Draft Natural Attenuation (NA) Guidance

For SAB Review

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Focus

Is the draft NA guidance....

- ✓Compatible with MTCA rules?
- ✓Scientifically defensible (& reasonable)?
- ✓Practicable and usable?
- ✓Any fatal flaws or missing some important points?
- ✓Ready for public review?
- ✓Highlighting issues/comments

Meeting Agenda

- ✓Project Time Line: past and future
- ✓Peer-reviewers: Internal/External
- ✓Specific issues/questions to SAB:
  Within scientific defensibility?
- ✓Any comments/recommendations from SAB

Project Time Line

- ✓ 10/01: Presentation to TCP program (scope of work)
- ✓ 1st draft: 10/02; 4 presentations to Ecology regions
- ✓ 2nd draft: 10/03; 3 presentations to Ecology regions; 2 invited presentations to national conferences
- ✓ 3rd draft: 5/04; internal and external peer-review & one presentation to TCP program
- ✓ 4th draft: 9/04; for SAB review

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- ✓ Today: SAB review and recommendations
- ✓ *5th draft: 12/15/04; for Public review and comments*
- ✓ ***3/1/05**: final delivered to the public*

Peer-Reviewers: Internal/External

- ✓10 TCP/NWP/HWTR regional & HQ Policy staff and WA DOH
- ✓US EPA OSWER/OUST: Hal White, Joseph Vescio; Region 9: Matthew Small
- ✓Groundwater Services, Inc.; Langan Engineering; Greg Glassmann; API?

Specific Issues

- ✓ Ecology's expectation on NA guidance
- ✓ Licensing requirements to conduct NA evaluation
- ✓ Conditions that preclude NA as a single cleanup action
- ✓ Minimum monitoring plan for feasibility of NA
- ✓ Methods for determining plume stability
- ✓ Demonstrating biodegradation
- ✓ Calculating restoration time
- ✓ Recommended minimum performance monitoring schedule
- ✓ Condition of site-closure under NA: compliance monitoring
- ✓ Analysis tool package: Beta test done

General Comments

1. Very diverse opinions:

✓ Does it really matter what's going on at a site…

✓ Too restrictive on the use of "NA" as a remedy…

✓ Too much flexibility on the use of NA…

Ex: Table 3.1 Monitoring Plan Table for Assessing Feasibility of NA?

- *Two Qr Monitoring is more than enough…*
- *At least 8 Qr monitoring is necessary…*
- *Does not need any numerical guide…*

2. Improve readability:

✓ A foreign born engineer's wording: will improve readability

✓ Redundancy, grammar, syntax: editorial change, proof-reading will be made

Ecology's Expectations/Assumptions on the Use of NA Guidance

✓ NA (@ for Petroleum HC) is occurring at every site: To what degree; how, is that good enough?

✓ Not trying to answer to every single possible/ potential question on NA;

✓ Rather, giving starting point (and simple hands-on tools) to implement NA more consistently than before;

✓ Cleanup standards (site-specific risk-based) not adjusted under this Guidance; site closure condition <CUL

✓ As a final polishing part of treatment train – major reduction (control) of source emphasized again and shrinking/stable plume expected for NA application

✓ For LUST sites: current practice not adequate; will resolve the conflict; more analysis being required

Should minimal licensing be required to conduct NA evaluation?

- Registered professional geologist with a specialty in hydrogeology, or
- Registered professional engineer with expertise in hydrogeology.

Situations where NA should not be used as a single cleanup action

✓Impacted (or imminently) receptors

✓Free Product

✓Expanding GW plume

Table 3.1 Minimum monitoring plan
for Assessing Feasibility of NA

Task	Minimum Duration and Frequency of Monitoring	Minimum Number and Location of Monitoring Wells
Contaminants of Concern & Ground Water Table Elevation	Four sampling events (quarterly) spaced evenly over one (1) year sampling period in order to define seasonal fluctuations in concentrations of contaminants and from multiple wells located at the centerline of plume	• One (1) well in up-gradient (not impacted) background area • One (1) well within source (most impacted) area • Two (2) wells within contaminated plume axis that are well above cleanup levels • One (1) well in down-gradient "sentinel" area (not impacted)
Geochemical Indicators	Four sampling events (quarterly) over one (1) year sampling period in order to define seasonal fluctuations in concentrations of geochemical indicators	

Methods for determining plume stability:
To demonstrate shrinking or stable plume + check GW elevation

- ✓Graphical and (log-linear) regression analysis
- ✓Non-parametric statistical analysis
- ✓Plotting maps of plume contours over time
- ✓Mass flux calculations over time

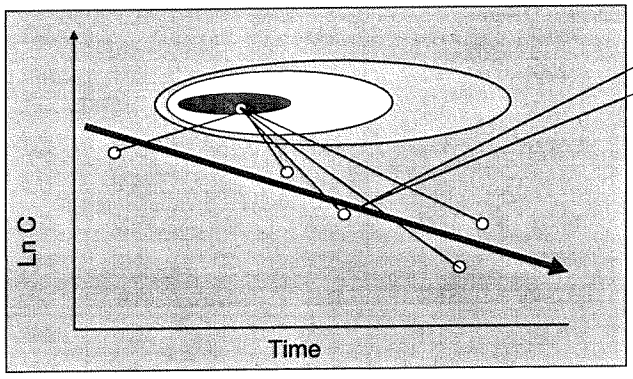
Any other methods?

Use of confidence level on handling uncertainty
for assessing plume stability and restoration time

- For non-parametric analysis: yes! Compulsory
- For linear regression analysis:
  - ✓Most states: silent or no specific directions
  - ✓Recommended/emphasized by EPA 1999 directive and most recent documents & USAF documents
  - ✓IA, WI, IN, actually using it without hands-on tools
- Input data handling: significant digit (3.54ug/L = 3.5ug/L?); ND,

1. Evaluation of statistical validity (@ a well)

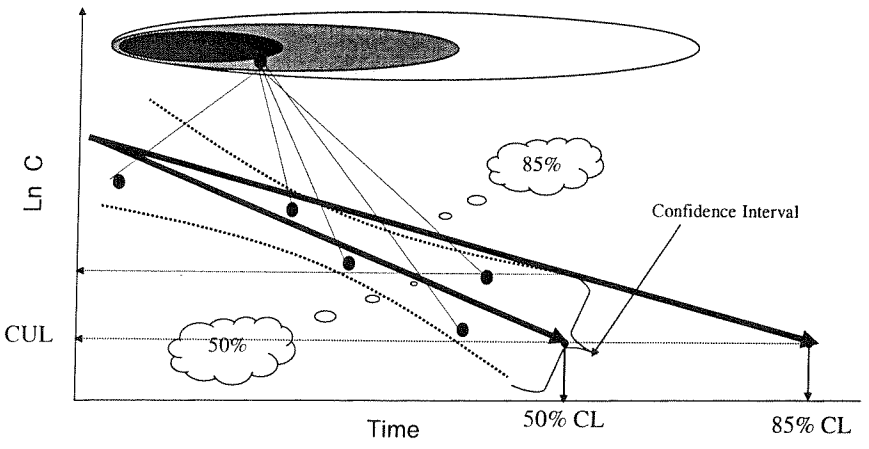
- Student t-test; confidence interval calculated on the slope of log-linear regression to demonstrate statistically different from "zero" @ number of data and natural scatter in data points
- Pearson product moment correlation coefficient:



R=0.878 @ n=5
=>
95% Confidence Level

2. Estimation of restoration time @ a well

@ one-tailed and a specified confidence level



Comparison between non-parametric and regression Analysis

Real example data @ central region

Well Location:		Unit	MW14	MW5	MW6	MW4
Dist from source, x-direction		ft	0	73	58	-34
Off-centerline dist, y-direction		ft	0	0	74	-13
Sampling Event	Date sampled	day	Unit of concentration is ug/L			
#1	1/30/01	0	7450			182
#2	4/26/01	86	26100	831	1320	673
#3	7/29/01	180	14200	53.8	5050	402
#4	10/27/01	270	9970	552	1910	200
#5	11/15/02	654	8380	108	1270	75.6
#6	5/9/03	829	4520	78.7	1710	61.8
#7	9/30/03	973	6230	229	1610	161
#8	12/11/03	1045	4890	50	624	50
#9	3/31/04	1156	6270	53	1160	267
#10	6/2/04	1219	3790	92.8	2300	140

Clear all dates

Non-parametric Analysis

Contaminant of Concern?	MW-14	MW-5	MW-6	MW-4
Confidence Level Calculated?	99.20%	91.00%	76.20%	92.20%
Plume Stability?	Shrinking	Shrinking	Stable	Shrinking
Coefficient of Variation?			CV <= 1	

Log-linear Regression Analysis

Well Location	MW-14	MW-5	MW-6	MW-4
Two-tailed Confidence Level calculated, %	99.205%	89.909%	73.252%	88.970%
Sufficient evidence to support a significant log-linear correlation ?	YES!	YES!	NO!	YES!
Coefficient of Variation?	NA	NA	0.680	NA
Plume Stability?	Shrinking	Shrinking	Stable	Shrinking

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Table 3.2 Decision Criteria Recommended for Determining Overall Plume Status @ multiple wells

Plume Status	Decision Criteria		
	[1]For monitoring wells within contaminated plume that are well above cleanup levels, evaluate plume status (e.g., with Module 1 or 2): see note below.	For any clean sentinel well where contaminant previously undetected, evaluate contaminant concentration:	For any water supply well where contaminant previously undetected, evaluate contaminant concentration:
Shrinking Plume, if **ALL** of the following occur	Plume status is defined as shrinking at more than 80% of all monitoring wells in contaminated plume axis.	Contaminant Not Detected	Contaminant Not Detected
Stable Plume, if **ALL** of the following occur	Plume status is defined as shrinking or stable at more than 80% of all monitoring wells in contaminated plume axis.	Contaminant Not Detected	Contaminant Not Detected
Expanding Plume, if **ANY** of the following occurs	Plume status is defined as expanding or undetermined at more than 20% of all monitoring wells in contaminated plume axis.	Contaminant Detected over one or more consecutive rounds	Contaminant Detected

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Why Ecology is emphasizing degradation mechanism?

Does it matter what is going on at a site – destruction versus dilution/dispersion – as long as concentration are reduced below CUL?

- ✓NRC, 1993: evidence of feasible biodegradation
- ✓ASTM, 1998: secondary line of evidence: geochemical indicator of naturally occurring degradation
- ✓US EPA, 1999 directive: Three lines of evidence: clear decreasing trend; demonstrating the biodegradation with geochemical data; microcosm study

Most recent NRC & EPA's position on degradation mechanism

- ✓ NRC, 2000: First and foremost community concerns: NA is a "do-nothing" approach; chosen because it is inexpensive; legitimizes the dilution and dispersion of contaminants into the environment.

  Pre-eminent position of NRC: "*Acceptable (or eligible) NA processes to destruction and strong immobilization more reliable and reducing risks..*"

- ✓ EPA SAB, 2001: *"Although the public's perception of NA is generally negative, public acceptance may improve when there is a reliable scientific basis for distinguishing those site at which the contaminants are controlled by processes that destroy or strongly immobilize the contaminants from sites at which NA is not a appropriate remedy....."*

MTCA's position on degradation

CES, 2001:

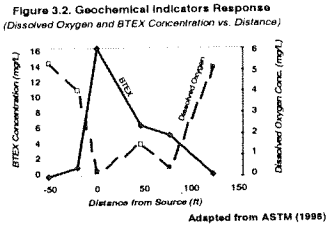
- ✓ NA alone, can be considered an active remedial measure, when conforming §370(7)
- ✓ Purpose of §370(7): further clarification of §350 and 360.
- ✓ Q:NA should be less restrictive… Response: necessary to demonstrate that natural biodegradation or chemical degradation is occurring and will continue to occur…

MTCA 2001:

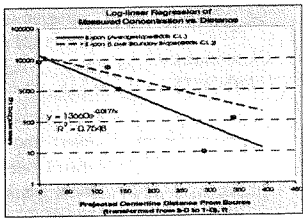
- ✓ §350 RI/FS: permanent cleanup action alternative
- ✓ §360 Minimum requirements for cleanup actions:
  "shall not rely primarily on dilution and dispersion…"
- ✓ §370(7): Ecology expects: "there is evidence that natural biodegradation or chemical degradation is occurring and will continue…."

Demonstrating degradation (destructive mechanism) during the feasibility study

✓Clear pattern/response of geochemical indicators and calculation of Assimilative capacity



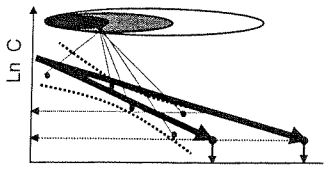
✓Estimation of contribution ratio of plume contaminant mass removed to overall attenuation: via modeling; steady-state or transient-state



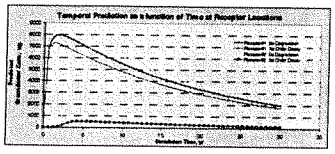
Any other methods?

Calculating restoration time

✓Log-Linear regression analysis (@ lower bound of regression line)



✓Analytical solute transport model: 2-D Domenico Model + site-specific hydro info



New & innovative methods? Ecology resource problem to review; encourage ⇒ may use

Table 3.4 Recommended Minimum Performance Monitoring Schedule

Type of Analysis	Number & Location of Monitoring Wells	Monitoring Frequency	
Contaminants of Concern & Ground Water Table Elevation & Primary Geochemical Indicators	• One (1) well in up-gradient (not impacted) area • One (1) well within source (most impacted) area • Two (2) wells within contaminated plume center line • One (1) well in down-gradient "sentinel" area	1st year	Quarterly
		2nd & 3rd years	Semi-annually, provided plume shrinking or stable during 1st year and quarterly monitoring indicates semi-annual monitoring will provide sufficient data
		Subsequent years	Annually, provided plume shrinking or stable for first 3 years and semi-annual monitoring indi cates annual monitoring will provide sufficient data
Secondary Geochemical Indicators		1st & 2nd years	Semi-annually
		Subsequent years	Annually, to the extent necessary to assist performance monitoring

Can site closure conditions under NA remedy be different?
After attaining cleanup standards

- ✓ Existing MTCA rules and guidance: > 3 years @ <CUL; 95% CUL, 2x, 10%.
- ✓ Draft NA guidance: at least 3 years of monitoring of which a minimum of 1-2 years @ <CUL

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- ✓ Other states: mostly silent; IN, WI, TX: clear decreasing/stable trends + others
- ✓ EPA: period of 1 to 2 years longer @ <CUL
- ✓ Current Ecy site manager's practice for a simple site: 2 consecutive Qr @ ND or 4 consecutive Qr @ <CUL

Analysis Tool Package and User's Manual

- ✓ At a first glance: Ecology staff said a little overwhelming… but…
- ✓ Modules 2 (log-linear regression analysis) and 3 (geochemical indicators plots and AC calculation) will be most heavily used
- ✓ Beta test for the usability, functionality, operatibility, and calculation accuracy: Ecology staff, GSI, EPA Region 9