criterion on a site-by-site basis.

TABLE 4-4
Summary of Comparative Analysis of Groundwater Alternatives – by Criterion Short-Term Effectiveness

	Groundwater Alternative					
Site	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**
Building 755	O	O	•	•	•	•
Landfill 3	O	•	•	●	-	-
Building 905	O	•	●	-	-	-
Building 916	O	•	●	-	-	-

Legend: Relative performance of the alternative at each site.

● Better satisfies criterion
• Moderately satisfies criterion
O Poorly satisfies criterion
- Alternative not applicable at this site

Alternative G1 – No Action
Alternative G2 – Monitored Natural Attenuation
Alternative G3 – Containment/Treatment/Discharge
Alternative G4 – Extraction/Treatment/Discharge
Alternative G5 – Source Area and Groundwater Extraction/ Treatment/Monitored Natural Attenuation
Alternative G6 – Source Area Extraction/Treatment/ Monitored Natural Attenuation

4.3.6 Implementability

The *Implementability* criterion evaluates the technical and administrative difficulties associated with implementing each alternative. An important component of technical implementability is consideration of the reliability of the technology. Each of the groundwater alternatives are implementable. Table 4-5 provides a summary qualitative evaluation of the groundwater alternatives against this criterion on a site-by-site basis.

TABLE 4-5
Summary of Comparative Analysis of Groundwater Alternatives – by Criterion Implementability

Site	Groundwater Alternative					
	G1	G2	G3	G4	G5	G6
Building 755	O	◍	●	●	●	●
Landfill 3	O	●	●	●	-	-
Building 905	O	●	●	-	-	-
Building 916	O	◍	●	-	-	-

Legend: Relative performance of the alternative at each site.

● Better satisfies criterion

◍ Moderately satisfies criterion

O Poorly satisfies criterion

\- Alternative not applicable at this site

Alternative G1 – No Action

Alternative G2 – Monitored Natural Attenuation

Alternative G3 – Containment/Treatment/Discharge

Alternative G4 – Extraction/Treatment/Discharge

Alternative G5 – Source Area and Groundwater Extraction/ Treatment/Monitored Natural Attenuation

Alternative G6 – Source Area Extraction/Treatment/ Monitored Natural Attenuation

4.3.7 Cost

Table 4-6 presents the total project cost estimates for each groundwater alternative at each site. These *Cost* criterion estimates are a total of the site-specific capital and annual Operations and Maintenance (O&M) cost estimates for implementing the alternative. The annual O&M cost estimates for Alternatives G2, G3, and G4 are based on a 30-year period of groundwater treatment plant operation. The annual O&M cost estimates for Alternatives G5 and G6 are based on a 10-year period of DPE operation and a 30-year period of groundwater treatment.

Detailed cost summary tables are provided in Appendix A of the *West/Annexes/Basewide Operable Unit Feasibility Study, 60th Air Mobility Wing, Travis Air Force Base* (CH2M HILL, 1998). The assumptions that were used to create the site-specific cost estimates are described in Section 8 of the above-cited document. These assumptions are divided into general project assumptions, such as well construction details and monitoring frequency, and site-specific assumptions, such as the selected treatment technology and the number of extraction and monitoring wells for each site.

TABLE 4-6
Cost Estimates for WABOU Groundwater Remedial Alternatives

	Site-Specific Total Project Cost Estimate ($)		
Alternative	**Building 755**	**Landfill 3**	**Buildings 905/916**
G1 – No Action	0	0	0
G2 – Monitored Natural Attenuation	510,300	565,400	532,800
G3 – Containment/Treatment/ Discharge	929,700	582,300	568,100
G4 – Extraction/Treatment/ Discharge	2,277,000	819,800	-
G5 – Source Area and Groundwater Extraction/Treatment/Monitored Natural Attenuation	4,950,000	-	-
G6 – Source Area Extraction/ Treatment/Monitored Natural Attenuation	7,406,000	-	-

4.4 Conclusion

The Comparative Analysis did not recommend the implementation of a specific alternative for each WABOU site. It described the overall performance and cost of each groundwater alternative at each site. The paragraphs below summarize the findings of this analysis.

At Building 755, Alternatives G3 through G6 were all comparable in the way they satisfy the criteria. Alternative G4-Extraction/Treatment/Discharge appeared to do a slightly better job at meeting the criteria, because it achieves capture of the contaminated groundwater at this site faster than the other alternatives. The main drawback with this alternative is that it does not address the source of the contamination. Suspected solvent pools beneath this site may release dissolved contaminants to the groundwater for a long time. Alternatives G5 and G6 address the source of the contamination, but rely on MNA to remediate the downgradient end the plume. Without the data needed to evaluate the capability of local natural attenuation processes, it was necessary to use conservative assumptions in the computer modeling which indicated that natural attenuation would need more than 100 years to remediate the contamination.

At Landfill 3, Alternative G4-Extraction/Treatment/Discharge was evaluated to best satisfy the criteria. Alternative G4 was judged superior to Alternative G3 because it included extraction at the source and thereby captured the plume more quickly. Pump-and-treat options were considered superior to MNA mainly because of lack of natural attenuation data. Alternatives G5 and G6 are not applicable at Landfill 3.

At Buildings 905 and 916, Alternative G3-Containment/Discharge/Discharge was evaluated to best satisfy the criteria. Alternative G2 (MNA) was the only viable alternative to compare to Alternative G3, and Alternative G2 does not compare well because of the lack of natural attenuation data at these sites. Alternatives G4, G5, and G6 did not apply at these sites.