Final Remedy Selection Case Example

Case objective: To be able to understand how to use the performance standards and evaluation/balancing criteria for a hypothetical example (not to conduct a detailed technical evaluation of any given technology).

Information Available: All of the data presented to date are assumed to be available to support the remedy recommendation.

Owner/Operator Final Remedy Recommendation

The owner/operator has evaluated two alternatives for a final remedy and proposed the following remedy recommendation:

- Install permeable reactive barrier wall into bedrock as shown in **Figure 9a** to capture the organics (and the inorganics) in the ground water plume;
- Continue monitoring program to ensure that barrier wall is making adequate progress toward meeting final remedy objectives throughout the plume area, consistent with the final media cleanup standards;
- Rely on monitored natural attenuation for the portion of the plume beyond the wall (assume data exists that demonstrates MNA is a viable alternative);
- Establish the estimated time to meet final media cleanup standards after one year of monitoring the progress of the barrier wall remedy;
- Excavate any concentrations of soils containing metals above risk-based levels and send off site for management; Continue post-closure care on closed lagoon unit;
- Continue quarterly monitoring of Smith well and any other residential wells on a voluntary basis (i.e., if the land owners want to participate).

The owner/operator provides the following rationale for this recommendation:

- It is protective of human health and the environment;
- It will attain media cleanup objectives;
- Barrier wall provides long-term effectiveness because of the permanent destruction or immobilization of the contaminants of concern;
- It poses no short-term effectiveness issues because the monitoring program will ensure no exposures to receptors occur;
- It is implementable and cost-effective.

The second alternative considered is installation of a pump-and-treat system as shown in **Figure 9b**. This system will also rely on monitored natural attenuation for any portion of the plume that extends beyond the anticipated capture zone of the extraction wells.

Owner/Operator's Final Remedy Selection Evaluation Matrix

	Remedy Recommendation: Permeable Reactive Barrier	**Other Alternative** Pump-and-Treat
Does the alternative protect human health and the environment?	Given the present and potential future residential and commercial use of this land, the installation of a Permeable Reactive Barrier (PRB) will result in the protection of both the present and future health of residents, visitors, employees, and the environment. The PRB accomplishes this by intercepting the contaminant plume and either rendering the contaminants non-toxic or immobilizing the contaminants before they come in contact with residential wells and the Crystal River.	Given the present and potential future residential and commercial use of this land, the use of a pump-and-treat system will result in the protection of both the present and future health of residents, visitors, employees, and the environment. The pump-and-treat method accomplishes this by controlling the movement of the plume and extracting the dissolved organic (and inorganic) contaminant concentrations, allowing the plume to achieve acceptable levels before the contaminants reach residential wells and the Crystal River.
Do alternatives attain media cleanup objectives?	This technology is successful in destroying chlorinated hydrocarbons and immobilizing heavy metals, which represent the range of ground water contaminants at the Derekwood site. Cleanup time frame, in general, is reported to be less than more conventional technologies due to the reactive media's ability to contain the contaminants as they reach the wall.	This technology is successful in the removal and treatment of chlorinated hydrocarbons and heavy metals. Cleanup time frame can be lengthy because of physical and chemical conditions in the subsurface and the inherent limitations of this approach.
Do alternatives control sources of release (principal threats)?	The PRB can treat both the TCA/DCA/DCE plume and most of the heavy metals present. The PRB is designed so that the contaminant plume must move through the barrier as it flows. Reactants within the barrier then degrade or immobilize contaminants so that treated water exits on the other side.	The pump-and-treat method can be applied to the TCA/DCA/DCE plume as well as to any heavy metals present. Pump-and-treat methods involve pumping contaminated water to the surface and using appropriate treatment and disposal approaches to manage residuals.
Long-Term Effectiveness	Although a relatively new technology, the PRB has proven a successful remediation method, especially with respect to the types of contaminants found at Derekwood. As of March 1998, at least thirteen PRBs have been installed at both private sector and Federal sites. Monitoring of PRBs at these sites has shown the technology to be effective in the long term.	The pump-and-treat approach is used at many remediation sites where groundwater is contaminated and at most sites where cleanup is required by RCRA and state laws. The technology has been especially effective (i.e., has achieved full restoration of groundwater quality) at sites with relatively simple characteristics. At many sites, the pump-and-treat method has been effective for a part of a site.

	Remedy Recommendation: Permeable Reactive Barrier	**Other Alternative** Pump-and-Treat
Implementability	PRBs of varying sizes and depths have been constructed at these thirteen sites, establishing technical feasibility of construction. The materials for construction (especially zero-valent iron) are also readily available. Because it is a passive treatment method, the PRB does not require "operation." Though the PRB must be monitored regularly for compliance, the need for performance monitoring decreases the longer the PRB has been installed which helps reduce overall costs. Quarterly monitoring for field parameters, organic and inorganic constituents, and monthly hydraulic monitoring can be reduced once the PRB has demonstrated consistently effective performance. One risk of implementation includes the potential for microbial activity that could inhibit the productivity of the reactive media. Mineral precipitation is also possible, which if left unchecked for an extended period of time, may cause an adverse reduction in barrier permeability. To date, these two risks have not significantly affected the productivity of existing PRBs.	Pump-and-treat systems have been constructed for the past twenty years, establishing the general feasibility of their construction. Site-specific data also supports the use of pump-and-treat at Derekwood. Waste management options for both treated ground water and waste residuals are available. It is likely treated ground water will be discharged to the Crystal River under a state permit or sent to a nearby treatment works. Waste residuals will be sent to a permitted facility for appropriate management.
Short-Term Effectiveness	The primary short-term risk is the potential for the plume to move around the barrier. Proper site characterization at Derekwood lessens this possibility. The amount of time required for PRB design, construction, and implementation varies. Remedy design is probably the most time-consuming due to the need for a detailed site characterization, including hydrogeologic, contaminant loading, geochemical, and microbial characteristics, but this should take no longer than six months.	The primary short-term risk is the potential for tailing and rebound, which can prolong treatment time and cause contaminant concentrations to exceed cleanup standards. Though NAPLs have not been specifically found at the Derekwood site, they are likely to be present, and their presence could significantly contribute to tailing and rebound. The amount of time required for pump-and-treat design, construction, and implementation varies.

	Remedy Recommendation: Permeable Reactive Barrier	**Other Alternative** Pump-and-Treat
Toxicity, Mobility, and Volume Reduction	This remedy will result in reduction of the toxicity of the plume by destroying or separating out the contaminants. Within the PRB are reactants (usually zero-valent iron) that will destroy VOCs and immobilize metals as they pass through the barrier. Treated water then flows through the other side of the barrier, towards residential water wells and surface water. Contaminants shown to be treated effectively by the PRB at the Derekwood site may include: TCA, DCA, DCE, Chromium (VI), Nickel, and Lead. The total amount of waste to be remediated at the Derekwood site is unknown, though monitoring wells have identified contaminant concentrations. The PRB method produces some treatment residuals, including an increase in the pH of a plume, although this will be lessened by adding pyrite or native aquifer sediments to the iron. The increase in pH causes sulfide to be produced as a result of the increased microbial activity. In addition, precipitates may form, or large quantities of dissolved hydrogen may be generated. It is unlikely, though, that any toxic products will be generated by the PRB.	This remedy may result in reduction of the toxicity of the plume by removing and treating VOCs and heavy metals. Groundwater will be pumped from a well at rates that cause all water in the plume to enter the well rather than continue traveling though the subsurface. Contaminants shown to be treated effectively by pump-and-treat methods at the Derekwood site may include: TCA, DCA, DCE, Chromium (VI), Barium, Nickel, and Lead.
Cost	The cost of a PRB will depend on the ultimate depth, width, and saturated thickness of the plume. It includes the price of reactive materials, funnel materials (if a funnel and gate PRB is chosen), and construction costs (excavation, etc). The owner/operator believes the costs of the PRB are reasonable and approximately 30-35% of the cost of the installation of a more comprehensive pump-and-treat system.	The cost of pump-and-treat depends on the specific removal and treatment methods selected, the length of time the system will operate, and the amount of groundwater and waste. Pump-and-treat systems tend to be more expensive than other remediation technologies due to high operating and monitoring costs and the costs associated with waste management.
Community Acceptance	The community is concerned about the effectiveness of the barrier wall and whether it will divert the plume toward the nearby homes rather than capture and treat the contaminants. They also prefer clear guidance be established before the remedy starts to operate that would define the conditions when the remedy would be considered "unsuccessful" so that an alternative approach could be implemented.	

Worksheet – Final Remedy Case Example

1. Would you ____ accept this remedy recommendation

   ____ request the owner/operator to modify this remedy recommendation

   ____ request the owner/operator to develop additional alternatives

2. Provide short bullet points on your group's rationale for its decision (use either of the tools attached if it will help illustrate your rationale)

3. What are the major uncertainties that must be addressed when selecting a final remedy for this site?

4. How would your analysis change, if at all, if the community strongly favored the recommendation?

Figure 8

AMT, Inc.
Derekwood, USA

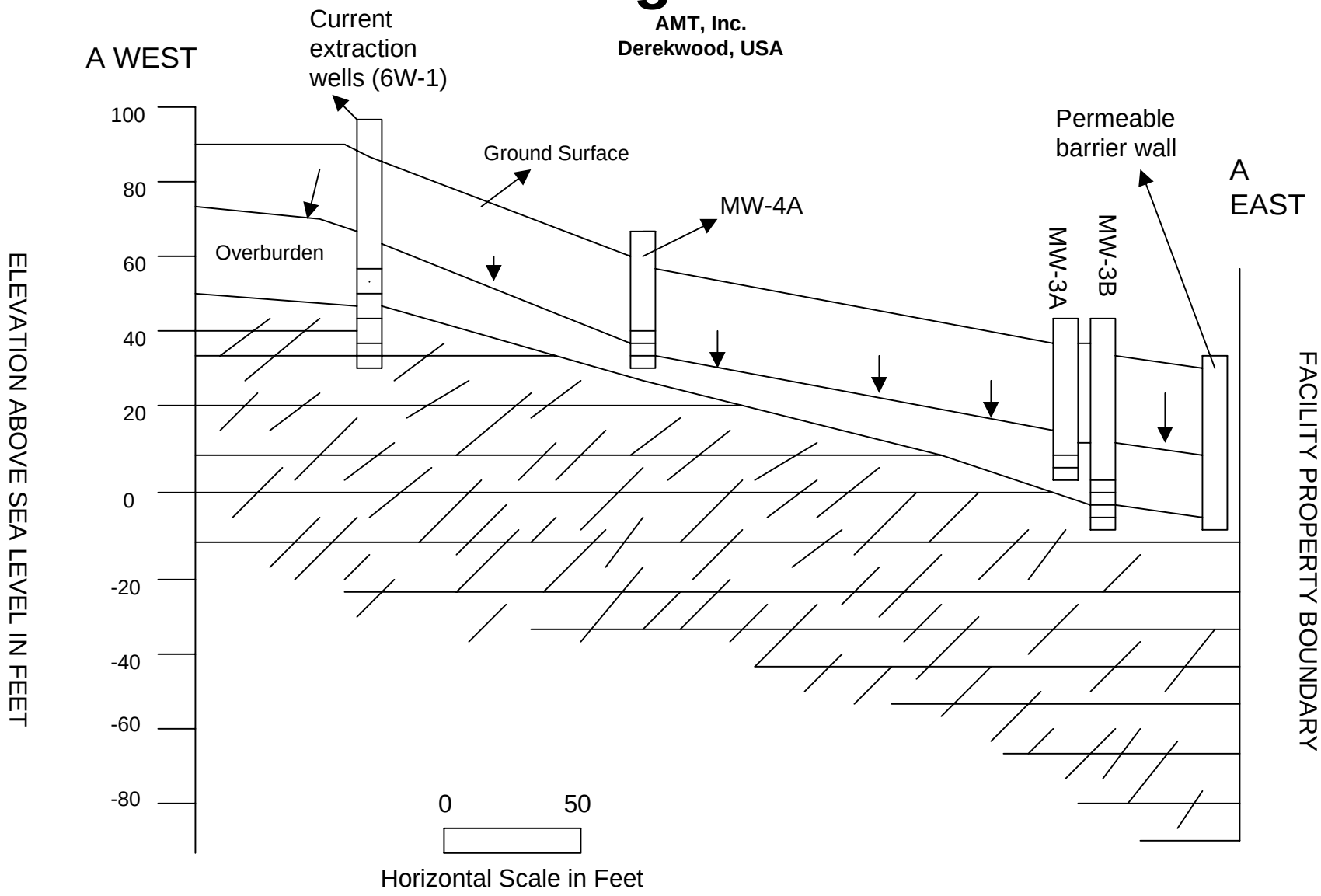
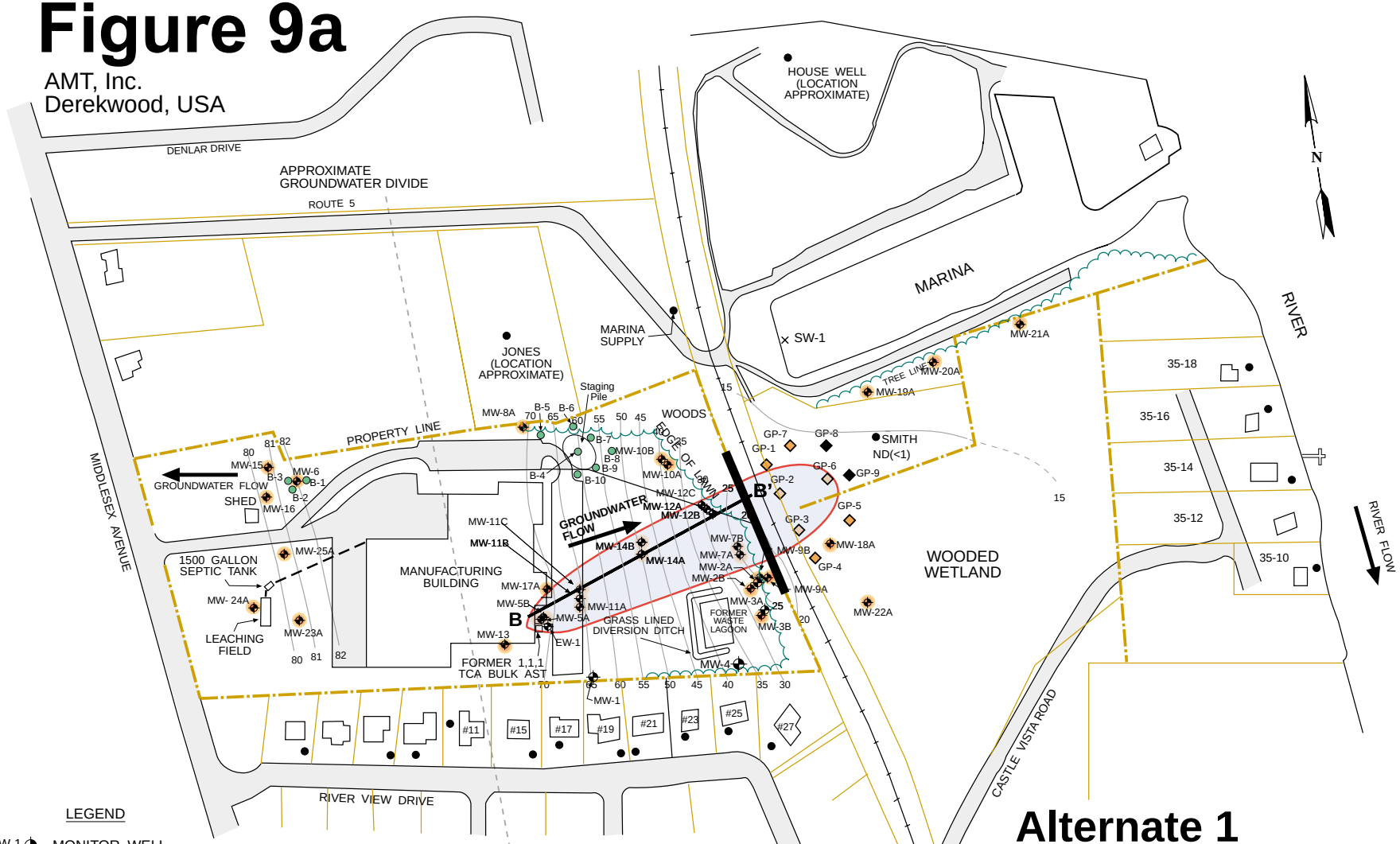


Figure 9a

AMT, Inc.
Derekwood, USA



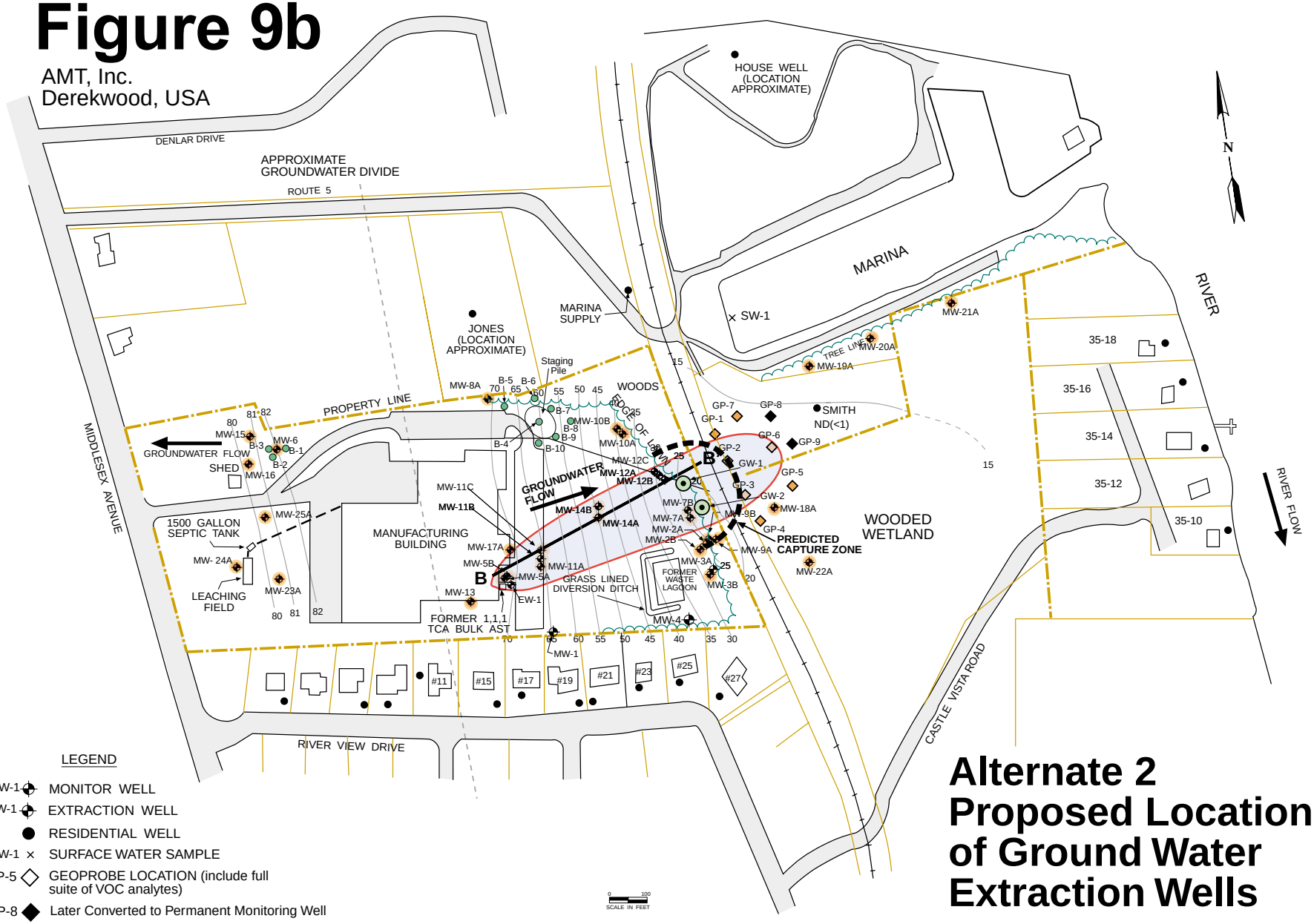
LEGEND

- MW-1 ⊕ MONITOR WELL
- EW-1 ⊕ EXTRACTION WELL
- ● RESIDENTIAL WELL
- SW-1 × SURFACE WATER SAMPLE
- GP-5 ◇ GEOPROBE LOCATION (include full suite of VOC analytes)
- GP-8 ◆ Later Converted to Permanent Monitoring Well
- ▬ PERMEABLE REACTIVE BARRIER

Alternate 1 Proposed Location of Permeable Reactive Barrier

Figure 9b

AMT, Inc.
Derekwood, USA

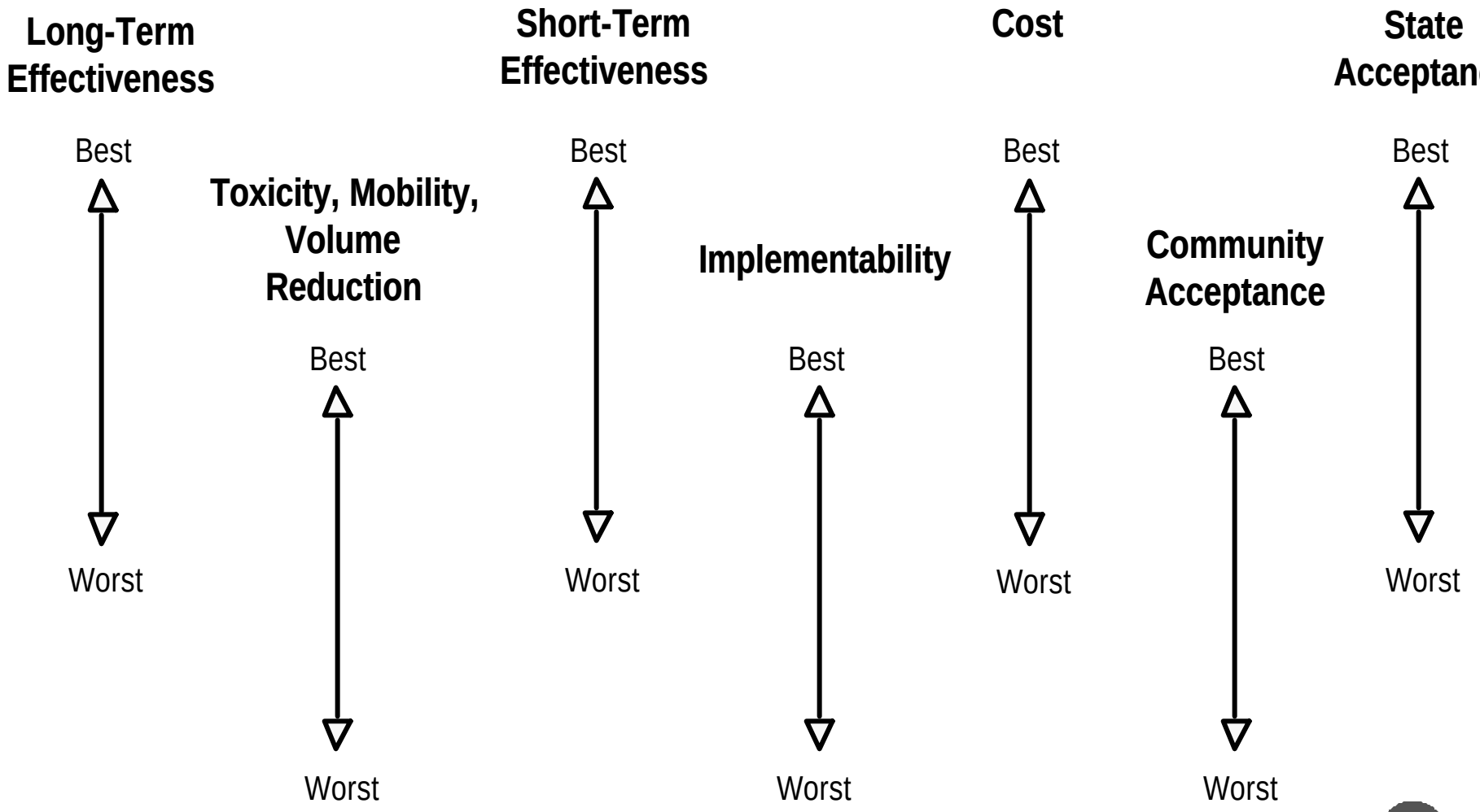


LEGEND

- MW-1 — MONITOR WELL
- EW-1 — EXTRACTION WELL
- RESIDENTIAL WELL
- SW-1 — SURFACE WATER SAMPLE
- GP-5 — GEOPROBE LOCATION (include full suite of VOC analytes)
- GP-8 — Later Converted to Permanent Monitoring Well
- GROUND WATER EXTRACTION WELL

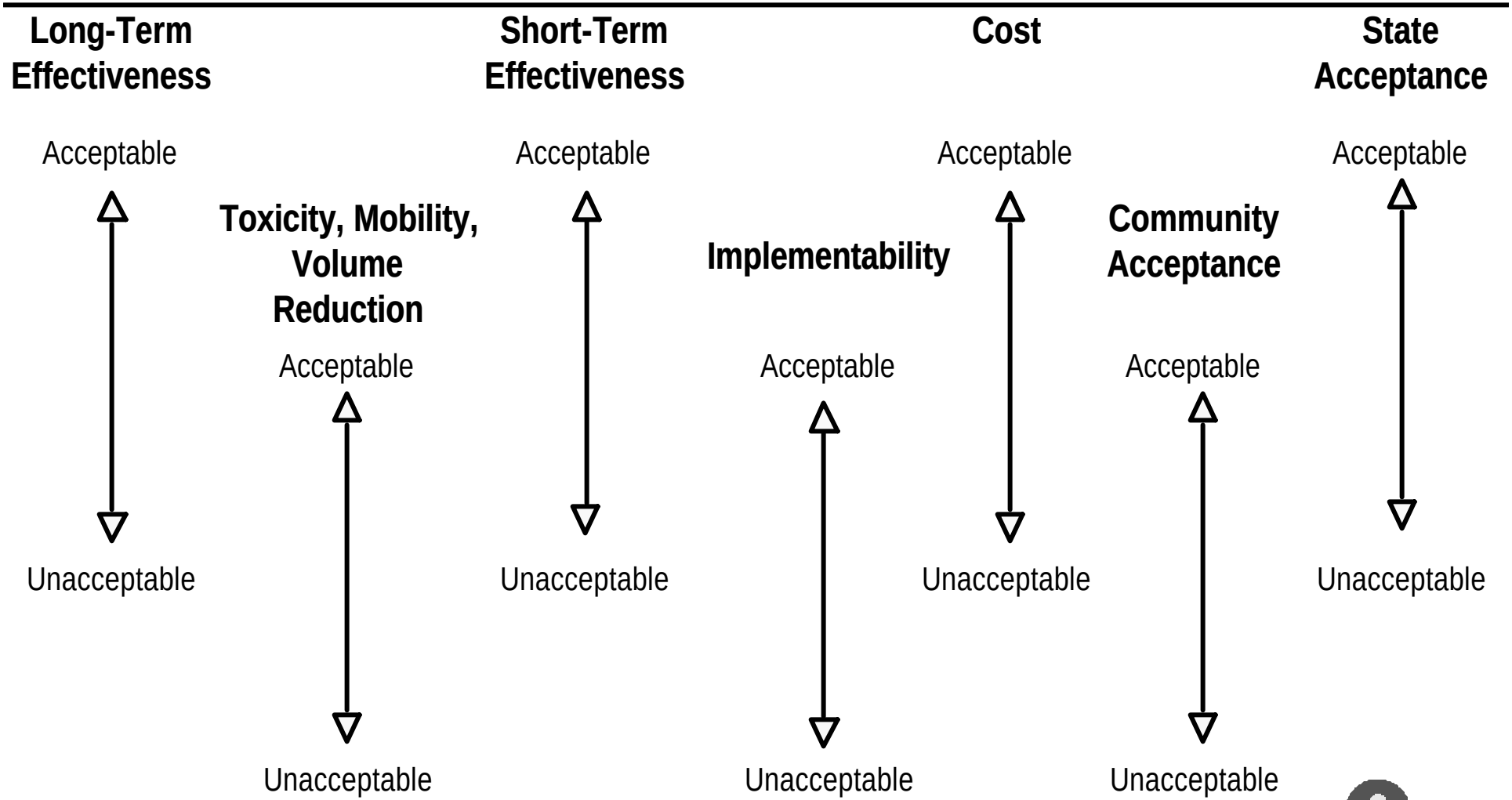
Alternate 2 Proposed Location of Ground Water Extraction Wells

Graphic Tool to Conduct Comparative Analysis of Final Remedy Alternatives



Directions: Rank each alternative relative to the others on the "Best-Worst" scale for each of the 7 criteria

Graphic Tool to Analyze Single Final Remedy Alternative



Directions: Rank each of the alternatives as to where it falls on the scale of acceptable to unacceptable for each alternative.