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July 29, 2004

Mr. Ken Lovelace
Office of Solid Waste & Emergency Response (MC-5202G)
U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Dear Mr. Ken Lovelace:

On May 10, 2004, the U.S. Environmental Protection Agency released Issues/Options papers entitled: "Ground Water Use, Value, and Vulnerability as Factors in Setting Cleanup Goals." and "Cleanup Goals Appropriate for DNAPL Source Zones." The stated intention of these papers is to:

> *"...promote dialogue by providing a brief background, followed by differing stakeholder points of view (based on written or anecdotal input) with respect to problems and/or challenges, and potential options for addressing these problems. Stakeholders include Federal and State regulatory officials, and members of the regulated community, as well as environmental and public interest groups."*

API[1] is pleased to provide the attached comments on the Issues/Options papers. We look forward to future stakeholder meetings to discuss these important ground water policy issues.

Feel free to contact me if you have any questions about our comments.

Sincerely,

Harley Hopkins, PG
Regulatory Analysis and Scientific Affairs

Cc:
Matt Hale
Steve Heare
Bob Hall
Tom Rinehart

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[1] The American Petroleum Institute represents more then 400 member companies involved in all aspects of the oil and natural gas industry.

Comments of the American Petroleum Institute

Option Papers Developed May 10, 2004 by EPA's Ground Water Task Force

A Workgroup Established Under the "One Cleanup Program Initiative" of the

Office of Solid Waste and Emergency Response:

"Ground Water Use, Value, and Vulnerability as Factors in Setting Cleanup Goals"

And

"Cleanup Goals Appropriate for DNAPL Source Zones"

July 30, 2004

American Petroleum Institute
1220 L Street, N.W.
Washington, DC 20005
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COMMENTS BY THE AMERICAN PETROLEUM INSTITUTE
REGARDING THE ENVIRONMENTAL PROTECTION AGENCY'S ISSUES/OPTIONS PAPER:

"GROUND WATER USE, VALUE AND VULNERABILITY AS FACTORS IN SETTING CLEANUP GOALS"

KEY COMMENTS

1. Groundwater use, value, and vulnerability are important issues to API, and have been a focus area of API's groundwater protection research program. In particular, API and the California MTBE Research Partnership collaborated between 2000 and 2002 to develop the *Groundwater Sensitivity Toolkit*, a software utility to help site managers, water purveyors, and regulators evaluate the sensitivity of a groundwater resource to a potential release of compounds of concern at a particular site. This research effort addresses several of the concerns raised in the Issues/Options paper.

   The *Groundwater Sensitivity Toolkit* can be downloaded at this URL:

   http://groundwater.api.org/toolkit

   While EPA has identified groundwater use, value, and vulnerability as factors for setting cleanup goals, the *Groundwater Sensitivity Toolkit* provides a technical basis for defining and classifying groundwater *Resource Value, Receptor Vulnerability, and Natural Sensitivity*. This approach, which was developed in a consensus-based process with representatives from industry, regulatory agencies, and water purveyors. It should be considered as a potential framework for EPA's Options/Issues paper.

   California is recognized as being very protective of its groundwater resources. In this environment, API was successful at developing a consensus between API members, California water purveyors, and California regulators (e.g., the Santa Clara Valley Water District) to build the *Groundwater Sensitivity Toolkit.* Given our technical expertise in the area and our experience working with a diverse set of stakeholders, we feel we have significant contributions to make towards EPA's effort to apply groundwater use, value, and vulnerability to setting cleanup goals. We ask that API be included as a key stakeholder in EPA's work in this area.

Note that as part of the toolkit project, API has done work on describing the various state groundwater programs that deal with classifying groundwater resources (see Table 1, attached: "*Examples of State Screening Criteria for Characterization of Groundwater Resources*"). This analysis was used to determine what key factors were used by the states to classify groundwater. The results served as the foundation for the toolkit design.

2. API feels that the current mixture of different state and federal programs that deal with groundwater classification are not very coherent, and that different programs can generate very different interpretations of groundwater use, value, and vulnerability. Additional coordination between state regulatory programs is recommended.

3. API feels that the concept of intrinsic value of groundwater is basically impossible to implement into any workable framework for valuing groundwater. The intrinsic value of groundwater is very subjective and there are no commonly accepted methods for establishing "intrinsic value." API recommends that the concept of "intrinsic value" not be used in the Issues/Options paper.

4. API feels that a risk-based approach is an accepted and practical strategy to manage contaminated groundwater, and recommends that risk-based and exposure control approaches be applied for setting cleanup goals.

SPECIFIC COMMENTS

Page 2, 1st paragraph: "All of these uses and functions are considered 'beneficial uses' of ground water. Furthermore, within a range of reasonably expected uses and functions, the maximum (or highest) beneficial ground water use refers to the use or function that warrants the most stringent ground water cleanup levels."

API Response: API feels that any definition of "reasonably expected uses" be based primarily on economic and risk-related factors. In particular, the concepts of water deliverability (e.g., well yield) and water quality (e.g., total dissolved solids concentrations) should play a key role in defining "reasonably expected uses."

Page 2, 2nd paragraph: "Ground water value is typically considered in three ways: for its current uses; for its future or reasonably expected uses; and for its intrinsic value."

API Response: The concept of intrinsic value for groundwater is very difficult to implement into any type of regulatory framework as different stakeholders could have very different concepts on what the "intrinsic value" for a particular resource would be. "Intrinsic value" (also called "existence value") is a very subjective concept. API feels that groundwater resources should be managed using scientifically based technical factors (e.g., deliverability and water quality) and not with personalized, emotion-based factors such as "intrinsic value."

Note that the 1997 National Research Council (NRC)'s Valuing Ground Water report states: "The topic of existence values for environmental assets is one of the most controversial in environmental economics." They also noted that (as of 1997) only one study had attempted to address existence value of groundwater, and that the approaches used in that study were criticized. The NRC report demonstrates that there is no scientifically accepted basis for applying the concept of "intrinsic value" to groundwater valuation.

API recommends that EPA does not make use of the concept of intrinsic value for groundwater.

Page 5, 4th paragraph: Problem Statements

API Response: API suggests that an additional problem statement be added, or that the existing problem statements be modified to reflect the lack of consistency on how different state programs deal with groundwater use, value, and vulnerability. Some states have very little technical basis to define groundwater use, value, and vulnerability, while other states have very sophisticated technical guidance to address these issues. Table 1 (attached to these comments) indicates the variability in regulatory approaches by different states.

API recommends that EPA provide guidance to the states so that non-degradation rules can be interpreted more flexibly regarding how groundwater is valued. With this flexibility, more practical and effective resource management approaches (such as the type of approach used in the *Groundwater Sensitivity Toolkit)* can be applied.

Page 6, Problem Statement 2: "There appears to be an increasing demand for reliance on exposure controls rather than cleaning up contaminated ground water. Decisions not to cleanup may be short sighted with regard to increasing future demands for clean drinking water supplies."

Page 6, Problem Statement 4: "Ground water cleanup activities and decisions are often not prioritized in a manner that would result in addressing the most pressing needs or maximizing the public health benefit of monies spent."

API Response: API feels that a risk-based approach is an accepted and practical strategy to manage contaminated groundwater. There has been an extensive body of research, including EPA research that has shown that complete restoration of groundwater underlying contaminated sites is very difficult or impossible to achieve due to technical constraints such as non-aqueous phase liquids, matrix diffusion, small-scale heterogeneities, and availability effects. Because of these constraints, a risk-based approach has been accepted for a wide variety of regulatory programs that deal with contaminated groundwater.

Problem Statement 2 highlights a common misconception about the use of exposure controls. Exposure controls are commonly used in conjunction with ground water treatment technologies as well as containment. Furthermore, exposure controls are used as an effective way to protect human health when other cleanup approaches shoe marginal benefit at much higher costs.

EPA research has presented decision approaches that account for various benefits from remediation, such as the Decision Chart Figure 3.2 in the EPA's "The DNAPL Remediation Challenge: Is There a Case for Source Depletion?" (attached). API feels that this type of decision approach provides a method to balance the costs and benefits of remediation.

Page 7, Option 2: "Conduct research on the impacts on other developed nations that have resulted from either the presence or lack of strong ground water protection programs."

API Response: API feels this is an appropriate option as long as the application of the research findings is in context with US land use and value, availability of water resources and risk management.

Page 7, Options 3 and 4: "Develop summaries of how individual EPA and State cleanup programs consider ground water use, value and vulnerability in setting cleanup goals (e.g., ground water classification and classification exception systems; ground water management zone type approaches, etc.)."

API Response: API has compiled information on different state programs, and has attached Table 1, "*Examples of State Screening Criteria for Characterization of Groundwater Resources*." The work was done as the initial step of the *Groundwater Sensitivity Toolkit* project to identify the methods being used by different states to classify groundwater resources. Note that this table was originally developed in October 2000.

This table illustrates that more consistency is needed between the different state programs. Guidance on how to manage groundwater as a resource is needed to address problems with inconsistency.

Page 8, Option 5: "Using information from Federal and State cleanup programs, develop a general framework that describes how to prioritize sites according to problem severity and ground water use, value and vulnerability."

API Response: API and the California MTBE Research Partnership have addressed this issue. Using a consensus approach with regulators and water purveyors, API and the California MTBE Research Partnership developed the *Groundwater Sensitivity Toolkit*, a software program to help site managers, water purveyors, and regulators evaluate the sensitivity of a groundwater resource to a potential release of compounds of concern at a particular site. API recommends that EPA review the *Groundwater Sensitivity Toolkit* as a potential framework for how to prioritize sites (see Figures 1-4, attached, for a diagram of the toolkit architecture).

The *Groundwater Sensitivity Toolkit* can be downloaded at this URL:

http://groundwater.api.org/toolkit

API feels that the toolkit can be a key resource in EPA's efforts in this area. API would be pleased to give the Task Force a presentation on the *Groundwater Sensitivity Toolkit* that would cover: i) the consensus approach that was used to develop the tool; ii) the tool architecture; iii) and how the tool is used.

Page 8, Option 6: "Use defined Source Water Assessment Program (SWAP) areas (required by the 1996 amendments to the Safe Drinking Water Act) to promote consistency in ground water cleanup decision making."

Page 9, Option 7: "Promote and provide funding assistance for regular meetings within an individual state or watershed that brings together the various programs and stakeholders involved with ground water cleanup and protection."

API Response: API feels these Options should be implemented based on the framework developed as part of Option 5. There is a need to engage stakeholders in a practical manner, particularly stakeholders such as API members who have nationwide experience/perspective related to groundwater use, value, and vulnerability. EPA should review state source water protection assessments and glean information to improve risk-based strategies for protecting vulnerable water sources. EPA's July 20, 2004 memo "Opportunity for Targeted Public Health Protection Through the Underground Storage Tank and Source Water Protection Programs" highlights an attempt to bring programs together. Such efforts could easily involve non-government stakeholders such as API to work towards consistency in addressing ground water vulnerability.

COMMENTS BY THE AMERICAN PETROLEUM INSTITUTE REGARDING THE ENVIRONMENTAL PROTECTION AGENCY'S OPTIONS PAPER:

"CLEANUP GOALS APPROPRIATE FOR DNAPL SOURCE ZONES"

KEY COMMENTS

1. API recommends that the EPA acknowledge that many of the processes that preclude complete removal of DNAPL also directly apply to LNAPL (e.g., formation of residual NAPL, impact of heterogeneities, etc.). API has significant expertise in NAPL science and NAPL management, and would like to be an active stakeholder in exploring options on this topic.

2. API feels that EPA should stress that the level of remediation should be a function of the risk from the DNAPL source zone. The level of site assessment should be determined 1st from receptor information and upgraded or downgraded based on pathway and source characteristics. This approach is described in API Soil and Groundwater Bulletin No. 11

3. The Remediation Technologies Development Forum (RTDF) NAPL Cleanup Alliance's "A Decision-Making Framework for Cleanup of Sites Contaminated with Light Non-Aqueous Phase Liquids" can serve as a resource for developing several of the Options, including Option 4 (flexible source zone policies); Option 6 (qualitative decision-making approach); Option 7 (performance measures), and Option 8 (guidance on long-term remedies).

4. API feels that EPA guidance should stress that remediation endpoints need to be established prior to implementation of any remedy rather than evolving into "moving targets."

5. API recommends that all the Options be implemented.

SPECIFIC COMMENTS

Page 2, Issue Background: "DNAPLs as a Source of Contamination"

API Response: Additional text should be added to discuss the prevalence of matrix diffusion effects and the impact of matrix diffusion (e.g., see page 9 of the "*The DNAPL Remediation Challenge: Is There a Case for Source Depletion?*" document). The presence of matrix diffusion can confound attempts at remediating zones that contain (or contained) NAPLs, and serve as a long-term source at many sites.

Page 10, Option 1: "Develop a fact sheet describing the potential benefits of DNAPL mass removal from the source zone, as well as the potential disadvantages."

API Response: API recommends that this Option be implemented. API feels that the Decision Chart Figure 3.2 in the EPA's "*The DNAPL Remediation Challenge: Is There a Case for Source Depletion?*" (attached) provides an excellent framework for evaluating the conditions that would reasonably justify DNAPL mass removal. In addition, EPA should rely on the Department of Defense Strategic Environmental Research and Development (SERDP) program, which has several research projects related to the performance of DNAPL mass removal technologies (including data mining studies where site performance data has been compiled) and studies of source processes at LNAPL sites.

Page 11, Option 2: "Develop a fact sheet describing program flexibilities and alternative cleanup goals that may be applied to the DNAPL source zone other than attainment of MCLs."

API Response: API recommends that this Option be implemented. Issues regarding delineation of DNAPL source zones should be clearly discussed in light of the difficulty in DNAPL source zone characterization (see comment on Option 5).

Page 11, Option 3: "Develop a supplemental EPA guidance on technical impracticability (TI)…"

API Response: API recommends that this Option be implemented. The Option 3 guidance should emphasize that a TI alternative will control the risk from the source zone, even though remediation is technically impracticable. EPA guidance should stress that remediation efforts should be applied to reducing risk "to the extent practical" and not to removing mass "to the extent practical."

Page 12, Option 4: "Develop a policy memorandum re-emphasizing existing EPA policy that program flexibilities are to be used for DNAPL source zones, as a means of setting cleanup goals that are achievable in a reasonable time frame."

API Response: API feels Option 4 should be implemented if the policy memorandum applies a risk-based approach in building flexibility into the management of DNAPL source zones. Removal of mass that does not reduce risk in a reasonable timeframe (i.e., 30 years) should not be required.

Page 12, Option 5: "Develop guidance on recommended methods and approaches for delineating the extent of the DNAPL source zone."

API Response: API recommends that this Option be implemented. However, API is concerned that DNAPL source zone characterization can become a difficult and expensive process if only direct indicators are used to establish the limits of a DNAPL zone. As indicated in the 1993 EPA report (cited in the Options Paper), DNAPL is never directly observed at most DNAPL sites. API recommends that EPA address the difficultly in defining precisely where DNAPL is located, and allow the use of indirect indicators (such as groundwater concentrations) for establishing the limits of the DNAPL source zone. The level of assessment and the level of remediation should be a function of the risk from the DNAPL source zone. API Publication No. 4699 "Strategies for Characterizing Subsurface Releases of Gasoline Containing MTBE" provides an illustration on how site characterization can be scaled to the risk at a particular site. This information is summarized in API Soil and Groundwater Bulletin No. 11 (http://api-ep.api.org/filelibrary/bulletin11.pdf)

Page 13, Option 6: "Develop guidance providing a qualitative approach for determining when source depletion technologies should be implemented, or should not be implemented."

API Response: API recommends that this Option be implemented. API feels that the qualitative approach developed by the EPA's Expert Panel on DNAPL Remediation (Decision Chart Figure 3.2 in the EPA's "*The DNAPL Remediation Challenge: Is There a Case for Source Depletion?*") provides an excellent method for addressing this important issue. The Panel's Decision Chart was developed by members of the EPA Expert Panel, approved by the panel for inclusion into the final document, and incorporates key concepts such as DNAPL migration, source longevity, cost, expanding/contracting plumes, time-to-receptors, need for near-term action, and long-term stewardship issues.

The Expert Panel Report describes the Qualitative Decision Chart this way:

> *An example of the qualitative decision approaches is the "weight-of-evidence" analysis where multiple factors important in reaching a decision are assigned relative weight factors or numerical scores (based on consensus expert opinion), and the aggregate score is used to guide the choice among multiple remediation options. Thus, this "weight of evidence" allows numerous factors to be considered, without letting a single factor control the decision analysis. Figure 3.2 illustrates the qualitative approach to decisions regarding the selection of source depletion technologies for DNAPL sites instead of the selection of a containment remedy. Depending on the geologic conditions and the DNAPL architecture, the size of the release, and the extent of land use, a DNAPL source zone would have a greater or lesser potential to achieve benefits from source depletion. Use of this screening level tool requires considerable judgment, and application to site-specific decision-making, and further development is needed to confirm its utility. Sale (Sale, 2003) also recently presented an example of the use of such "decision charts" based on an assessment of various benefits accrued from full-scale deployment of source depletion at LNAPL sites.*

See Figure 3.2 of the EPA's "*The DNAPL Remediation Challenge: Is There a Case for Source Depletion?*" (attached).

Other related resources that could be applied to develop this guidance are the Remediation Technologies Development Forum (RTDF) NAPL Cleanup Alliance's "A Decision-Making Framework for Cleanup of Sites Contaminated with Light Non-Aqueous Phase Liquids" and *Standard Practice / Guide for Conceptual Model Development and Associated Remedy Decision-Making for Light Nonaqueous Phase Liquids Released to the Subsurface* now being developed be a subcommittee under ASTM E50.

Finally, the Option 6 guidance should emphasize what site attributes make aggressive DNAPL removal more likely to succeed, based on actual case studies and databases showing the performance of source depletion technologies in the field (e.g., SERDP studies). Key factors such as the size of the affected source zone, the presence of surface obstacles (such as active operating units), and the hydrogeologic setting should be applied in this guidance.

Page 13, Option 7: "Develop guidance on performance measures for the effectiveness of DNAPL mass removal, and on how to determine when active DNAPL removal efforts should be discontinued."

API Response: API recommends that this Option be implemented, and that it be tied into risk reduction associated with DNAPL source removal. In addition, the Option 7 guidance should stress that endpoints need to be established prior to implementation of any remedy rather than evolving into "moving targets." The RTDF Decision Making Framework (discussed above) can be used as a resource for implementing this important concept.

Page 14, Option 8: "Develop guidance describing improved methods for comparing long-term remedies, which would allow a more realistic accounting of the costs and other disadvantages of long-term custodial care."

API Response: API recommends that this Option be implemented. Decisions on long-term remedies are influenced by regulations, the ability of remediation technologies to perform in a way necessary to meet site goals and the complex accounting rules (e.g., SEC rules) that influence how businesses assess the cost of long-term remedies and provide financial assurance. Thus, any guidance must show how the regulatory, technology and financial/accounting issues are considered together.

API feels that this guidance would be very useful as long-term containment will likely be required at many sites. Any guidance developed for comparing long-term remedies should also describe how performance monitoring is a key component of many long-term remedies.

DESIRED REMEDIAL BENEFITS[1]	**MORE NEED** FOR SOURCE DEPLETION ←		**LESS NEED** FOR SOURCE DEPLETION →
Reduce potential for DNAPL migration as separate phase	1a. Expanding mobile DNAPL Zone (probably rare at chlorinated solvent sites)[2] *(containment addresses this problem too)*	1b. Free-Phase DNAPL present but stable in stratigraphic traps	1c. Immobile, residual DNAPL Zone
Reduce source longevity, and reduce long-term management requirements	2a. High life-cycle containment cost (for example, containment Net Present Value (NPV) >> cost of remediation) 3a. Low reliability of containment system 4a. High resource value that cannot be used due to DNAPL (for example, sole-source aquifer OR Well Yield > 144,000 gpd with TDS < 3000 mg/L)[3] 5a. High probability of a meaningful reduction in time to reach MCLs (for example, small sites with low complexity)	2b. Moderate life-cycle containment cost 3b. Moderate reliability of containment system 4b. Moderate resource value 5b. Moderate probability of a meaningful reduction in time to MCLs	2c. Low life-cycle containment cost (for example, containment Net Present Value (NPV) << cost of remediation) 3c. High reliability of containment system 4c. Low resource value (for example, resource not being used AND either Total Dissolved Solids > 10,000 mg/L or Well Yield < 150 gpd)[4] 5c. Low probability of meaningful reduction in time to reach MCLs (for example, large releases at complex sites)
Near-term enhanced natural attenuation due to reduced dissolved phase loading	6a. Expanding dissolved phase plume (source loading > assimilative capacity) *(containment addresses this problem too)*	6b. Stable dissolved phase plume (source loading ~ assimilative capacity)	6c. Shrinking dissolved phase plume (source loading < assimilative capacity)
Near-term reductions in dissolved phase loading to receptors (e.g., a well or a stream)	7a. Receptor impacted now or impacted soon (for example, < 2 years travel time)[5] *(containment addresses this problem too)*	7b. Potential longer-term risk to receptor (for example, >2 years travel time)	7c. No risk to receptors now or in the future
Near-term attainment of MCLs	8a. Need for rapid cleanup (for example, impending property transfer)	8b. Limited need for rapid cleanup	8c. No users of resource within expected time frame needed for restoration of aquifer and no other exposure pathways likely, e.g., vapor migration
Intangibles	9a. Desire for active remedy; desire to test new technologies; desire to reduce stewardship burden on future generations	9b. Neutral on intangible issues.	9c. Desire for low-impact remedy; desire to use proven technologies; desire to not expend financial resources for limited risk reduction benefits

References and background sources:

1. Sale, T.C., 2001.
2. Pankow, J.F., and J.A. Cherry (Eds), 1996.
3. American Petroleum Institute, 2002.
4. Texas Council on Environmental Quality, 2003.
5. Aziz, et al., 2000.

Figure 3.2 Decision chart: Benefits from full-scale applications of source depletion.

Table 1
Examples of State Screening Criteria for Characterization of Groundwater Resources

State Regulatory Authority	Citation	Groundwater Resource Criteria
California Regional Water Quality Control Board (CRWQCB) - North Coast Region	CRWQCB Interim Guidance on Petroleum Hydrocarbons Cleanups, 12/8/95	• **Low-Risk Groundwater Criteria**: LUFT sites are to be designated as low-risk groundwater case requiring no active remediation if DTW $\leq$ 50 ft and no drinking water well is screened within the affected water-bearing unit within 250 ft of leak source.
California State Water Resources Control Board (CSWRCB)	CSWRCB Draft Resolution 1021b, 11/15/96	• **Low-Risk Groundwater Criteria**: LUFT sites are to be designated as low-risk groundwater case if benzene concentration $\leq$ 1 ppm and no surface water discharge or drinking water well within 750 ft of leak source.
Iowa Department of Natural Resources (DNR)	Title X, Iowa Administrative Code, 567-135.2 (455B)	• **Groundwater Resource Criteria**: Groundwater not considered a drinking water resource if there is an existing water supply well within 1000 ft of source or if affected unit meets definition of "protected groundwater resource" (i.e., hydraulic conductivity > 0.44 m/day, TDS < 2500 mg/L).
Illinois Environmental Protection Agency (IEPA)	35 IAC 620.450(4)(B)	• **Alternate Risk-Based Groundwater Standards:** Site may be closed with exceedance of state water quality criteria if beneficial use of groundwater is protected to extent practicable and threat to public health or environment is minimized.
	35 IAC 742.320	• **Groundwater Resource Criteria**: Potable groundwater not considered drinking water resource if NAPL removed to extent practicable, no groundwater impacts likely within setback zone of potable water supply, no impacts likely to surface water, and groundwater use prohibited by government ordinance within 2500 ft of source of release.
Louisiana Department of Environmental Quality	Risk Evaluation/Corrective Action Program (RECAP), June 20, 2000	• **Groundwater Resource Classification:** Categorized as Class 1, 2, or 3 based on current use, maximum sustainable yield, and TDS concentration: • Class 1: Water from impacted aquifer used as public water supply within one mile of impacted site. OR max. sustainable yield of >4,800 gpd and TDS < 1000 mg/L. • Class 2: Water from impacted aquifer used as domestic or agricultural supply within one mile of impacted site; or a maximum sustainable yield of >800 gpd and TDS < 10,000 mg/L. • Class 3: Groundwater with a maximum sustainable yield of <800 gpd or TDS >10,000 mg/L.

Note: DTW = Depth to water; NAPL = Non-aqueous phase liquid; GW = Groundwater; NFA = No further action; LUFT = Leaking underground fuel tank; SW = Surface water; LUST = Leaking underground storage tank

Table 1
Examples of State Screening Criteria for Characterization of Groundwater Resources

State Regulatory Authority	Citation	Groundwater Resource Criteria
Massachusetts Department of Environmental Protection (MDEP)	310 CMR 40.0000, Massachusetts Contingency Plan	**Groundwater Resource Criteria**: Groundwater classified by one or more of 3 categories. • GW-1: Current or future drinking water source. • GW-2: Shallow plume (< 15 ft) within 30 ft of occupied building, posing indoor air concern. • GW-3: Groundwater potentially discharging to SW (applies to all sites). For GW-1, potential drinking water resource defined based on proximity to water supply well or distribution system (500 ft) or classification as Potentially Productive Aquifer (PPA). PPA is a unit classified as a high or medium yield aquifer by U.S.G.S. or a specific coastal aquifer. GW-1 category does not apply to Non-Potential Drinking Water Source Areas (NPDWSA), which are areas of 100 acres or more, located in municipalities with population density $\geq$ 4400 persons per square mile with industrial, commercial, dense residential, or otherwise urban development.
Michigan Department of Environmental Quality (MDEQ)	MDEQ Operational Memorandum No. 11, 8/25/97	• **Groundwater Resource Criteria**: Potable groundwater not considered a drinking water resource if i) groundwater formation yields insufficient water (as determined by one of several criteria), ii) affected water-bearing unit is not in communication with lower adjacent aquifer, iii) site conditions have been documented in a site investigation and closure reports, and iv) monitoring wells used in study have been properly constructed and developed.
Minnesota Pollution Control Agency (MPCA)	MPCA LUST Investigation and Cleanup Policy, Fact Sheet 3.1, April 1996	• **Groundwater Resource Criteria:** Groundwater aquifers are classified as "resource aquifers" (serving as only viable water service in area or producing at least 5 gpm per well and meeting minimum thickness requirements) and "non-aqueous aquifers" (which do not meet these criteria). For non-resource aquifers or "soils-only" impacts, no active groundwater remediation is needed, unless necessary to protect a resource aquifer. For resource aquifers, stable groundwater plumes less than 200 ft in length are eligible for immediate case closure. For all other plumes in resource aquifers, point of drinking water standards application is to be 200 ft from source. (MPCA data shows that 80% of groundwater plumes at LUST sites are less than 200 ft long.)

Note: DTW = Depth to water; NAPL = Non-aqueous phase liquid; GW = Groundwater; NFA = No further action; LUFT = Leaking underground fuel tank; SW = Surface water; LUST = Leaking underground storage tank

Table 1
Examples of State Screening Criteria for
Characterization of Groundwater Resources

State Regulatory Authority	Citation	Groundwater Resource Criteria
New Jersey Department of Environmental Protection (NJDEP)	NJAC 7:9-6.5	• **Groundwater Classification:** Groundwater classified into three categories: Class I groundwaters are groundwaters of special ecological significance; Class II groundwaters are potable groundwater; and Class III groundwaters are non-potable groundwater. • Class I Groundwaters of Special Ecological Significance: groundwaters specifically listed by statute in exceptional or pineland ecological areas. • Class II Potable Groundwaters: Groundwaters that are currently potable or are non-potable but can be restored or enhanced to through conventional water treatment to be made potable. • Class III Non-Potable Groundwaters: Aquitards ≥ 50 ft thick with hydraulic conductivity ≤ 0.1 ft/day, and an areal extent of ≥ 100 acres; or saline groundwaters with concentrations of chloride ≥ 3,000 mg/L or TDS ≥ 5,000 mg/L.
New York Department of Environmental Conservation (NYDEC)	6 NYCRR 701.15-.18	• **Groundwater Classification:** Groundwater classified into two primary categories: fresh and saline. • Class GA Fresh Groundwaters: Groundwaters used for potable supplies. • Class GSA Saline Groundwaters: Groundwaters containing minerals that can be converted to fresh potable water. • Class GSB Saline Groundwaters: Groundwaters containing ≥ 1,000 mg/L chloride or ≥ 2,000 mg/L TDS.
Texas Natural Resource Conservation Commission (TNRCC)	TNRCC Petroleum Storage Tank (PST) Division, Interoffice Memorandum, 2/10/97	• **Groundwater Resource Criteria**: Groundwater not considered a drinking water resource if NAPL has been recovered to extent practicable, there are no existing impacts to water supply wells or surface water in excess of applicable limits, and the following conditions are met: • For GW Plumes Delineated to Drinking Water Limits: If no future groundwater use anticipated in plume area and maximum plume concentration < Class III ground-water limits (e.g., benzene ≤ 0.14 mg/L), NFA for groundwater. Otherwise, show plume stable, and then NFA. • For GW Plumes Not Delineated to Drinking Water Limits: If no existing water supply wells or surface water discharge within 1200 ft and no anticipated use within 1200 ft, NFA for GW if maximum plume concentrations < Class III limits (e.g., benzene ≤ 0.14 mg/L). If Class III limits exceeded, show plume stable and then NFA.

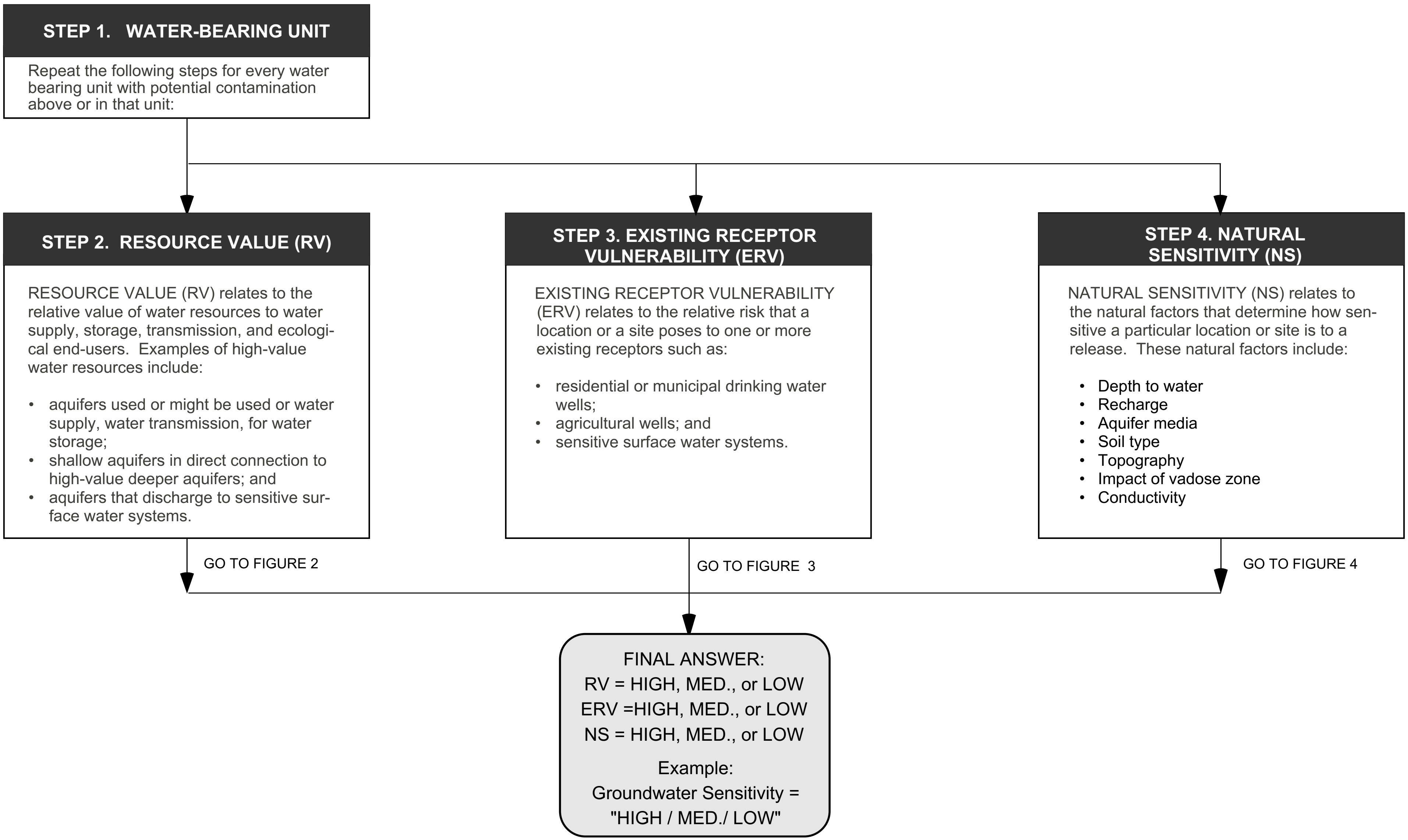
Note: DTW = Depth to water; NAPL = Non-aqueous phase liquid; GW = Groundwater; NFA = No further action; LUFT = Leaking underground fuel tank; SW = Surface water; LUST = Leaking underground storage tank

Table 1
Examples of State Screening Criteria for Characterization of Groundwater Resources

State Regulatory Authority	Citation	Groundwater Resource Criteria
Texas Natural Resource Conservation Commission (TNRCC)	Texas Risk Reduction Program (TRRP), 30 TAC Chapter 350, §350.51	• **Groundwater Resource Criteria:** Groundwater classified into three categories: Class 1, Class 2, and Class 3. Class 1 and Class 2 groundwaters considered actual or potential drinking water supplies. Class 3 groundwater is not a drinking water resource. • Class 1 Groundwaters: groundwater-bearing units located within 1/2 mile of a public water supply system well, or are capable of yielding groundwater with a total dissolved solids (TDS) concentration of <1,000 mg/L at a sustainable rate of >5,000 gpd. • Class 2 Groundwaters: groundwater-bearing units located in a production zone for human consumption or agricultural purposes, or capable of yielding groundwater with a TDS concentration of <1,000 mg/L at a sustainable rate of >150 gpd. • Class 3 Groundwaters: groundwater-bearing units that produce water with a TDS concentration >1,000 mg/L or yield groundwater at a sustainable rate of <150 gpd.

Note: DTW = Depth to water; NAPL = Non-aqueous phase liquid; GW = Groundwater; NFA = No further action; LUFT = Leaking underground fuel tank; SW = Surface water; LUST = Leaking underground storage tank

FIGURE 1
GROUNDWATER SENSITIVITY TOOL KIT FLOWCHART
API / California MTBE Research Partnership



Note: If Resource Value is LOW, Steps 2 and 3 default to "Not Applicable" (N.A.)

FIGURE 2
RESOURCE VALUE FLOWCHART FOR GROUNDWATER SENSITIVITY TOOL KIT
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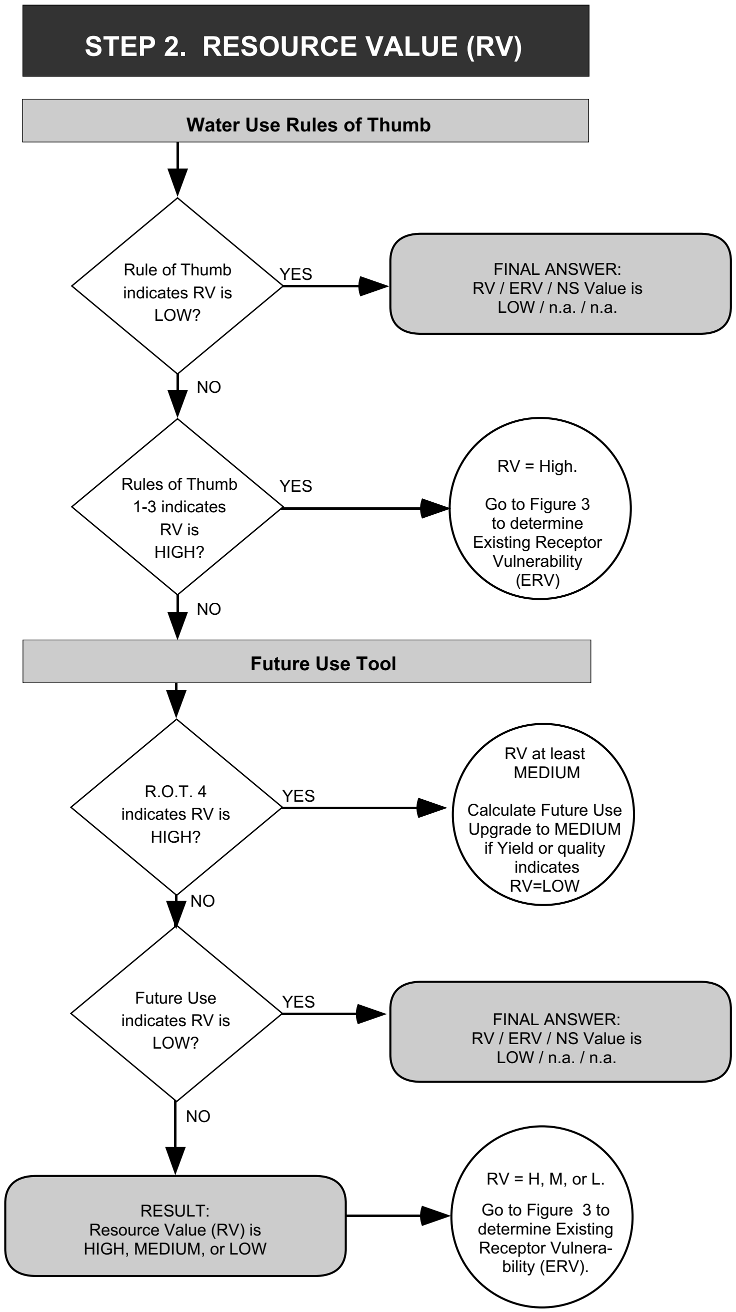

DETAILS

Water Use Rules of Thumb: DETAILS

Apply simple screening rules to identify Low or High RV.

R.O.T. 1:
Answer YES only if both of the following statements are true, otherwise, answer NO:
a) Groundwater use at this location is precluded by some type of existing regulatory restriction.
b) There is no groundwater discharge to a high- or moderate-value surface water within 2500 ft of this location.

R.O.T. 2:
Is the water-bearing unit a sole-source aquifer or does the unit serve an area with no alternative supply? (no if unknown)

R.O.T. 3:
Is the unit currently being used? (are there any drinking water wells screened in the unit within 2500 ft?) (no if unknown)

Future Use Tool: DETAILS

R.O.T. 4:
Is there a publically available water development plan indicating that the aquifer will be used, or can it be reasonably anticipated to be used in the future?

Evaluate potential for future use of water based on well yield, quality, and water resource planning info.

Step 1.1: Determine Yield using simple well yield formulas based on hydr. conductivity, thickness, confining head of aquifer at location:

- Yield ≤ 200 gpd*: RV_Y=LOW.
- 200 gpd* < Yield <144,000 gpd**: RV_Y = MED.
- Yield ≥ 144,000 gpd**: RV_Y =HIGH.

Source of numerical values:
*** In Calif. GW Classification**
**** In TRRP GW Classification**

Step 1.2: Determine Water Quality using simple rules regarding TDS, other contaminants of groundwater at location:

- If TDS ≥ 3,000*, RV_{wq}=LOW
- 500** < TDS<3,000*, RV_{wq}=MED.
- TDS ≤ 500** mg/L, RV_{wq}=HIGH
  If other natural contaminants>MCL or secondary MCL, RV_{wq}=LOW

Step 1.3: Use lowest rank from Steps 1.1 and 1.2 for answer. For example, if RV_{wq} is HIGH, but RV_Y is LOW, final RV is LOW.

Step 1.4: (Must perform if Step 1.3 result is MED). Evaluate potential for future utilization of aquifer based on information/resources regarding: local, regional, and state waterplanning, water demand, replacement value for groundwater, treatment cost, alternative supplies. This module will discuss each item, and provide links/sources of information. Based on information, the user can designate can increase a MED ranking to HIGH if future utilization of the aquifer is planned or likely. (system will provide examples)

FIGURE 3
EXISTING RECEPTOR VULNERABILITY FLOWCHART FOR GROUNDWATER SENSITIVITY TOOL KIT

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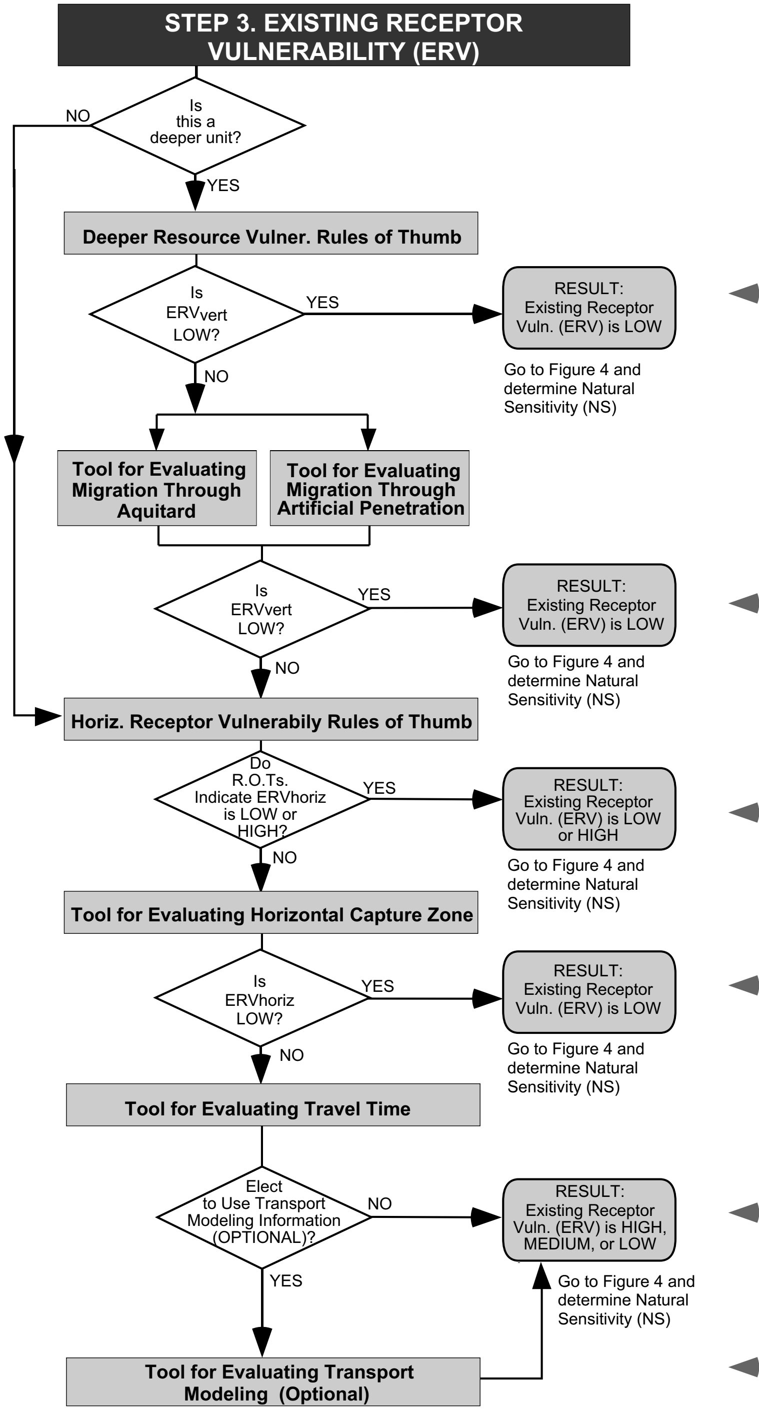

DETAILS

Deeper Resource Vulner. Rules of Thumb: DETAILS

Use simple rule of thumb to estimate if vertical migration is possible.

Do data from continuous cores show 50 ft or more of homogeneous, continuous, fine-grained material (clay or shale) over the ultimate area of a plume from the site with no artificial penetrations between the upper unit and lower unit, and wells in this deeper unit? If yes, ERV_{vert} = LOW

Tool for Evaluating Migration Through Aquitard and/orArtificial Penetration: DETAILS

Use simple mixing algorithms to determine potential concentrations in deeper unit after mixing with groundwater from shallow unit.

Step 2.1: Estimate concentration of deeper unit after mixing with contaminants migrating through aquitard. Required parameters:
- Effective vert. K, thickness of aquitard, vert. gradient
- Velocity of deeper groundwater, mixing zone thickness
- Ultimate size, representative conc. of plume in upper zone,

If conc. in deeper unit < STD, $ERV_{vert\text{-}aqtd}$ = LOW.
If conc. in deeper unit > STD, $ERV_{vert\text{-}aqtd}$ = HIGH.
STD = MCLs or other water quality criteria

Step 2.2: Estimate concentration of deeper unit after mixing with contaminants migrating through an annulus or open well. Required parameters:
- Diameter, screened interval of well, or dimensions of annulus
- Downward gradient
- Velocity of deeper groundwater
- Size of plume in upper zone

If conc. in deeper unit < STD, $ERV_{vert\text{-}hole}$ = LOW.
If conc. in deeper unit > STD, $ERV_{vert\text{-}hole}$ = HIGH.

Step 2.3: Use highest rank from Steps 2.1 & 2.2 for answer.
For example, if $ERV_{vert\text{-}hole}$ is LOW but $ERV_{vert\text{-}aqtd}$ is HIGH, ERV_{vert}= HIGH.

Horiz. Receptor Vulnerabil. Rules of Thumb: DETAILS

Use two simple rules of thumb to determine horizontal receptor vulnerability.

1) Is the location a potential MTBE source, or within 2500 ft* of a current or potential municipal drinking water well in the same unit in any direction, or within 2500 ft upgradient from a current or potential domestic water well in the same unit, or within 2500* ft of sensitive surface water receiving groundwater discharge? If no, ERV=LOW. *(*2500 ft or other locally established plume length)*

2) Is location on fractured bedrock geology or karst geology that is used as public water supply within 2 miles? If yes, ERV = HIGH. *Note: California MTBE guidelines state: "Located on near-surface fractured bedrock geology that is a source of water supply for a community." 2 mile limit was added to this flowchart to make this rule more practical to implement.*

Tool for Evaluating Horizontal Capture Zone : DETAILS

Use simple capture zone relationships to determine if location is within capture zone of well or surface water discharge. Required parameters: hydraulic conductivity, aquifer thickness, well pumping rate, width of potential plume from location, hydraulic gradient, fluctuation in flow direction, number and type of wells in area.

If location is not in capture zone, ERV = LOW.

Tool for Evaluating Travel Time : DETAILS

Use simple travel time relationships to determine if location can have near-term impact to receptors (either drinking water wells or surface water discharge). Required parameters:
- Hydraulic conductivity
- Hydraulic gradient
- Pumping rate of well (used to adjust gradient)
- Distance from location to well

If travel time from location to well is 5 years* or less, ERV=HIGH. If travel time from location to well is between 5 and 20 years*, ERV=MED. If travel time from location to receptor is greater than 20 years*, ERV= LOW.

Source of values:
* In Calif. MTBE Guidelines

Tool for Evaluating Transport Modeling (Optional): DETAILS

Show links to commonly-used models (including DAFgraph). Provides BTEX and MTBE-specific data for use in models. If travel time from location to well is 5 years* or less, ERV=HIGH. If travel time from location to well is between 5 and 20 years*, ERV=MED. If travel time from location to receptor is greater than 20 years*, ERV= LOW.

FIGURE 4
NATURAL SENSITIVITY FLOWCHART FOR GROUNDWATER SENSITIVITY TOOL KIT
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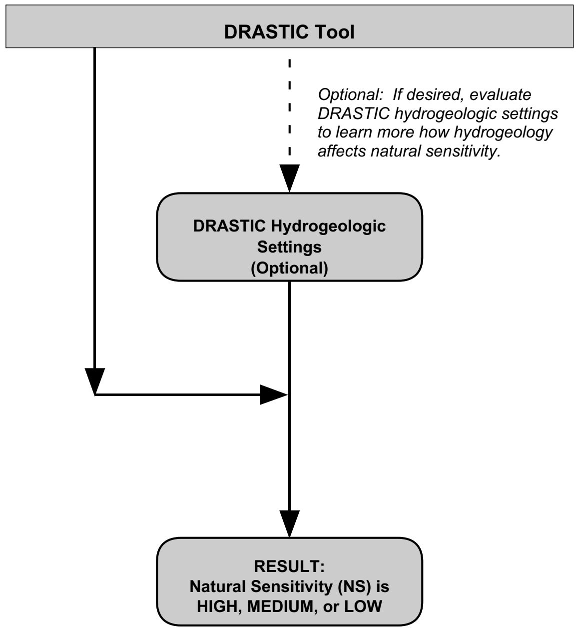
STEP 4. NATURAL SENSITIVITY (NS)



DETAILS

DRASTIC Tool: DETAILS

Use DRASTIC hydrogeologic settings as an optional educational resource for users wishing to learn more about how hydrogeology affects natural sensitivity.

DRASTIC Hydrogeologic Settings (Optional): DETAILS

Use site-specific DRASTIC methodology to estimate if Natural Sensitivity is HIGH, MEDIUM, or LOW.

Required parameters:

Use site-specific DRASTIC methodology to estimate if Natural Sensitivity is HIGH, MEDIUM, or LOW.
Required parameters:

- Depth to water
- Recharge*
- Aquifer media
- Soil type
- Topography
- Impact of vadose zone
- Conductivity

*(will put more detail about corrective recharge value to use for confined aquifers)

Potential Rules for This System:

If Precipitation > Evapotranspiration:
DRASTIC Index ^{3} 120,.................. NS = HIGH
120 > DRASTIC Index > 100........ NS = MED.
DRASTIC Index ^{2} 100................. NS = LOW

If Precipitation < Evapotranspiration:
DRASTIC Index ^{3} 150,................. NS = HIGH
150 > DRASTIC Index > 100........ NS = MED.
DRASTIC Index ^{2} 100................. NS = LOW

Definition of HIGH from EPA Groundwater Classification Guidance, 1988 *(this is the original reference cited in the EPA's Handbook of Ground Water and Wells, 1994 to support a DRASTIC Index cut-off of 150 for "highly vulnerable" aquifers).*
Definition of LOW (DRASTIC Index ^{2} 100) from our experience with DRASTIC.

As a point of reference, with this approach ~47 of the 111 DRASTIC settings (42%) are HIGH, ~47 settings (42% are MED.), and 17 settings (15%) are LOW. The 17 LOW settings are described as:

Mountain Slopes Facing East; Mountain Slopes Facing West; Mountain Flanks in Western Mountain Ranges
Mountain Slopes; Continental Deposits in Alluvial Basins
Mountain Slopes in Columbia Lava Plateau
Consolidated Sedimentary Rock; Resistant Ridges in Colorado Plateau/Wyoming Basin
Alternating Sandstone, Limestone, and Shale Sequences in High Plains
Metamorphic/Igneous Domes and Fault Blocks; Uncons. & Semicons. Aquifers in Nonglaciated Central Region
Glacial Till Over Shale in Glaciated Central Region
Regolith; Mountain Slopes;Mountain Slopes in Piedmont and Blue Ridge
Mountain Slopes in Northeast and Superior Uplands
Regional Aquifers in Atlantic and Gulf Coastal Plain
Bedrock of the Uplands and Mountains in Alaska

Note that the software will not use DRASTIC hydrogeologic settings system directly, but will rely on site-specific data to calculate the DRASTIC Index for a particular site. This discussion of DRASTIC settings is provided only to give a point of reference for potential DRASTIC cutoff for LOW Natural Sensitivty (DRASTIC Index ^{2} 100).