KELLY AFB
TEXAS

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 3308

KELLY AIR FORCE BASE TECHNICAL REVIEW SUBCOMMITTEE
MEETING AGENDA
Tuesday, 27 October 1998, 18:30
Garni Hall, Room 217, St. Mary's University

Topic	*Time*	*Presenter*
I. Introduction - Agenda Review and Handouts	18:30 - 18:40	Dr. Lene'
II. Discussion On Natural Attenuation	18:40 - 19:15	AFCEE: Mr. Patrick Haas
III. Presentation on Reinjection of Groundwater	19:15 - 19:45	KAFB: Dr. Mark Stapleton (WPI)
IV. Action Items/Summary - Location/Time of Next 6 TRS Meeting	19:45 - 20:00	Dr. Lene'
V. Adjournment	20:00	Dr. Lene

EXHIBIT A

MEETING MINUTES
KELLY AFB TECHNICAL REVIEW SUBCOMMITTEE (TRS)
TO THE RESTORATION ADVISORY BOARD (RAB)
17 NOV 98, ST. MARY'S UNIVERSITY

I. Introduction

Dr Lene started the TRS Meeting at 1830 hours. Attachment 1 is the attendance -- 16 people attended. Major deVenoge volunteered to take minutes. Dr Lene mentioned the need to focus the TRS on technical issues. Also, the TRS membership needs to be firmed up - - sign in sheets were placed at the entrance to the room. The TRS should be considerate of the regulators and their time constraints. Related to this, Major deVenoge distributed a letter (atch 2) from TNRCC describing actions needed by the TRS to improve the efficiency of the TRS. Mr Banner also noted that the TNRCC will stay no later than 2030.

II. Discussion on Natural Attenuation:

The first presentation was provided by Mr Patrick Haas of the Air Force Center for Environmental Excellence (AFCEE). Mr Haas spoke on the subject of natural attenuation . TRS members had many questions for Mr Haas, to which he responded. A copy of his presentation is provided at Atch 3. Dr Lene and the TRS thanked Mr Haas for the information.

III. Reinjection of Groundwater

The next presentation was provided by Dr Mark Stapleton of Waste Policy Institute (WPI), providing contract support to Kelly AFB. Dr Stapleton provided a presentation on reinjection of groundwater and spoke very generally about its use around the country and at Kelly AFB. Major deVenoge noted that the presentation was being provided as a follow up to a meeting between Mr Rice, Mr Quintanilla and MGen Childress. A copy of Dr Stapleton's presentation is at attachment 4. Mr Rice noted that Kelly should be able to demonstrate on a site specific basis where reinjection may be applicable. Major deVenoge noted that a model is presently being developed that would allow for this type of simulation.

IV. Action Items/Summary

- Administrative items:

-- Spill Reporting Committee: The TRS discussed the provision in the RAB charter for a committee to be notified regarding spills on base as a result of Kelly AFB operations. The TRS unanimously decided that the "committee" would be the TRS. The notification method or process was also discussed. TRS members unanimously decided that a written notification provided monthly at the TRS would suffice for the notification.

The RAB charter may have to be amended to reflect these decisions by the TRS. The RAB will also be informed of these decisions.

-- Future TRS Dates: Major deVenoge mentioned the need to synchronize TRS dates with the BRAC Cleanup Team (BCT) dates to maximize efficiency of the regulators travel time. The following dates were subsequently established following comments from the TRS on general timeframes. Typically, the TRS and BCT will meet the second Tuesday of each month (NOTE: Dec and Jan dates were set prior to this meeting):

15 Dec
12 Jan
09 Feb 99
09 Mar 99
13 Apr 99
11 May 99
08 Jun 99
13 Jul 99
10 Aug 99
14 Sep 99
12 Oct 99
09 Nov 99
14 Dec 99

The following summary is a list of action items noted during the course of discussion of the evening:

- Provide copy of AFCEE Technical Protocol on Natural Attenuation of Chlorinated Solvents to TRS for availability to all TRS members
  (OPR: Major deVenoge)

- Provide TRS information on Groundwater Treatment Plant (GWTP)
  - Average daily flow
  - Average discharge to Leon Creek
  (OPR: Major deVenoge)

- Provide copies to TRS of the Kelly AFB reports that discuss reinjection as noted by Dr Stapleton
  (OPR: Major deVenoge)

- Provide TRS with a list of upcoming Kelly documents
  (OPR: Major deVenoge)

- Provide web site address to TRS members of the meeting notes from the Center for Environmental Public Oversight (CEPO) at the recent conference in San Francisco
  (OPR: Major deVenoge)

- December Agenda (thus far):
  - TAPP Update (Leslie Brown)
  - Phytoremediation video (Sam Murragh)

V. ADJOURNMENT

The TRS adjourned at approximately 2030 hours.

Attachments:
1. Attendance
2. TNRCC Letter on TRS
3. AFCEE Presentation
4. Reinjection presentation

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

November 17, 1998

Brig. General Robert M. Murdock, Installation Co-chair
Kelly Air Force Base (Kelly AFB) Restoration Advisory Board (RAB)
100 Moorman Street, Suite 1
Kelly AFB, Texas 78241-5808

Mr. Damian Sandoval, Community Co-chair
Kelly AFB RAB
515 Hoover Street
San Antonio, Texas 78225

Re: Recommendations for Improving the Kelly AFB RAB Technical Review Subcommittee

Dear Gentlemen:

In March of this year I assumed the role of the TNRCC's representative to the Kelly AFB RAB Technical Review Subcommittee (TRS), and more recently also became the TNRCC's representative to the RAB. As such, I have participated in five meetings of the TRS and one of the RAB, as well as observed RAB meetings over the course of the three years I have been involved with projects at Kelly AFB. In addition, I have participated in and observed RABs and TRSs for other federal facilities that are managed by myself and others at the TNRCC. From this experience I have concluded that there is a need to increase the efficiency of the Kelly AFB TRS.

While the TNRCC's primary role at the RAB and TRS is to provide regulatory assistance, we are also concerned whether these forums achieve the Kelly AFB RAB Charter's stated purpose of providing an expanded opportunity for input by stakeholders into the environmental restoration process. Also, I feel it is incumbent upon all participants to make the RAB and TRS proceedings as efficient as possible in order to attain this important goal. To this end, the following recommendations are offered for consideration:

- The RAB Charter should be amended to define the goal and activities of the TRS. The TRS goal should be to review and comment on current restoration project documents, and to provide these comments to the RAB on a regular basis. This is also consistent with the goals adopted for TRSs at other federal facilities.

- The tone of interaction at the TRS (and, to some extent, at the RAB) should be more conducive to participation by all members.

- The TRS should avoid revisiting issues that have been previously discussed and closed; discussion should be guided by the topic and time specifications on the agenda.

These recommendations are similar to those offered by the RAB Introspection Tiger Team. They are reiterated here, in part, to encourage the Tiger Team to lead the effort in their implementation. Efforts to improve the TRS should begin now to take advantage of the excellent opportunity provided by the recent and upcoming changes in the TRS chair and RAB co-chairs.

Moreover, progress at the TRS must be made soon. The TNRCC must be able to justify involvement in time intensive activities like the RAB and TRS. If improvements are not realized over the next few meetings the issue will be brought before my management for review of TNRCC participation.

I and other TNRCC staff working on Kelly AFB projects look forward to working with all RAB and TRS members to come closer to meeting the RAB's goals.

Sincerely,

Gordon Bannet

Gordon Bannet, Project Manager
Team II, Corrective Action Section
Remediation Division

cc: Dr. Gene Lene, Chair, Kelly AFB TRS, San Antonio
Mr. Larry Bailey, Director, Environmental Management, Kelly AFB
Mr. David Neleigh, Environmental Protection Agency Region VI, Dallas
Mr. Thomas Edwards, Office of Texas Attorney General, Austin

HQ Air Force Center
for
Environmental Excellence

Technology Transfer Division

Presented by
Mr Patrick E. Haas
210-536-4331

Air Force Center for Environmental Excellence | Technology Transfer Division

California Regulatory Reform

- **CA *LUFT Historical Case Analyses**
  - 1500 LUFT case files analyzed - groundwater contamination
  - 50% of sites - mean ground water depth < 15 ft.; 25% < 7.5 ft.
  - Ground water plumes < 200 ft. at 85% of sites
- **Bottom-line - Natural Attenuation is preventing petroleum plumes from spreading**
- **Sites will be monitored to prove:**
  - Clean up is happening
  - Site is safe for public

*Leaking Underground Fuel Tank (LUFT)

Air Force Center for Environmental Excellence | Technology Transfer Division

Extent, Mass, and Duration of Hydrocarbon Plumes from Leaking Petroleum Storage Tank Sites in Texas

- 19,000 documented leaking petroleum storage tank sites in Texas, more than 6,000 have impacted ground water
- Data from 605 sites analyzed. 500,000 data entries, >4,000 groundwater monitoring wells
- 75% of ground water benzene plumes (10 ppb line) are less than 250 ft (76 m) long.
- "Even without remediation (intrusive), plume mass increases, stabilizes, and rapidly declines over time"
- "There is no statistical difference in benzene plume length in different hydrogeologic settings in Texas" or with or without pump and treat.

Reference: University of Texas at Austin Bureau of Economic Geology, 1997

Air Force Center for Environmental Excellence | Technology Transfer Division

Influence of Remediation on Plume Described by Average Concentrations

	Sites with pump & treat*	Sites without pump & treat**
Phase II Stable Concentrations	35%	38%
Phase III Decreasing Concentrations	61%	52%
Phase IV Exhausted Concentrations	4% 100%	10% 100%

* 67 Sites
** 117 Sites

Reference: University of Texas at Austin Bureau of Economic Geology, 1997

Air Force Center for Environmental Excellence | Technology Transfer Division

Influence of Site Conditions on Maximum Plume Length

	Number of sites	25th Quartile	50th Quartile (median)	75th Quartile	Maximum
Aquifer texture					
•with sand	63	180	220	340	1,700
•with clay	95	190	200	300	970
•with limestone	26	170	200	300	7,600
•only sand	26	180	240	350	1,700
•only clay	40	170	200	300	820
•only limestone	7	170	220	400	7,600

Units: feet

Reference: University of Texas at Austin Bureau of Economic Geology, 1997

Air Force Center for Environmental Excellence | Technology Transfer Division

Influence of Site Conditions on Maximum Plume Length

Hydraulic Conductivity	Number of sites	25th Quartile	50th Quartile (median)	75th Quartile	Maximum
<0.01 m d^{-1}	23	200	230	330	1,700
0.01 to 1 m d	57	160	200	310	1,300
1 to 100 m d	27	160	200	260	860
>100 m d	33	150	190	300	1,200

Units: feet

Reference: University of Texas at Austin Bureau of Economic Geology, 1997

Air Force Center for Environmental Excellence — Technology Transfer Division

Influence of Site Conditions on Maximum Plume Length

Free Product?	Number of sites	25th Quartile	50th Quartile (median)	75th Quartile	Maximum
Yes	115	170	210	330	7,600
No	78	160	200	290	1,700

Units: feet

Reference: University of Texas at Austin Bureau of Economic Geology, 1997

Air Force Center for Environmental Excellence — Technology Transfer Division

CA & TX Summary

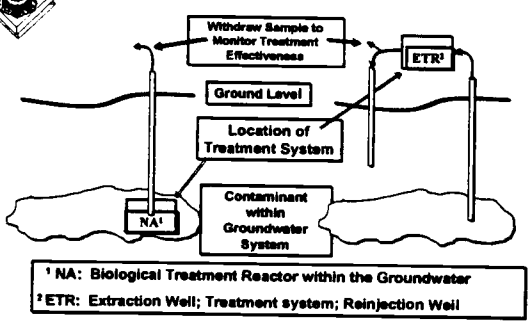
- Petroleum Ground Water Plume Length
  - Plumes stabilize when flux of fuel from source zone equals removal via natural attenuation, within 200 - 300 feet.
  - Our job is to find the few "long" plumes that impact public
- Natural Attenuation
  - Has been measured; Can be measured; Should be measured
  - Major controlling process at all petroleum sites
    - Electron acceptors (i.e. Sulfate, CO_2, Nitrate, Iron, O_2) "drive the engine"
  - Significant controlling process at some chlorinated sites (i.e. TCE, PCE) when a separate carbon source is present
    - Carbon Sources (e.g. Jet fuel, landfill leachate, naturally-occurring carbon, etc.) "drive the engine"

Air Force Center for Environmental Excellence — Technology Transfer Division

What Do We Need to Know?

- How to select the best technology for the site
- How to determine if the technology is working
  - Subsurface cleanup, not just above ground treatment system efficiency
  - Performance and effectiveness measurement

Air Force Center for Environmental Excellence — Technology Transfer Division



¹ NA: Biological Treatment Reactor within the Groundwater
² ETR: Extraction Well; Treatment system; Reinjection Well

Air Force Center for Environmental Excellence — Technology Transfer Division

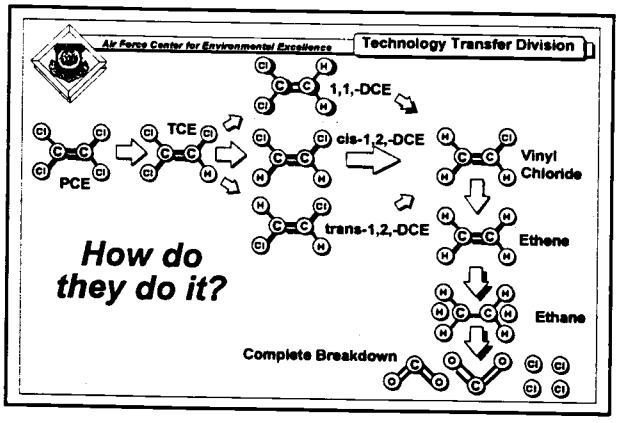
Biodegradation

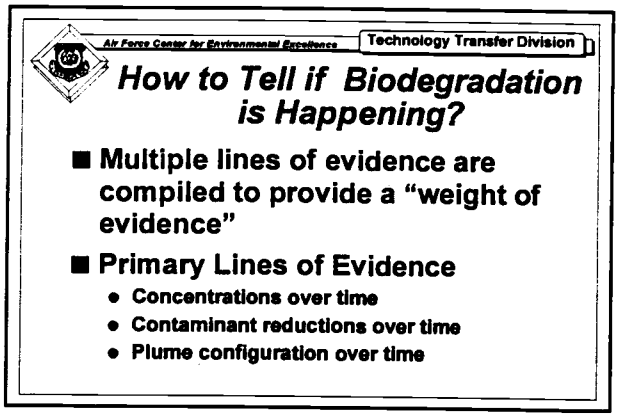
- Why would microorganisms consume contaminants?
- How do they do it?
- How to verify if it is happening?

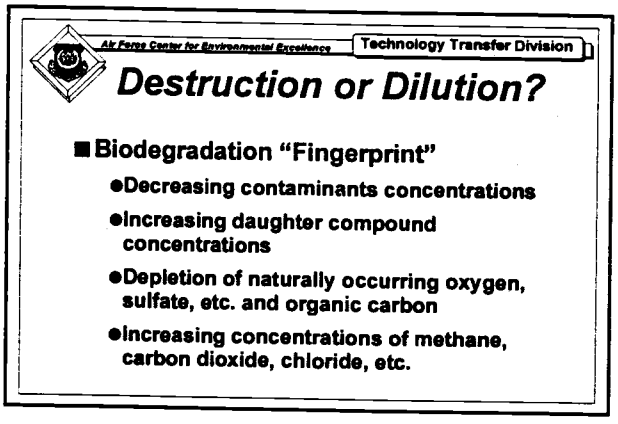
Air Force Center for Environmental Excellence — Technology Transfer Division

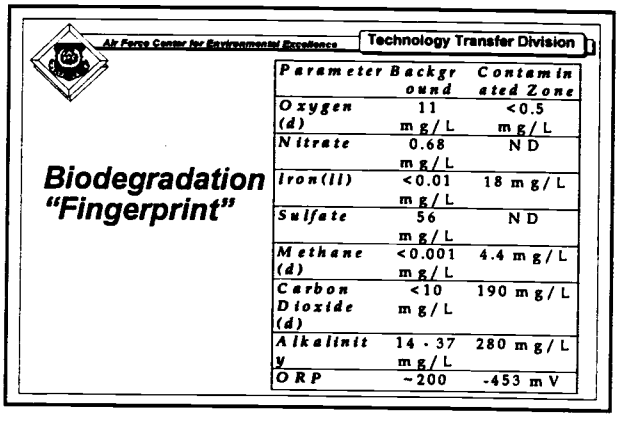
Why Would Microorganisms Break Down Contaminants?

- Microorganisms, like humans need: FOOD
  - Spilled gasoline and oil products, landfill leachate, etc.
  - Typically, chlorinated Volatile Organic Compounds are used in the breakdown of food sources

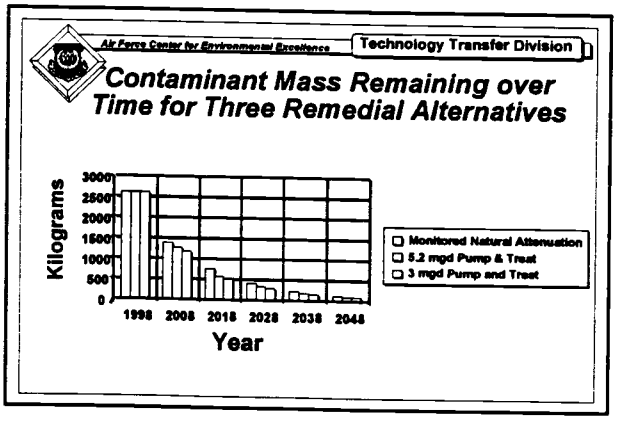


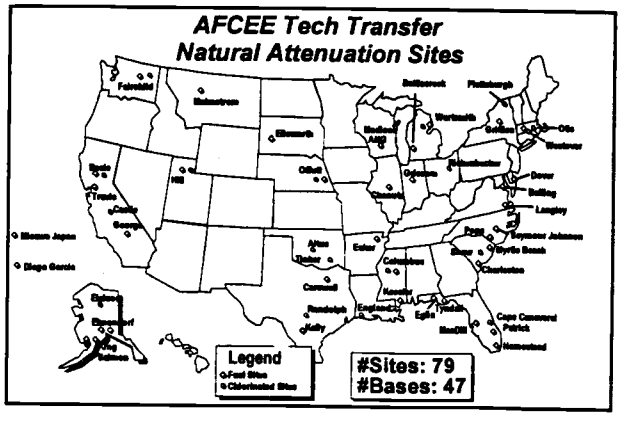






Parameter	Background	Contaminated Zone
Oxygen (d)	11 mg/L	<0.5 mg/L
Nitrate	0.68 mg/L	ND
Iron(II)	<0.01 mg/L	18 mg/L
Sulfate	56 mg/L	ND
Methane (d)	<0.001 mg/L	4.4 mg/L
Carbon Dioxide (d)	<10 mg/L	190 mg/L
Alkalinity	14 - 37 mg/L	280 mg/L
ORP	~200	-453 mV





Air Force Center for Environmental Excellence | Technology Transfer Division

EPA

Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water

http://www.epa.gov/ada/reports.html
ftp://ftp.epa.gov/pub/ada/reports/protocol.pdf

Air Force Center for Environmental Excellence | Technology Transfer Division

Summary

- A Good Starting Point:
  - http://www.epa.gov/ada/reports.html
  - ftp://ftp.epa.gov/pub/ada/reports/protocol.pdf
  - AFCEE/ERT Toolbox - http://www.afcee.brooks.af.mil/ER/ERFORM.HTM
- All Bioremediation Technologies can be monitored to verify effectiveness
- Biodegradation can be confirmed through:
  - Contaminant reductions
  - Measurement of known breakdown products
  - Biodegradation indicators (e.g. Oxygen, Carbon dioxide, etc.)

Air Force Center for Environmental Excellence | Technology Transfer Division

Closing Message

- Burden of proof is on the proponent of natural attenuation
- You do not have to "trust" that natural attenuation is going to cleanup a site
- You verify cleanup via natural attenuation with sound science and "hard" sampling data
- The US EPA "Technical Protocol for Evaluating Natural Attenuation" provides you a method to independently verify cleanup via natural attenuation

Air Force Center for Environmental Excellence | Technology Transfer Division

References

Rice, D. W., Grose, R. D., Michaelsen, J. C., Dooher, B. P., MacQueen, D. H., Cullen, S. J., Kastenberg, W. E., Everett, L. G., and Marino, M. A., 1995, California Leaking Underground Fuel Tank (LUFT) Historical Case Analyses: Environmental Protection Department, Environmental Restoration Division, Lawrence Livermore National Laboratory, UCRL-AR-122297.

Mace, R. E., Fisher, R. S., Welch, D. M., and Parra, S. P., 1997, Extent, Mass, and Duration of Hydrocarbon Plumes from Leaking Petroleum Storage Tank sites in Texas., University of Texas at Austin, Bureau of Economic Geology, Geological Circular 97-1.

Freeze, R. A., and McWhorter, D. B., A Framework for Assessing Risk Reduction Due to DNAPL Mass Removal from Low-Permeability Soils, January - February 1997, Groundwater, Volume 35, No. 1, Pages 111 - 123.

Texas Natural Resource Conservation Commission

INTEROFFICE MEMORANDUM

To: PST Corrective Action Coordinators
SLR Project Managers

Date: April 29, 1997

Thru: Danny Lien, Manager
Responsible Party Remediation Section

Anton Rozsypal, Manager
Responsible Party Investigations Section

Jackie Hardee, Manager
State Lead Remediation Section

From: Chet Clarke, Director of Programs
Petroleum Storage Tank Division

Charles D. Stone, Project Manager
State Lead Remediation Section
Petroleum Storage Tank Division

David Highfield, Coordinator
Responsible Party Remediation Section
Petroleum Storage Tank Division

Subject: Interim Guidance: Monitoring Natural Attenuation for Verification of Groundwater Plume Stability

The February 10, 1997 memorandum *Closure Process for Petroleum Hydrocarbon LPST Sites Exceeding Target Concentrations* highlights situations where natural attenuation should be evaluated as a remedial alternative for groundwater contamination. The memorandum also indicates situations where the stability of a groundwater plume should be verified prior to site closure. Plume stability is dependent on natural attenuation processes.

Responsible parties may include the collection of natural attenuation indicator information in proposals to verify plume stability or propose to use monitored natural attenuation as a corrective action plan (CAP). The recently implemented guidance *Operation, Monitoring and Performance of Remedial Systems* (RG-261) lists many natural attenuation indicators that can be evaluated to determine if natural attenuation is occurring at sites. The attached table lists the only natural attenuation indicators that should typically be monitored as a "first cut" evaluation of natural attenuation in groundwater. Do not require/preapprove the collection of additional natural attenuation indicators (e.g., methane, alkalinity, carbon dioxide, etc.) unless there is a site-specific basis for doing so (i.e., the indicators in the table have yielded equivocal information), or the additional indicator information can be obtained for no additional cost.

Proposals for verification of plume stability should provide for the collection of one or two rounds of the natural attenuation indicators and at least a total of three to four contaminant concentration monitoring events. The second round of natural attenuation indicator sampling may be necessary if no clear trends were identified from the first sampling event. If one round of contaminant concentration data has been collected, then only two or three more monitoring events may be needed. If no natural attenuation indicators are to be measured, then additional site concentration monitoring

events may be necessary. It is important that the natural attenuation indicator information be measured in wells which document background concentrations, and in wells within and beyond the plume. Optimally, the indicator information will be collected from a series of wells positioned along the axis of the contaminant plume (in the direction of plume migration) and transverse to the contaminant plume. Some additional monitoring wells sited specifically to collect critical natural attenuation information may be needed. Plume stability will be indicated when the extent of the contaminant plume appears to be stable or declining, and there is a clear trend with the indicator information which coincides with the location of the contaminant plume. If at the conclusion of this monitoring program, the results are equivocal (e.g., the indicator data do not confirm natural attenuation, or contaminant concentrations are highly variable across the sampling events), additional monitoring events may be warranted. If there is adequate historical contaminant concentration monitoring data to demonstrate a stable or declining plume, then the natural indicator information would not be needed.

Proposals for plume stability evaluations should be submitted as a groundwater monitoring proposal and not as CAPs. In addition to the information normally contained within groundwater monitoring proposals, the proposal should indicate the natural attenuation indicators that are to be measured, identify the wells to be sampled and frequency of sampling, and identify the sampling/analysis techniques for the natural attenuation indicators. If additional monitoring points are needed to support the evaluation, then a proposal should also be provided for well installation.

Only when further corrective action is needed to achieve a protective concentration at a point of exposure is a natural attenuation CAP necessary and appropriate. Natural attenuation CAPs should: identify the indicator information that is to be collected; detail the frequency of monitoring and sampling techniques; identify the wells that will be monitored; include a proposal for the installation of any additionally needed monitoring wells; contain an estimate of the degradation rate and remedial time frame based on prior monitoring; contain a contingency plan in case more aggressive actions are needed (for higher risk groundwater sites only); and include a description of how the data will be analyzed. To support development of a natural attenuation CAP, preliminary information such as that needed to support plume stability may need to be collected first. The guidance document *Corrective Action Plans for LPST Sites* (RG-41) provides additional guidance for developing a CAP.

The guidance provided herein is interim, pending completion of more thorough guidance. It is highly recommended that the attached article *A Practical Approach to Evaluating Natural Attenuation of Contaminants in Ground Water (McAllister and Chiang, 1994)* be studied. The article explains the typical plume behavior characteristics and data patterns that signal the occurrence of natural attenuation processes.

cc: Danny Neal, Manager, Reimbursement Section, PST Division

Attachment

Natural Attenuation Indicators: (The attached information was taken from the draft *ASTM Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites*, and from McAllister and Chiang, 1994.)

Parameter	Field or Lab Method	Analytical Method	Comments	Use of Data
Dissolved Oxygen (D.O.)			With all D.O. methods extra care must be taken to avoid aeration during all steps of the analysis including well purging and sample collection.	An inverse correlation of D.O. to BTEX concentrations indicates aerobic biodegradation is occurring. This relationship may also be expressed as depressed or non-detectable levels through the plume. Generally 1-2 mg/l D.O. is required to sustain aerobic degradation. Verify that groundwater beyond the plume has at least this D.O. concentration.
	Field	Meter or Probe	Use a flow thru cell with a dissolved oxygen electrode. Other parameters such as temperature, pH, oxidation reduction can be measured simultaneously. If an oxygen consuming probe is used, then care must be taken to ensure sufficient and continuous flow from the well thru the cell.	D.O. measurements should be measured in monitoring wells inside and outside the plume including upgradient of the plume.
	Field	ASTM D888-92 Winkler Titration	Field kits for performing Winkler titrations can be used as the primary method of D.O. measurement or to confirm meter measurements. A combination of both methods can be used to ensure data quality.	D.O. measurements should be measured in monitoring wells inside and outside the plume including upgradient of the plume.
	Field	Down hole probe	If an oxygen consuming probe is used down hole, then gentle agitation of the probe is required. Vigorous agitation should be avoided to prevent aeration. This technique is recommended only in low permeability conditions where continuous well purging is not possible	D.O. measurements should be measured in monitoring wells inside and outside the plume including upgradient of the plume.
Ferrous Iron (Fe II)				Increased concentrations of Fe (II) may indicate Fe (III) is being used as an electron acceptor during anaerobic biodegradation of petroleum hydrocarbons.
	Field	Colorimetric Standard Methods 18th Edition. Method 3500-Fe D	Collect 100 ml of water in glass container. Filter sample with 0.2µ filter.	Measure inside and outside of plume.
	Field	Hach 25140-25	Filter sample with 0.2µ filter.	Measure inside and outside of plume.

Parameter	Field or Lab Method	Analytical Method	Comments	Use of Data
Oxidation Reduction Potential				Defines region of the plume under oxidizing and reducing conditions. Evaluates potential for biologically mediated redox reactions to occur and helps validate the D.O. measurements
	Field	Ion Selective Electrode	Oxidation Reduction Potential probe can be inserted into flow thru cell and reading obtained simultaneously with D.O., pH, and temperature Can be taken down hole if necessary	Measure inside and outside of plume.
	Field	Direct reading meter	Oxidation Reduction Potential probe can be inserted into flow thru cell and reading obtained simultaneously with D.O., pH, and temperature	Measure inside and outside of plume.
	Field	ASTM D 1498-93	Can be taken down hole if necessary	Measure inside and outside of plume.
pH				Difference in pH between contaminated and uncontaminated groundwater may be an indicator that biological activity is occurring and may confirm the oxidation reduction potential results.
	Field	EPA Method 150.1 or SW-9040	Can be analyzed in flow thru cell or collect 100-200 ml of water in glass or plastic container and analyze immediately. Calibration should be conducted using manufactures standard solutions.	Measure inside and outside of plume.
	Field	Direct reading meter	Calibration should be conducted using manufactures standard solutions.	Measure inside and outside of plume.
	Field	ASTM D 1293-84	.Calibration should be conducted using manufactures standard solutions.	.Measure inside and outside of plume.

Parameter	Field or Lab Method	Analytical Method	Comments	Use of Data
Nitrate				Decreased nitrate concentrations in the anaerobic portion of the plume may indicate use of nitrate as an electron acceptor for anaerobic biodegradation of petroleum hydrocarbons.
	Field	Colorimetric field kit	Collect 100 ml of water in a glass container.	Measure inside and outside of plume.
Sulfate				Decreased sulfate concentrations in the anaerobic portion of the plume may indicate use of sulfate as an electron acceptor for anaerobic biodegradation of petroleum hydrocarbons.
	Field	Colorimetric field kit	Collect 100 ml of water in a glass or plastic container, cool to 4°C, analyze immediately.	Measure inside and outside of plume.

REPORT OF THE NATIONAL STAKEHOLDERS' FORUM ON MONITORED NATURAL ATTENUATION

Center for Public Environmental Oversight
San Francisco Urban Institute, San Francisco State University
October, 1998

The National Stakeholders' Forum on Monitored Natural Attenuation, held near San Francisco August 31 and September 1, 1998, brought together nearly 250 scientists, activists, and government officials. Organized by the Center for Public Environmental Oversight (CPEO), with sponsorship from the Air Force, the Navy, U.S. EPA, and the Department of Energy, the Forum offered a balanced series of informative presentations on natural attenuation as a cleanup strategy, and it provided the public stakeholder participants with perhaps their only opportunity to influence national policy on natural attenuation.

The racially diverse community participants, many of whom live near federal facilities, represented communities from throughout the U.S. Most indicated their appreciation for the opportunity to gain a wider understanding of the science and policy of natural attenuation, as well as the chance to network with people from other areas of the country with similar problems. Participants from all constituencies recognized the value of the Forum's *unique* format: Large numbers of people representing federal responsible parties, regulators, consultants, academia, and the public nationally were able to exchange their views openly and respectfully.

To guide national policy development, organizers of the Forum laid out four questions for participants:

1. What are the advantages and disadvantages of monitored natural attenuation as a remedy?

2. When and where is monitored natural attenuation appropriate?

3. How does one predict and verify the effectiveness of natural attenuation?

4. What should be done if natural attenuation doesn't work as anticipated?

Forum planners did not seek consensus. There was no formal voting. Rather, the Forum provided opportunities for those present to express themselves, in breakout groups as well as plenary sessions, and CPEO recorded those points of view.

Panelists consisted of community activists, regulators, academics, and scientists in the employ of the Departments of Energy and Defense. They represented differing points of view, but each brought his or her own expertise to the podium. Community representatives, for example, not only stressed the importance of community concerns, but they showed how grassroots activists could, over time, achieve a serious level of technical competence.

Other speakers stressed the importance of factoring in *all* scientific aspects when considering natural attenuation as a remedy. They described how cleanup teams study contamination in the subsurface environment, pointing out how difficult it is to know exactly

what's going on underground. Speakers agreed that natural attenuation, to some degree, always occurs at contamination sites. While project scientists must estimate the extent of natural attenuation processes, the question for decision-makers is whether such processes are sufficient to achieve cleanup goals. Finally, panelists explored the terminology used to describe natural processes. Though some found the term "natural attenuation" acceptable, others felt it confused degradation with other natural paths to reduce contaminant concentration.

Forum participants offered a wide range of comments on Monitored Natural Attenuation in general and specifically on EPA's interim policy, but the public stakeholders who spoke out tended to agree on key issues. Below is CPEO's summary of those comments.

The Importance of Trust

Public participants indicated widespread suspicion of Monitored Natural Attenuation as a cleanup strategy, but they did not challenge the science presented by its proponents. In fact, at first Forum organizers were frustrated by comments that centered on what seemed to be other issues, such as risk assessment, institutional controls, and the general absence of trust for government officials, particularly those working for agencies, such as the Departments of Defense and Energy, which have large contamination problems.

In reviewing the Forum record, however, that response stands out as the key lesson of the event: *Decision-makers who believe monitored natural attenuation is the best remedial response at a site must win the trust of the public long before they propose it as a remedy.*

Many traditional remedial strategies, such as "dig and haul" or "pump and treat," are superficially simple. Most people understand the basic concepts. They can see whether it's happening. The case for monitored natural attenuation, on the other hand, relies upon complex analysis before and after the fact. Before remedy selection, site characterization must show that natural attenuation is likely to achieve remedial objectives. Once natural attenuation is endorsed, long-term monitoring must continue until those objectives are reached. Both characterization and monitoring depend upon multiple lines of evidence, most of which involve variables that are difficult, at best, for the average person to understand.

Furthermore, at least one public participant pointed out that in practice decision-makers often rely upon only *two* lines of evidence, but use the term *multiple* to reinforce the perceived certainty that natural attenuation is proceeding with enough strength, speed, and stamina to complete the job.

Typically, when natural attenuation is under consideration, experts working for the responsible party present charts, graphs, and arguments designed to show that Monitored Natural Attenuation will achieve comparable results to other, more expensive remedial options. In fact, at the forum one Air Force scientist presented a graph showing that the rate of contaminant mass reduction in one major plume using natural attenuation wasn't much different than the estimated rate using conventional remedies. That graph demonstrated, he suggested, that Monitored Natural Attenuation was worth considering at that site.

However, from the public stakeholders' point of view, the only sure thing in the presentation was that natural attenuation would save the polluter—in this case the Air Force—a great deal of money. They had no way to independently test the Air Force's projection. And in fact, many were aware that even in the best of situations the Air Force comparison was fraught with technical uncertainty. As one speaker pointed out, "It's dark down there." That is, it's difficult to measure what's going on throughout the subsurface environment. Finally, they had no way to know whether there might be a third approach, with a better graph, waiting in the wings.

If, as many of the Forum participants indicated, people are already mistrustful of responsible parties—and often regulators—around issues they better understand, such as land use and health, they are unlikely to believe the promises of even the most knowledgeable, articulate experts. Natural attenuation is suspect, therefore, wherever the rest of the restoration program is suspect. It takes more than pretty pictures or sound science to win support where there is little trust.

On the other hand, at those facilities where the public believes that officials are both honest and willing to shape their decisions to meet public concerns, the public appears willing to evaluate the lines of evidence for natural attenuation, or any other remedy, on their merits.

Not surprisingly, public representatives at the forum underscored the importance of public participation in the screening and selection of remedial alternatives. The people who design and approve a natural attenuation strategy for a groundwater plume will be long gone by the date at which remedial objectives are expected to be reached, but most of the residents or their descendants will still have to live with the results. Public stakeholders also bring to the table local expertise and frequently an institutional memory that the scientific or regulatory experts lack. However, seeking public approval may present a "Catch 22" for the proponents of monitored natural attenuation. To win endorsement, they must increase the possibility of rejection.

To support such public participation, attendees called for a printed primer and more events like the Forum, to discuss the science and implications of natural attenuation. Though many of the participants said that they valued the technical presentations, some expressed frustration that speakers at the Forum were too technical, hard to follow, and difficult to understand.

Relationship to Other Remedies

Monitored natural attenuation seemed to be most acceptable to public stakeholders when regarded as just another tool in the remediation toolbox. As suggested in EPA's policy, natural attenuation may complement other remedies.

One participant, for example, argued that "enhanced" natural attenuation was more acceptable than the other kind, although he didn't provide a sharp line distinguishing the two. While some other participants, in their written comments, complained that too many people were focusing on the semantics of the term "monitored natural attenuation," it's clear that "natural attenuation" still carries with it the baggage with which it was first widely publicized, as a "do-nothing" remedy.

Another stakeholder proposed that monitored natural attenuation be approved as a remedy only in conjunction with other remedies, though she allowed that there might be exceptions. While some argued that other remedies were usually required for technical reasons, others echoed the perceptual importance of visibly "doing something" at a site. In other words, the presence of a visible physical or engineered remedy at a site demonstrates that action is actually being taken.

In particular, numerous people supported source removal as essential for natural attenuation to work. However, at the Forum this was not up for debate. All of the proponents of natural attenuation made the case for source removal. No one—as others have elsewhere—suggested letting natural processes deal with free product contaminants.

A number of speakers challenged the Defense Department's perceived policy of always considering monitored natural attenuation as a possible remedy for groundwater contamination. While an Air Force spokesman said that current guidance simply required that site characterization efforts collect the data necessary to evaluate the extent of natural attenuation, the critics felt that natural attenuation was almost a presumptive remedy, that budgets would be built and characterization would be biased on the assumption that natural attenuation was a front-running option. They argued that natural attenuation should be on a equal footing with other approaches.

Some participants expressed concern that reliance upon natural attenuation would undermine the development and use of innovative alternatives. In a site-specific evaluation of alternatives, monitored natural attenuation might look like it better satisfies remediation criteria—such as the nine criteria of the National Contingency Plan—than pump-and-treat, but there may be other, less well known options. A Cape Cod participant explained that residents in one neighborhood didn't want intrusive extraction systems in their yards, so they tended to support monitored natural attenuation as the local remedy. They were unaware of other options, such as horizontal wells, that might meet their needs while accelerating the removal of contaminants.

Some speakers raised the fear that natural attenuation might be approved at some sites now, because better alternatives are not yet proven. Then, when new technologies emerge that better satisfy remediation criteria, it's unlikely that the remedy will be reopened, even at five-year review. They asked: If monitored natural attenuation is approved as the best of a collection of uninspiring alternatives at a large number of sites, what incentive is there for anyone to invent better approaches? If new alternatives are developed, will there be any incentive to employ a new remedy at a monitored natural attenuation site?

At least, EPA's policy discusses the need for contingency remedies should monitoring demonstrate that natural attenuation is not working as expected. Participants liked that idea, but they showed concern that monitoring might not be good enough or soon enough to flag problems before they get out of hand. Because natural attenuation is frequently much less costly than other approaches, they expressed concern that budgets built on the assumption that natural attenuation will do the job may actually lock it in as a remedy, even when it doesn't work. One participant suggested a performance bond that would guarantee that money is available should it be necessary to call upon contingency remedies.

Destructive vs. Non-Destructive Remedies

Public stakeholders expressed strong preference for degradation as opposed to other forms of natural attenuation, such as dilution, dispersion, and volatilization. Many believed the non-destructive forms of attenuation should not be acceptable, and one tried to pin that down by asking what share of attenuation should be attributable to degradation for it to be considered the principal process. Another asked that the record of decision for each site specify the dominant attenuation process anticipated there.

Similarly, some participants were uncomfortable with the goal of "plume stabilization," considering it just another form of containment. They felt that treatment or removal, as currently required by regulations, was more desirable.

As a result of these preferences, some participants appeared more willing to accept monitored natural attenuation at petroleum sites, where degradation of the principal contaminants is more widespread and better documented, than at sites with volatile organic compounds. Few responded to the Department of Energy's description of the natural attenuation of inorganic substances—it was too new and too different. Those who did respond thought that metals should be dealt with in a separate policy, since degradation does not occur (except with radionuclides).

No matter what the principal contaminant, participants were concerned that remedies address all contaminants—such as MTBE (methyl tertiary butyl ether) in gasoline or whatever sits in a landfill—and that the persistent formation of toxic breakdown products, such as vinyl chloride, was an unacceptable result.

Land Use

Finally, a number of participants—particularly from communities with closed and closing military bases—expressed concern that natural attenuation, as a slow, uncertain remedy, could delay the transfer and/or reuse of contaminated properties. While long-term pump-and-treat as a groundwater remedy may be essentially as cumbersome as natural attenuation, "dig-and-haul" is a much faster way to deal with soils. And sometimes pump-and-treat can reduce or limit the size of a plume, making it easier to reuse or transfer property which does not lie over the contamination, even if the achievement of cleanup objectives remains a long way off. Some noted that any step in the remedial process that delays unrestricted use of property represents a real or potential economic loss to the community or property owner receiving the property.

Several participants felt the land and water use control as a component of remedial action is a significant area with many unresolved issues. They noted that the Defense Department, as evidenced by discussions at the most recent meeting of the Defense Environmental Response Task Force, is just beginning to grapple with complex issues surrounding institutional controls. Since monitored natural attenuation often depends upon the implementation of land and water use restrictions, participants from various constituencies urged the organization of a similar forum to discuss institutional controls.

Conclusion

On the whole, forum participants recognized that the adoption of monitored natural attenuation often requires more scientific review than conventional, engineered remedies. They expressed concern, however, that the open discussion of natural attenuation does not begin early enough in the remediation decision-making process. Many also felt that natural attenuation, as it is currently being defined, does not accurately depict the remedial strategy. For the most part, public stakeholders are willing to accept uncertainty when reviewing proposed remedies, but they are much less open to unconventional or complex remedies when they mistrust decision-makers.

That is, the uncertainty and technical complexity surrounding monitored natural attenuation magnify the mistrust found at many major contamination sites. To compensate for that uncertainty, the public wants contingency plans in place should monitored natural attenuation not perform as advertised. Community members want a clear mechanism for revisiting remedies if better alternatives are developed.

Researchers at the forum may have been disappointed that public participants chose not to focus on the scientific questions to which they devote their professional lives. They brought questions of their own to the table, instead. Until communities, responsible parties, and regulators better address the causes and consequences of mistrust, then proposals to rely upon monitored natural attenuation to address complex or significant contamination sites will be greeted, more often than not, with skepticism.

Reinjection Technology Evaluation

by

J. Mark Stapleton, Ph.D. - WPI

Acknowledgements

- Ground-Water Remediation Technology Analysis Center (GWRTAC, *University of Pittsburgh*)
- Mr. Bill Hughes, WPI, Matter AFB - EMR
- Mr. Gary Tiedeman, SAIC

Outline

- Documents Reviewed
- Task & Background
- Concept - Reinjection Design
- Factors That Impact Reinjection
- Advantages & Disadvantages
- Conclusions

Task

- Determine if reinjection (*In-Situ flushing*) is a viable addition to the Clean-up program at Kelly AFB

Background

- Extracted ground water that undergoes aboveground treatment is reinjected back into the shallow ground-water aquifer and used as a remedial tool

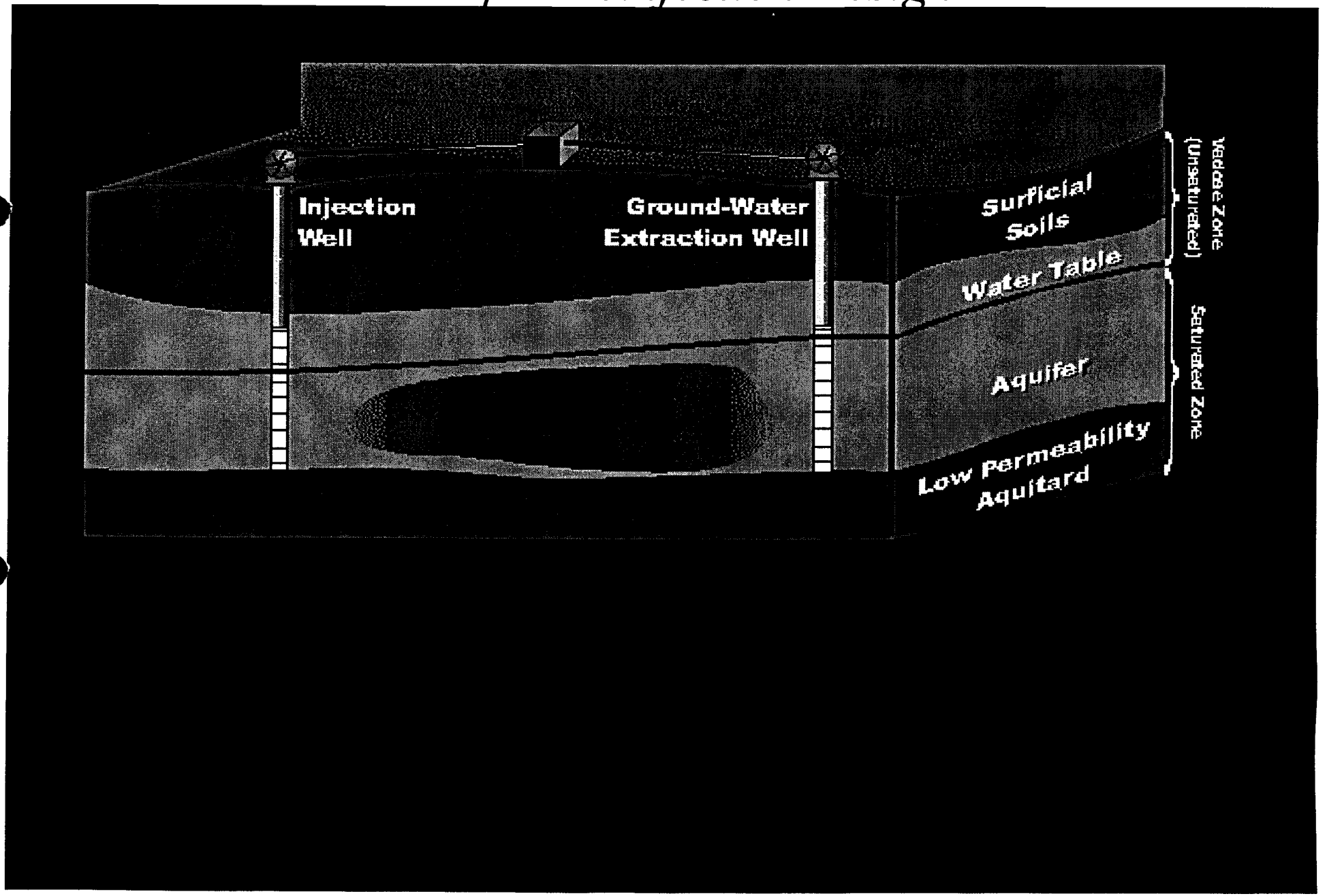
Documents Reviewed

- 73 Case Studies (GWRTAC at the University of Pittsburgh, Kelly AFB and Matter AFB)
- Draft Final Preliminary Engineering Report for Phase 1 Groundwater Remediation of the Main Base/Strategic Air Command Industrial Area Plume and Groundwater Remediation of the Site 7 Plume, (Matter AFB)
- Summary Aircraft Control & Warning (AC&W) Workshop, (Matter AFB)
- A Compendium of Cost Data for Environmental Remediation Technologies, (Los Alamos National Labs)

Documents Reviewed (cont.)

- In Situ Flushing, (GWRTAC)
- Remedial Design for Soil and Groundwater, IRP Zones 1, 2 and 3, (Kelly AFB)

Concept - Reinjection Design



Factors that can Impact Reinjection

- Suspended particles
- Biofouling
- Temperature/pressure changes
- Dissolved air
- Formation mineralogy
- Precipitation of iron
- Alterations of clays
- Chemical reactions
- Ion-exchange reactions
- Biochemical reactions
- Friction losses
- Mechanical jamming

Advantages of Reinjection at Kelly AFB

- Possible reduced time to clean-up
- Recharge the shallow ground-water aquifer
  - perceived resource value

Disadvantages of Reinjection at Kelly AFB

- Implementability
  - Limited site applications
    - Large distances between reinjection and extraction wells
  - Heterogeneity makes predictive water movements difficult
    - Channeling affects can short-circuit this technology
- Maintenance
  - Labor and materials
    - Manpower intensive
    - Sequestering agents
    - Cycling

Disadvantages of Reinjection at Kelly AFB (cont.)

- Cost
  - Capital and O&M intensive
    - NPDES to potable water requirement
    - Extensive monitoring
- Regulatory approval necessary

Conclusions

- Can be technically feasible, but typically cost prohibitive
- Site specific
  - Typically, poor performance in low hydraulic conductivity material and heterogeneous water bearing strata
- Risky
  - Reinjection/extraction well proximity
  - Dispersion - Increasing the time to clean-up
  - Possible negative affects to neighboring remedial systems

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE