Final
Attachment: Optimization Tools

May 2012
Geostatistical Temporal/Spatial Optimization Algorithm (GTS) - more technically complex monitoring optimization software that provides:

Trend Analysis
- Uses statistical tools to demonstrate trends and "out of bounds" data

Constituents of Concern (COCs) Assessment
- Narrows COCs down to most meaningful two or three for optimization (maximum of four)

Temporal Optimization
- Uses temporal variograms and iterative thinning to provide recommendations
- Optimizes monitoring frequency at individual wells
- Removes data points systematically until trend cannot be reconstructed

Spatial Optimization
- Analyzes multi-well redundancy allowing for well network optimization
- Allows for comparison of baseline vs. optimized plume maps

Key Uses:
- Analyzes multiple sites at once
- Evaluates sites with several rounds of data from at least 10 to 15 wells
- Assists in developing an effective monitoring program at the startup of a remedy

Temporal Optimization Tool identifies how sampling frequency can be reduced. For example, at this site, reduction from 240 data points to 27 data points results in similar trend lines. Reducing the sampling frequency based on this optimization evaluation could result in a 90% reduction in sampling and significant cost savings.

COC Assessment narrows the parameter list for evaluation down to the most meaningful COCs

Spatial optimization Tool identifies how monitoring well network can be reduced. For example, at this site, elimination of 40% of the wells from the monitoring network does not significantly modify the plume configuration.
Optimization Tools: MAROS

Monitoring and Remediation Optimization Software (MAROS) – low cost, user friendly, and simple monitoring optimization software that provides:

- Statistical Trend Analysis • Evaluates data trends for individual wells/constituents of concern (COCs) using Mann-Kendall and Linear Regression
- COC Analysis • Identifies most appropriate COCs for evaluation based on toxicity, frequency, and mobility
- Moment Analysis • Analyzes plume mass and spread of plume over time • Evaluates both source and tail stability of the plume
- Power Analysis • Evaluates data trends and sampling frequency • Provides well by well recommendations for reducing sampling frequency for specific COCs
- Redundancy Analysis • Evaluates the need for specific sample locations using Delauney Triangulation • Identifies new sample locations needed to delineate the plume boundary

Key Uses:
- Evaluates well by well for optimization of monitoring network for smaller sites
- Evaluates benefits for potential additional well locations
- Evaluates plume stability and data trends

Use software-specific data entry windows and Microsoft Excel or Microsoft Access data tables to import information.

Redundancy Analysis identifies recommended sampling locations.

Comprehensive output summary includes site details and optimization recommendations.

MAROS Site Results

1. Compliance Monitoring/Remediation Optimization Results:
   Preliminary Monitoring System Optimization Results. Based on site classification, source treatment and Monitoring System Category the following suggestions are made for site sampling frequency, duration of sampling before nonmonotony, and Well Density. These criteria take into consideration: Plume Stability, Type of Plume, and Groundwater Velocity.

   Key Uses:
   - Evaluates well by well for optimization of monitoring network for smaller sites
   - Evaluates benefits for potential additional well locations
   - Evaluates plume stability and data trends
NAS (Natural Attenuation Software) - monitored natural attenuation (MNA) software that provides:

Three main interactive numerical and analytical solute transport modules that provide estimates for:
- Source concentration required for a plume to contract to within regulatory limits
- Time required for a plume to contract to within regulatory limits
- Time required for free phase contaminants to attenuate to a predetermined source concentration

The capability to model comingled plumes with constituents from multiple contaminant categories

Models advection, dispersion, sorption, non-aqueous phase liquid (NAPL) dissolution, and biodegradation

Key Uses:
- Estimates remediation timeframes for MNA
- Designed for application to groundwater systems consisting of porous, relatively homogenous, saturated media such as sands and gravels, and assumes that groundwater flow is uniform and unidirectional
- Can provide comparisons for time of treatment between natural attenuation and pump and treat if data on pumping system are entered
Optimization Tools: Navy Vapor Intrusion Evaluation Tool

Navy Vapor Intrusion (VI) Evaluation Tool - tool that provides a step-by-step user interface for evaluating VI data and whether there is a complete exposure pathway including the following elements:

- Illustrated tutorials and tips on a wide range of VI topics
- An electronic repository for relevant site information to support the conceptual site model
- A question and answer interview interface for assessing data and drawing conclusions

Navy Environmental Restoration Program Management and Monitoring Approach
Remediation Evaluation Model for chlorinated solvents (REMChlor) - model used for simulating the effects of groundwater source and plume remediation. Simulates first-order sequential decay and production of several species (e.g., PCE to TCE to DCE, etc). The software is based on a power function relationship between source mass and source discharge. Decay rates and parent/daughter yield coefficients within the plume are variable functions of time and distance.

- Allows for greater flexibility in simulating differing conditions that may occur throughout the downgradient extent or lifetime of the plume.
- Model allows simulating the inclusion of an enhanced biodegradation zone, such as might occur through the implementation of a biobarrier, in one portion of the plume, while simulating more naturally occurring conditions in other portions of the plume.

### Key Uses:

- Can accommodate and evaluate the impacts of partial source remediation at any time after the initial release.
- Includes the ability to calculate cancer risks in the plume, assuming that contaminated water is used for drinking, bathing, and other household uses.

Visually intuitive model parameter input

Provides a variety of options for displaying the model output
Optimization Tools: Ricker Plume Stability Method

Ricker Plume Stability Method - an optimization method that demonstrates plume dynamics in order to evaluate treatment effectiveness and monitored natural attenuation (MNA)

Plume Dynamics Evaluation
- Calculates and assesses historical trends in contaminant plume area
- Calculates average concentration, contaminant mass, and center of mass
- Calculates overall chlorinated volatile organic compound molar mass
- Spatially evaluates temporal changes in plume

Key Uses:
- Demonstrates plume stability
- Helps determine if site is appropriate for MNA
- Evaluates classes of compounds
- Evaluates sites with established monitoring well networks and multiple years of data

The concentration isopleth maps show the change in spatial plume extent over time. The concentration difference map shows areas and relative magnitude of concentration decreases (blue shading) and increases (pink shading) within the plume.

Trend graphs depicting temporal trends in plume stability characteristics assist in understanding plume dynamics.
Spatial Analysis and Decision Assistance (SADA) - combines multiple scientific models into a single user interface to provide:

- Visualization/GIS
- Statistical Analysis
- Geospatial Interpolation
- Geospatial Uncertainty Analysis
- Human Health Risk Assessment
- Ecological Risk Assessment
- Custom Analysis
- MARSSIM Module
- Area of Concern Frameworks
- Cost Benefit Analysis
- Sampling Designs
- Export to Arcview / Earthvision

Data input files must be in comma delimited format (csv) or Microsoft Access

Key Uses:

- Makes cost vs. clean up estimates based on the conceptual site model
- Creates human health and ecological risk contour and point maps
- Can be used to develop sample designs using systematic, random, judgmental, adaptive fill, high value, and boundary approaches

Broad Set of output capabilities include 3-D models and risk contour maps
Optimization Tools: SiteWise™

SiteWise™ - series of excel spreadsheets used to calculate the environmental footprint of remediation in terms of sustainability metrics.

Metrics that are calculated with the SiteWise™ tool include:
- Energy consumption
- Greenhouse gases emitted
- Criteria air pollutants emitted
- Water impacts
- Worker safety

Receive output in quantitative and graphical form to allow for easy comparison of optimization options.

Relative Impact

<table>
<thead>
<tr>
<th>Management &amp; Monitoring Alternatives</th>
<th>GHG Emissions</th>
<th>Energy Usage</th>
<th>Water Usage</th>
<th>NOx Emissions</th>
<th>SOx Emissions</th>
<th>PM10 Emissions</th>
<th>*Accident Risk Fatality</th>
<th>*Accident Risk Injury</th>
<th>Community Impacts</th>
<th>Resources Lost</th>
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<td>Option 1</td>
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<td>High</td>
<td>user select</td>
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</tbody>
</table>
Optimization Tools: Summit

Summit – more technically complex monitoring optimization software that provides:

Sample Optimization Module
- Identifies redundant sampling locations and/or frequencies
- Considers numerous sampling plans with fewer samples than baseline
- Allows for comparison of baseline vs. optimized plume maps
- Allows for comparison of trends at various sampling frequencies
- Calculates error where samples are removed
- Evaluates multiple constituents of concern simultaneously

Data Tracking/Evaluation Module
- Flags new sample results out of expectations
- Tracks relative plume mass over time

Import data as comma-delineated text file

The Sample Optimization Module shows how the monitoring network can be reduced. For example, at this site the well network can be reduced from 55 to 41 wells with virtually no change in the plume configuration for the site. Reducing the well network to 30 wells results in a minimal change to the plume configuration. Therefore, the well network can likely be reduced to 30 wells at this site without resulting in any changes in the site management and monitoring approach.

The Data Tracking/Evaluation Module shows when new data collected are out of expected “bounds.”

Key Use:
- Evaluates large, complex sites with numerous wells or high sampling frequency

Current Data: “Out of Bounds”