MAROS 2.1 SOFTWARE TRAINING

Introduction

The AFCEE Monitoring and Remediation Optimization System software (MAROS) is a collection of statistical and data visualization tools in one software package designed to aid stakeholders in developing efficient long-term groundwater monitoring programs.

The MAROS methodology is designed to organize large quantities of site data and focus analysis to reveal underlying trends in the data. By reviewing several lines of evidence on plume stability and predictability, the user can improve a groundwater monitoring network while maintaining adequate delineation of the plume. Different users will employ the tool in different ways and interpret the results from different viewpoints. Therefore, it is important to not only have a consensus conceptual site model before beginning the MAROS analysis, but to assess all of the MAROS results in conjunction with detailed knowledge of site conditions, regulatory framework, community issues, and other site specific situations.

The MAROS 2.1 Software Training Program presents an introduction to the MAROS 2.1 methodology. The Program is intended to provide users with the basic skills to begin site analysis and to understand the application of the methodology to various regulatory contexts.

Objectives of Training

The key objectives of the MAROS Software Training include familiarizing the user with typical applications, implementation and interpretation of the MAROS modules:

The Training Program consists of Activities illustrating different aspects and capabilities of the MAROS software. The MAROS 2.1 methodology is explained in general terms during this training. More detailed information is provided in the MAROS Manual and in references listed at the end of this training.

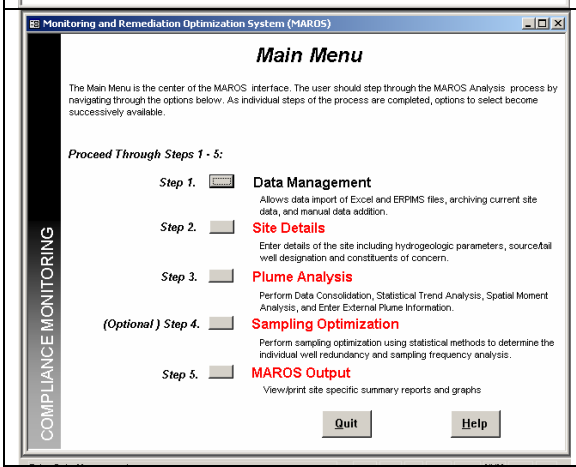
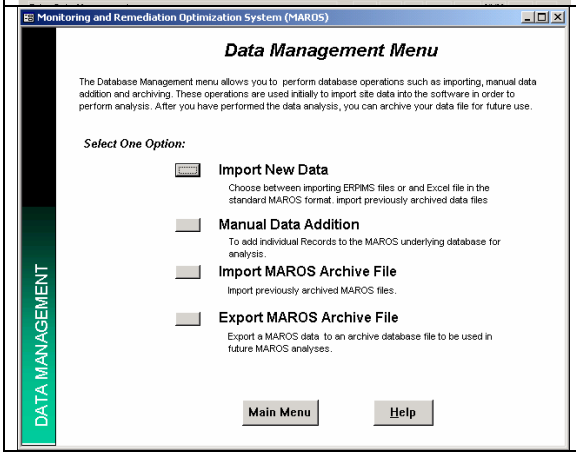
Upon completing this training, the user should be able to:

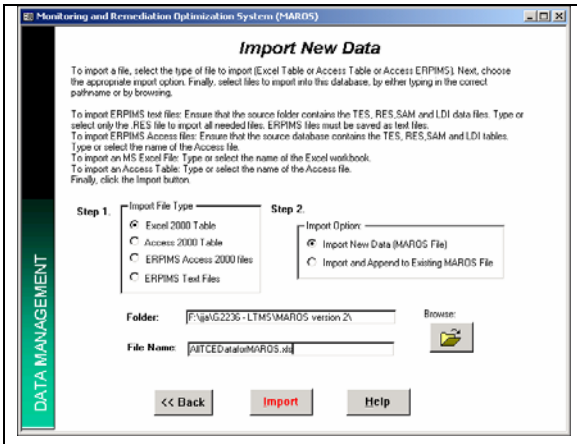
- Enter data into the software from both Excel files and Access archive files;
- Rank and choose COCs that control long-term monitoring decisions;
- Select time ranges to analyze data and consolidate large data sets;
- Determine the overall plume stability through trend analysis;
- Evaluate plume stability using moment analysis;
- Evaluate individual well concentration trends over time;
- Reduce, where possible, redundant wells without information loss
- Suggest locations for new wells for future sampling;
- Provide future sampling frequency recommendations while maintaining sufficient plume stability information;
- Evaluate risk-based site cleanup status using data sufficiency analysis.

Optional Activity 1

Download MAROS 2.1	
Download	1) Go to http://www.gsi-net.com/software/Maros.htm A link to the MAROS download site is also accessible from the AFCEE web site.
	2) Save MAROS_v2_1.exe file to a folder in Program Files. The MAROS download file is a zipped collection of Access, Excel and other files.
	3) Double click MAROS_v2_1.exe, and unzip files to home file C:/AFCEE_MAROS_v2_1. 12 files will appear in the folder: AFCEE_MAROS.HLP MAROS_AccessImportTemplate.mdb MAROS_ConstituentList.xls MAROS_ERPIMS_Import_Template2000.mdb MAROS_ExcelImportTemplate.xls MAROS_v2_1.mdb ** MAROS_V2_1Manual.pdf xlsDelaunay2K.xls ** xlsLOETrendResults.xls ** xlsNewLocation.xls ** ** = *File essential to MAROS program*
Create Backup	4) Create a new folder, convenient to your data files.
	5) Copy the contents of the AFCEE_MAROS_v2_1 to the new folder. This will be your *working copy* of MAROS.
Prepare Site Data	6) Prepare the data for analysis. Open Excel file *AFCEEMAROS_ExampleData.xls* ***The data format should match the templates exactly!*** The constituents should be spelled exactly as in MAROS_ConstituentList.xls. Well location coordinates should be in units of feet (usually State Plane Coordinates). The Result field for non-detects is blank. All data should have detection limits (even if they are estimated).

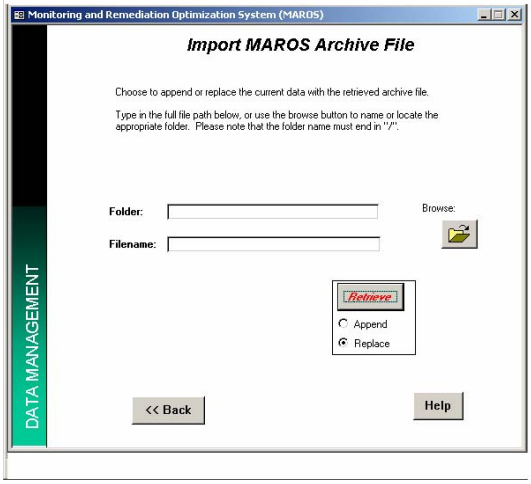
ACTIVITY 2

Import Data		
		**1) Opening Screen** Open *MAROS_v2_1.mdb.* *The User name and project name will appear on subsequent reports.* Choose 'Start'.
		**2) Main Menu** *The Main Menu screen will indicate available choice in **Black** and unavailable choice in Red.* Choose 'Data Management'.
		**3) Data Management Menu**. *Choose the option corresponding to type of file you want to import.* Choose 'Import New Data' from the menu options.



4) Choose type of New Data to Import:

If you were to import an Excel file do the following:
Browse to the file you will be importing.
Under Import Option choose 'Import New Data'
Choose 'Import' button
Confirmation box should appear. Click OK.
Click 'Back' button on the Import menu.



5) Import Archive file, created previously in MAROS.
An Archive file has already been created for you. (We will demonstrate file creation in Activity 3 Step 13), you can import it using this screen.

Browse to file.
Choose
AFCEEMAROS_ExampleArchive.mdb

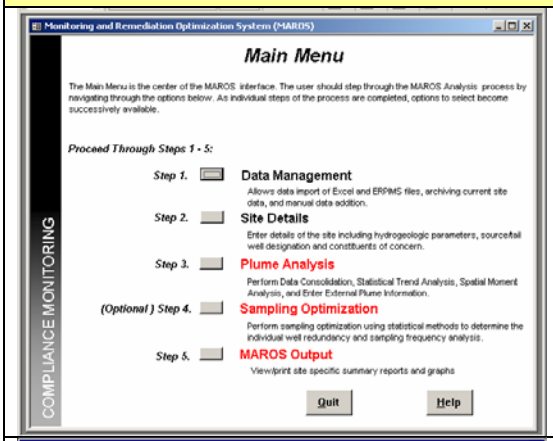
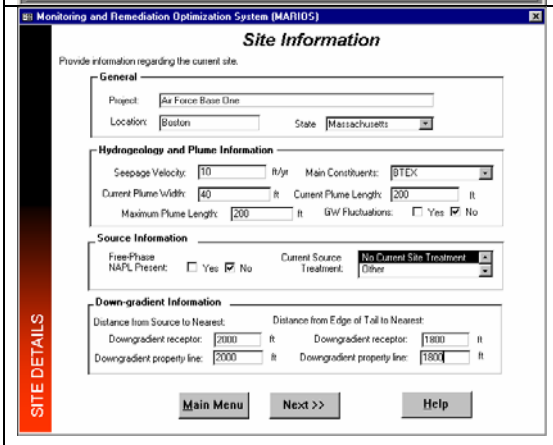
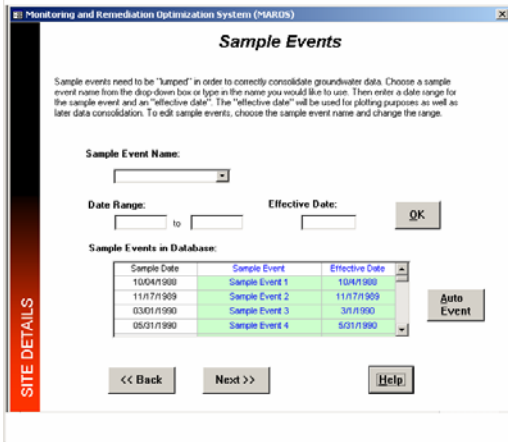
Choose Retrieve with 'Replace' option.

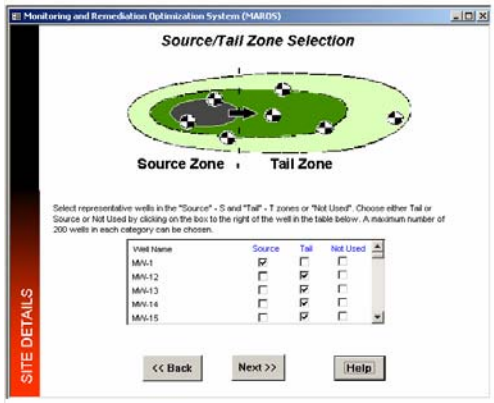
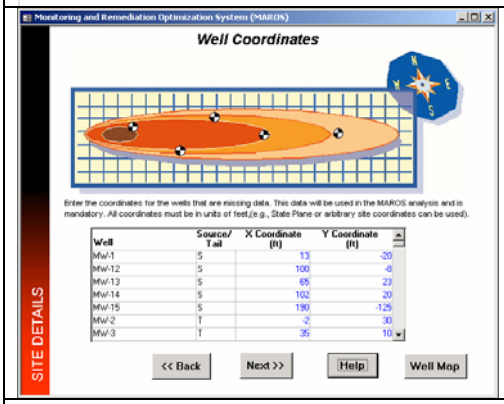
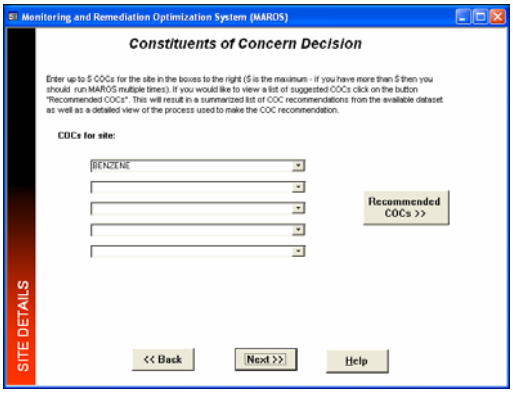
The 'Replace' option eliminates old data that may be in the database, and lets you start with a clean set of files.

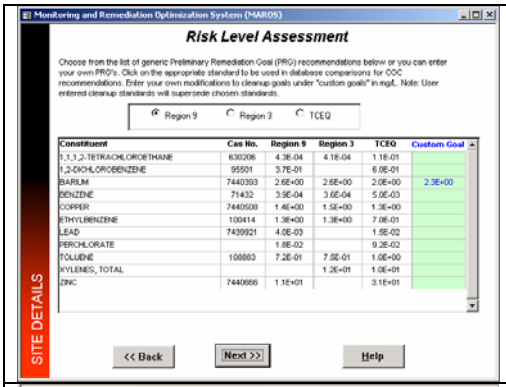
Choose 'Yes' then 'OK" in the dialog boxs.

Choose 'Back' and then 'Main Menu' for the subsequent screens.

Activity 3

Site Details	
	**1) Main Menu** Choose Step 2 Site Details.
	**2) See site information**: State: *Texas* Seepage Velocity *92* Current plume width *150* Main Constituents *BTEX* Current plume length *270* Maximum plume length *270* GW Fluctuations *Yes* Source Treatment *In Situ Biodegradation* Free Phase NAPL *No* Downgradient receptor *1000* Downgradient property line *1000*
	**3) Sample Events** *Sometimes sampling all wells at a site takes a few days. Here is where you can assign one date per sample event.* Choose 'Auto Event' Choose a name for your sample event e.g. *March 1990* Type in the date range for the event *03/01/1990 and 03/02/1990* Choose an effective date *03/01/1990* Choose 'OK'. Choose 'Next'.

	**4) Select source and tail wells.** *Choice of source and tail wells is up to the User.* Choose: Wells MW-1, 2, 3, 5, 6, 7 and 8 as Source wells, the rest are Tail wells.
	**5) Review and edit well coordinates**. Choose 'Well Map' to visualize locations of wells.
	**6) Constituents of Concern Decision Window** Choose COCs from drop down menus. *5 COCs can be evaluated simultaneously in the software* Choose 'Benzene' *To refine and prioritize COC choice, and enter regulatory limits, choose the 'Recommended COCs' button.*

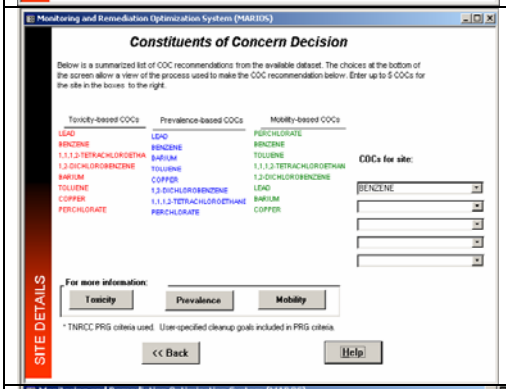


7) Risk Level Assessment

Choose 'TCEQ'.

The User can choose a regulatory framework or add custom risk limits to the software.

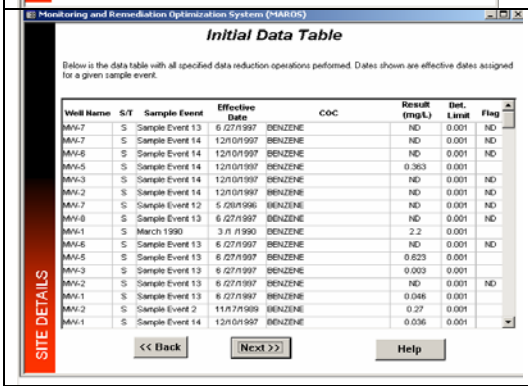
Choose 'Next' to see the risk ranking of COCs; choose 'Back' to return to the program.



8) Constituents of Concern Decision

Explore the window.

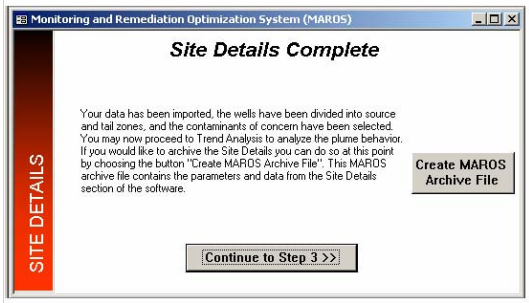
Choose 'Back' button twice to get back to the main Constituents of Concern Decision screen.



9) Initial Data Table

From the Constituents of Concern Decision screen, click 'Next' to get to the Initial Data Table.

After checking table, Choose 'Next' to display the Site Details Complete screen.



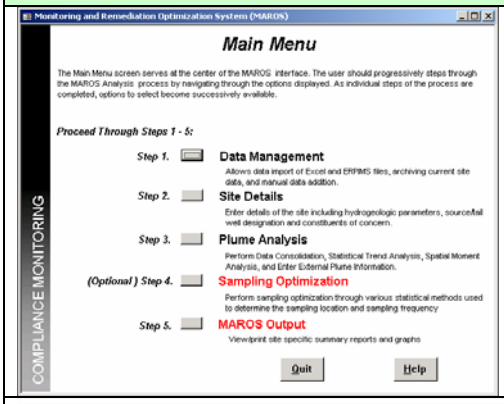
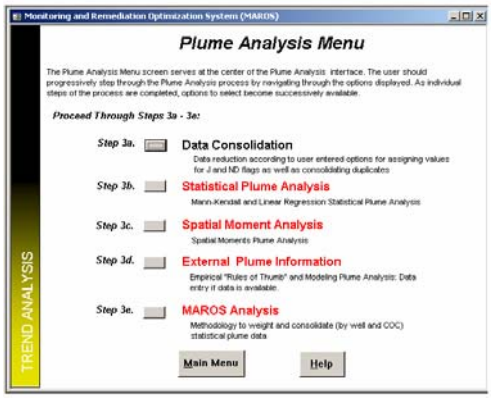
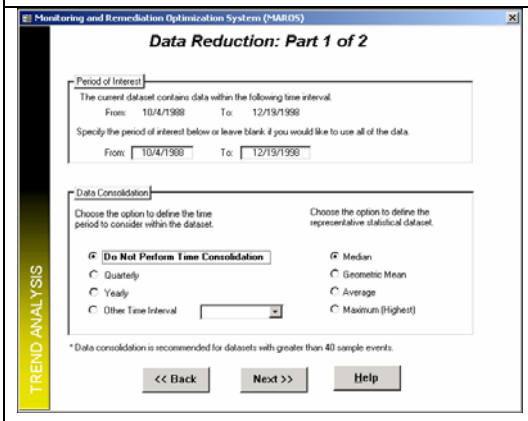
10) Create MAROS Archive File

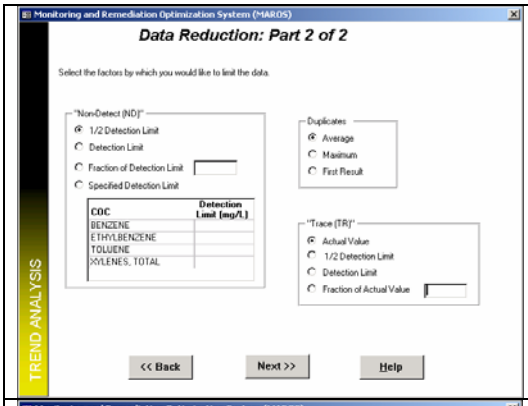
Choose 'Create MAROS Archive File'

Browse and name your Archive File and choose 'Create'.

After the file is created, click 'Back' to return to the Site Details Complete page, then click 'Continue to Step 3'

Activity 4

Plume Analysis	
Data Consolidation	
	**1) Main Menu** From Main Menu choose 'Plume Analysis (Step 3).
	**2) Data Consolidation Step 3a** Choose 'Data Consolidation Step 3a.'
	**3) Data Reduction Part 1** *Note: If the User wants to limit time span for the analysis, the date range can be entered in the. 'Period of Interest' dialog box. The Tutorial dataset is small and does not require much consolidation.* Choose 'Do not Perform Time Consolidation' Choose 'Median'.



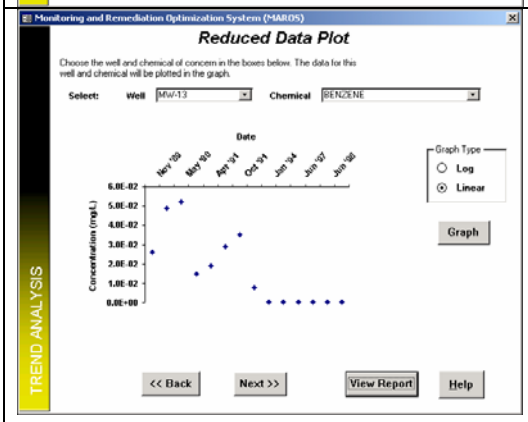
4) Data Reduction Part 2

Choose 'Uniform Detection Limit'

'Average' Duplicates

Trace values are 'Actual Values'

Choose 'Next' and review the **Reduced Data Table**, then proceed to the Next screen.

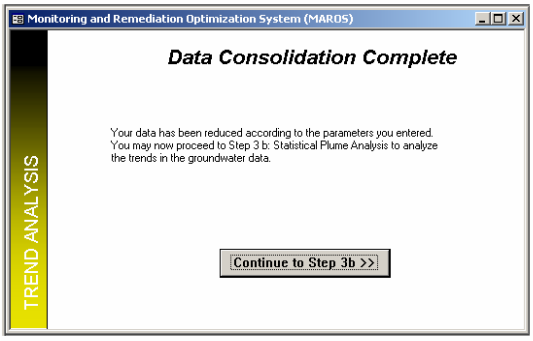


5) Reduced Data Plot

Choose a well.
Choose the chemical 'Benzene'.
Choose 'Graph'.

Choose 'View Report'

Note: Reports can be printed from the current window. They are also saved during the session, and can be printed at the end of the analysis. Hint: Reports can be printed to Adobe Acrobat and saved as pdf files!

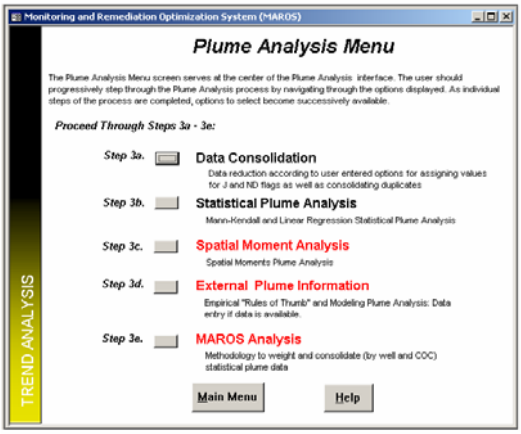
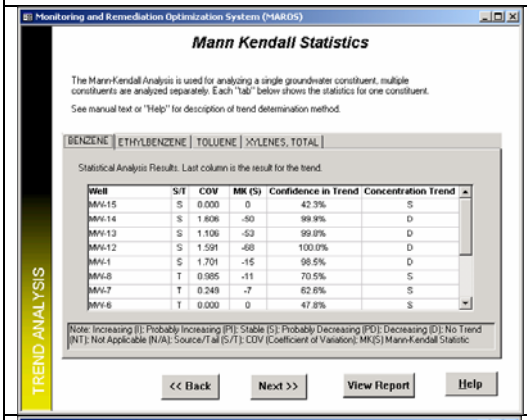
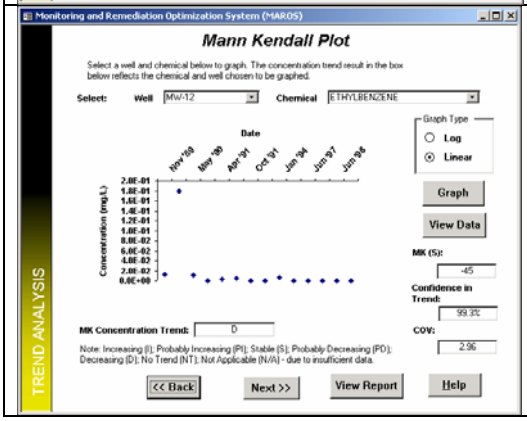


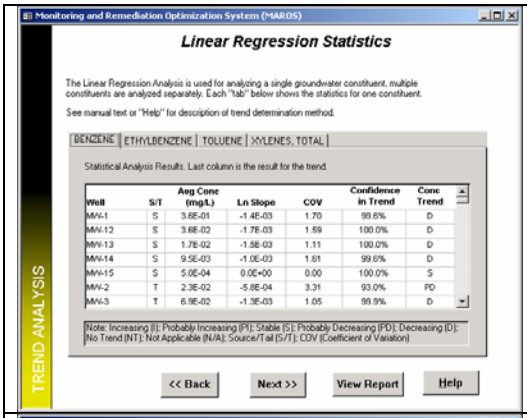
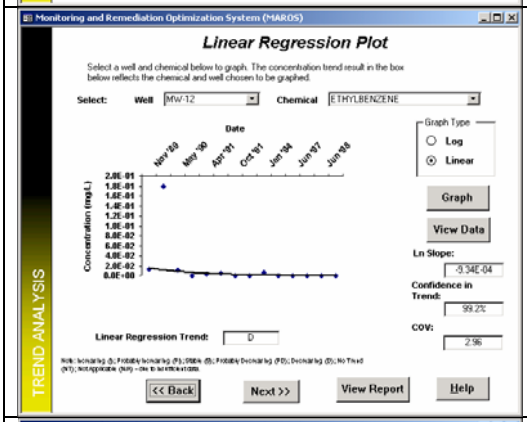
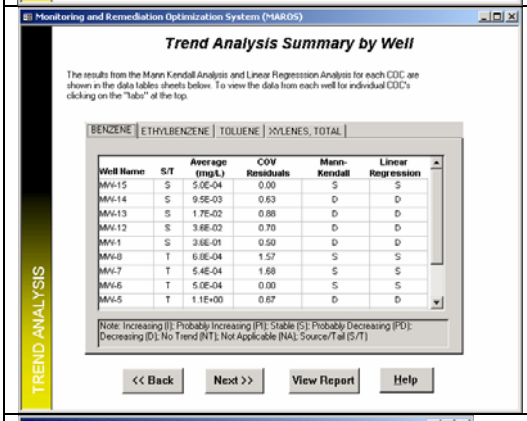
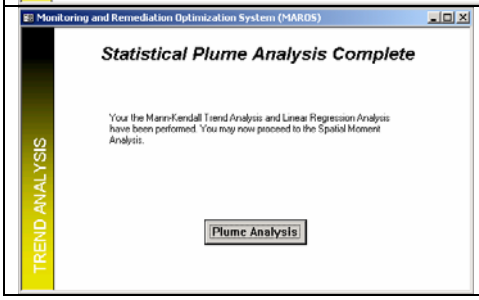
6) Complete Data Consolidation

Close Report file and choose 'Next' on the Reduced Data Plot

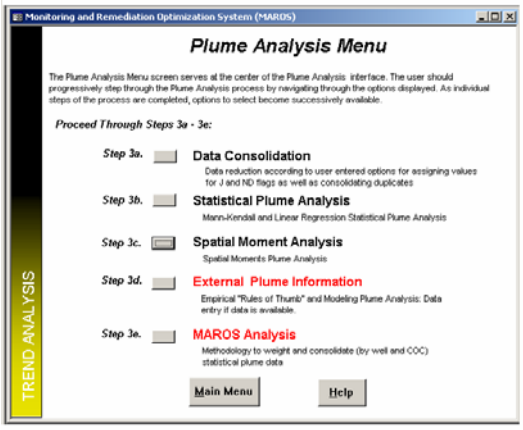
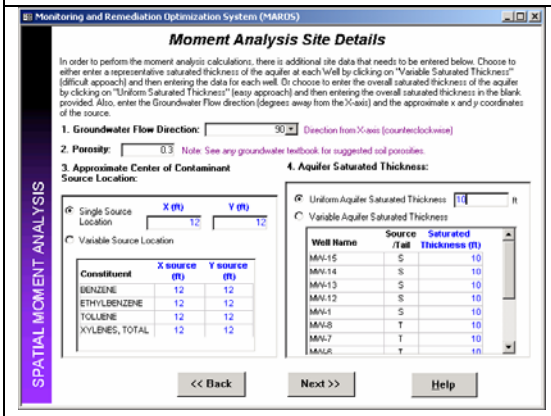
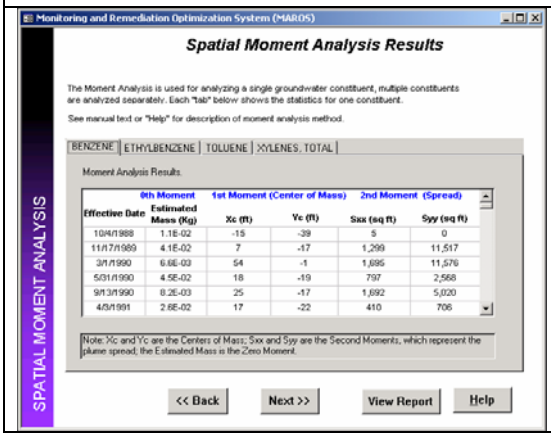
Data consolidation is complete; proceed to Step 3b.

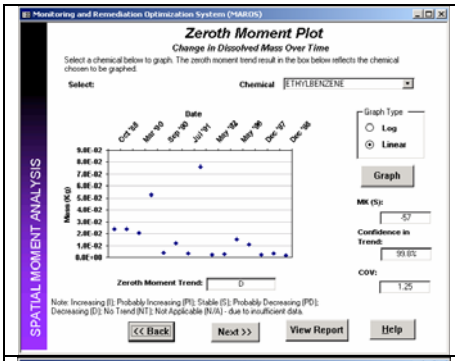
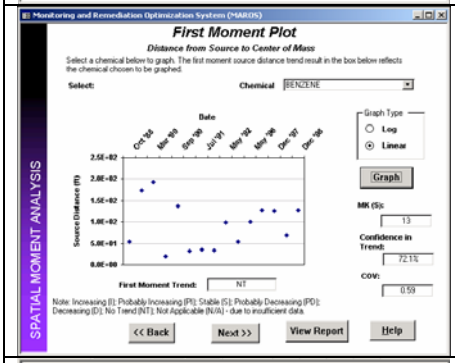
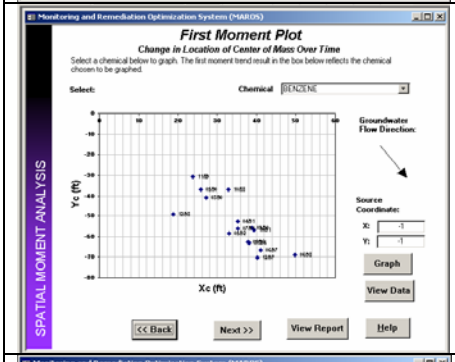
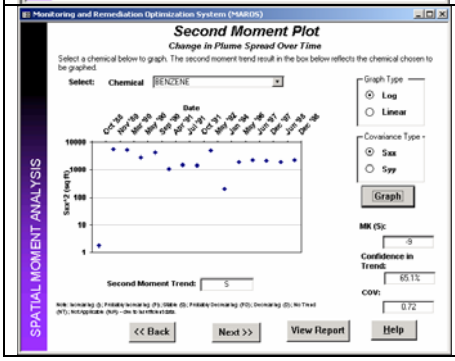
Activity 5

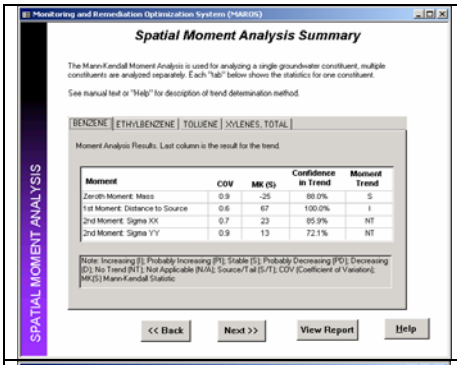
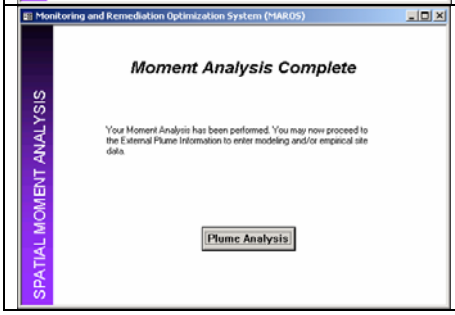
Plume Analysis	
Statistical Plume Analysis	
	**1) Plume Analysis Menu Step 3b** Choose ‘Statistical Plume Analysis Step 3b.’
	**2) Mann-Kendall Statistics** Explore the window. Choose ‘Next’.
	**3) Mann-Kendall Plot** Choose a well and a chemical. Choose ‘Graph’. Choose ‘Next’.

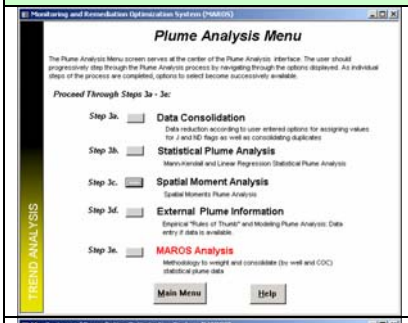
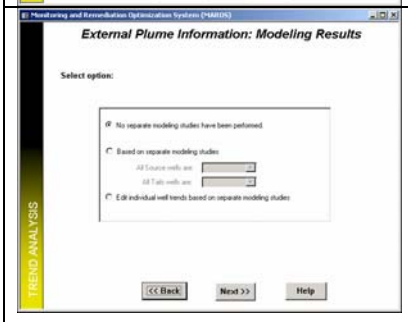
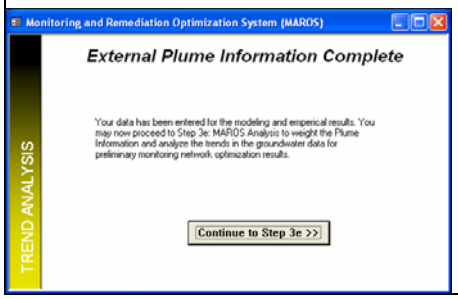
		**4) Linear Regression Statistics** Explore the window. Choose 'Next'
		**5) Linear Regression Plot** Choose a well and a chemical. Choose 'Graph'. Choose 'Next'.
		**6) Trend Analysis Summary** Explore screen. Choose 'Next'.
		**7) Statistical Analysis Complete** Choose 'Continue to Step 3c'.

Activity 6

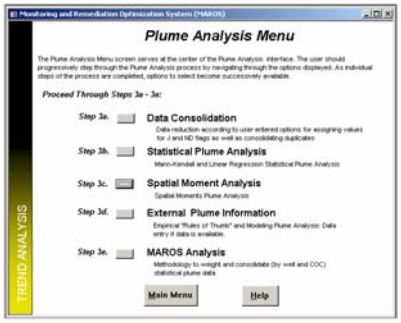
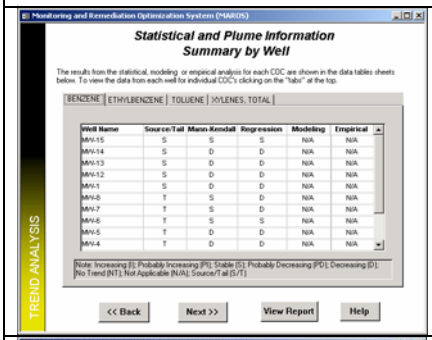
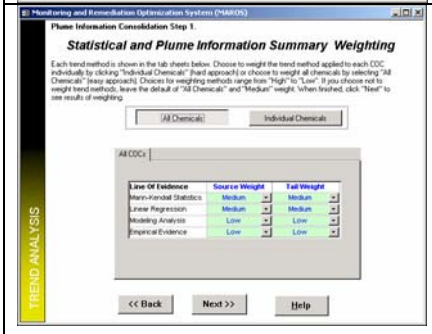
Plume Analysis	
Moment Analysis	
	**1) Plume Analysis Menu** Choose ‘Spatial Moment Analysis’.
	**2) Moment Analysis Site Details** Choose ‘315 ‘SE’ from the Groundwater Flow Direction drop down box. Enter ‘0.3’ in the Porosity box. Enter ‘Single Source’ with X = -1 and Y= -1. Choose Uniform Saturated Thickness and enter ‘12’ in the box. Choose ‘Next’.
	**3) Spatial Moment Analysis Results** Explore screen. Choose ‘Next’.

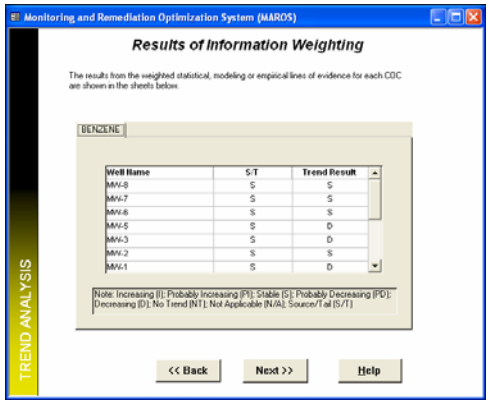
		**4) Zeroth Moment Plot** *Illustrates trend in total mass over time using Mann-Kendall approach.* Choose chemical, linear or log type graph. Choose 'Graph'. Explore screen and choose 'Next'.
		**5) First Moment Plot** Illustrates trend in center of mass over time using Mann-Kendall approach. Choose chemical, linear or log type graph. Choose 'Graph'. Explore screen and choose 'Next'.
		**6) First Moment Plot Visualization** Illustrates location of center of mass over time. Explore screen and choose 'Next'.
		**7) Second Moment Plot** Choose chemical, log or linear scale and data from the X (Sxx) or Y (Syy) direction. Choose 'Graph'. Explore the screen and choose 'Next'.

		**8) Moment Analysis Summary** Summarizes Trend analysis of zeroth, first and second moments. Explore screen and choose 'Next'.
		**9) Moment Analysis Module Complete** Continue to Step 3d.

Plume Analysis	
External Plume Information	
	**1) Plume Analysis Menu** Choose External Plume Information Step 3d
	**2) Modeling Results** If you have trend modeling results from an independent analysis, enter them here. Choose ‘No separate modeling studies’. Choose ‘Next’. Explore ‘See Empirical Evidence’ and choose ‘Next’.
	**3) External Plume Information Complete** Continue to Step 3e.

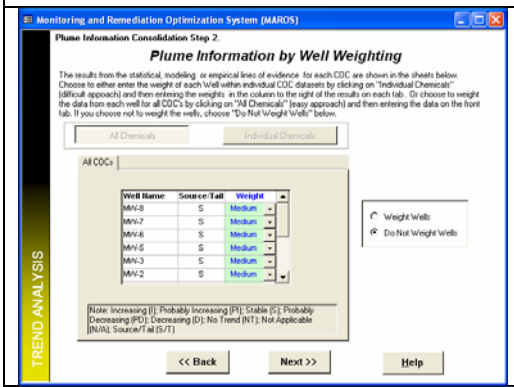
Activity 7

Plume Analysis	
MAROS Analysis	
	**1) Plume Analysis Menu** Choose 'MAROS Analysis Step 3e'. The MAROS module allows the user to weight trend results for different wells and chemicals, based on external information.
	**2) Statistical Summary** Explore screen and choose 'Next'.
	**3) Statistical and Plume Information Summary Weighting** Click on the drop down arrow under the "Source Weight" text box to the right of "Modeling Analysis". A list of choices will appear. Select "Not Used". Repeat for the text box to the right ("Tail Weight") and for the two text boxes adjacent to "Empirical Evidence".



4) Results of Information Weighting

Explore screen and choose 'Next'.

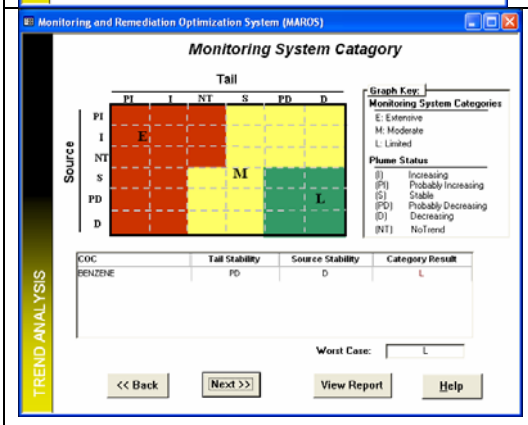


5) Plume Information by Well Weighting

Choose 'Do not Weight Wells'

This window allows the User to weight wells, by individual chemical or all chemicals.

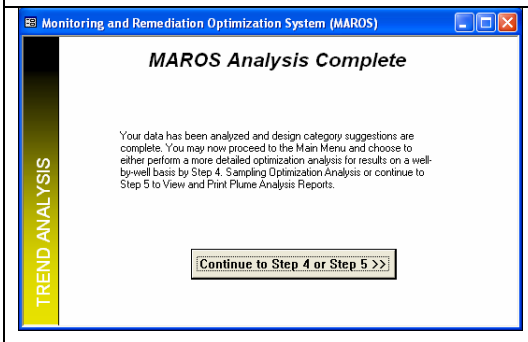
Choose 'Next'.



6) Monitoring System Category

This window presents a graphic illustration of the results for Overall Statistics for the plume. Like the Reports, this window can be printed or printed to Acrobat as a pdf file for inclusion in larger reports.

Choose 'Next'.



7) MAROS Analysis Complete

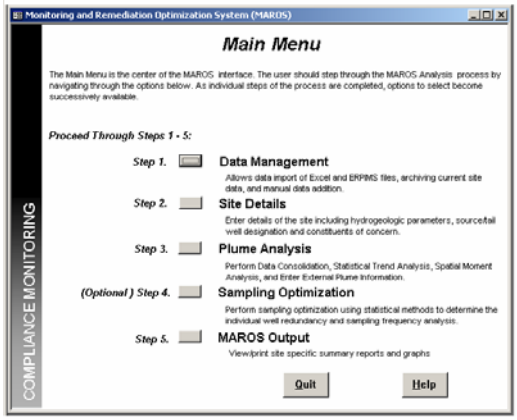
This screen concludes the initial 'Overall' Statistical analysis section of MAROS.

Choose 'Continue to Step 4 or Step 5'.

Activity 8

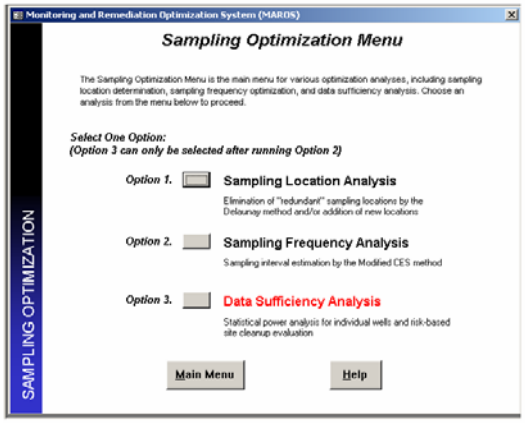
Sampling Optimization

Sampling Location Analysis



1) Main Menu

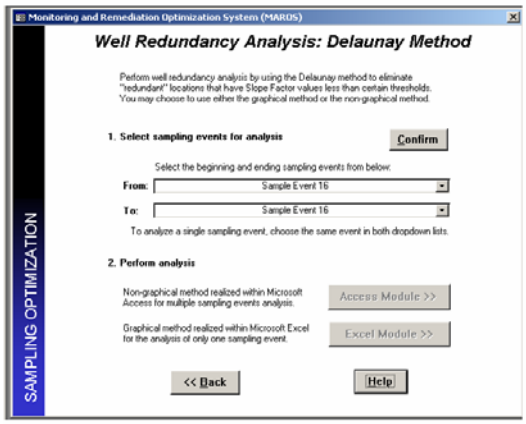
From Main Menu choose ‘Sampling Optimization (Optional) Step 4’



2) Sampling Optimization Menu

Choose ‘Option 1’ Sampling Location Analysis.

This module analyzes the network for redundant wells and for new locations that would better define the plume.



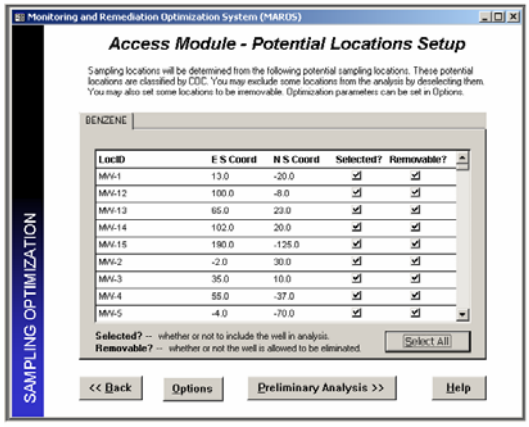
3) Well Redundancy Analysis: Delaunay Method

Under ‘From’ Choose Sample Event 10 and under ‘To’ choose Sample Event 16 from the drop-down box.

Select ‘Confirm’.

Choose ‘Access Module’.

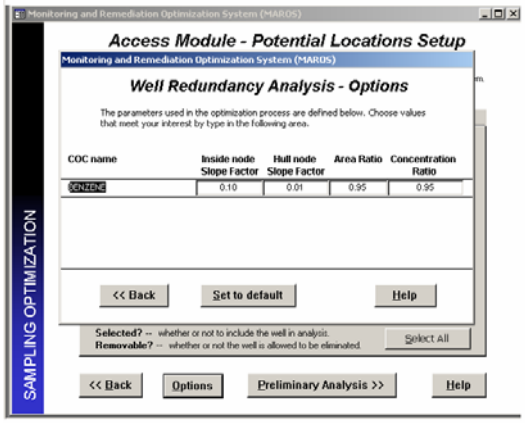
We will only be using 5 years of data for this analysis.



4) Access Module—Potential Locations Setup

This screen allows you to select wells to be considered for removal and to select parameters for the Delaunay Analysis.

Choose 'Options'.

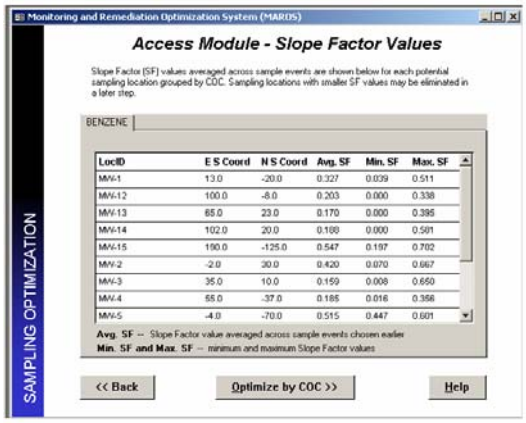


5) Redundancy Analysis Options

This window allows the User to set the parameters for Well Elimination Decision. AR = Area Ratio and CR = Concentration Ratio.

Set 'Inside Node Slope Factor' to 0.20.
Do not change other parameters.

Choose 'Back'.
Choose 'Preliminary Analysis' from the Access Module Screen.

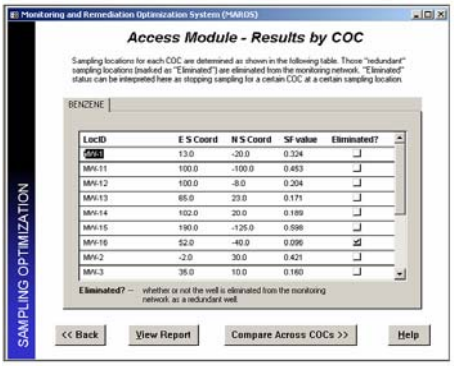
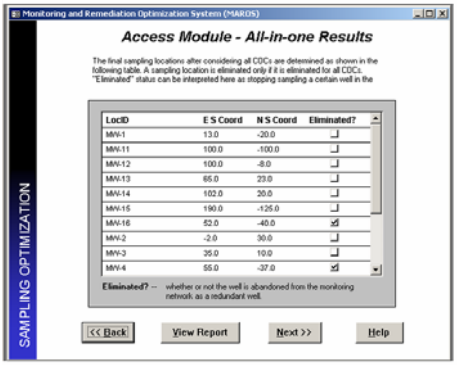
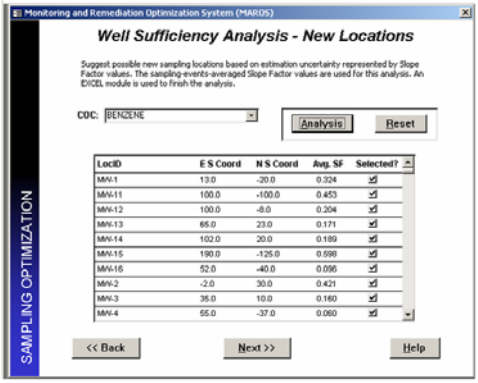
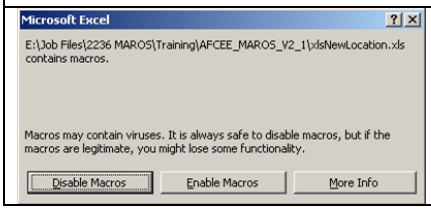


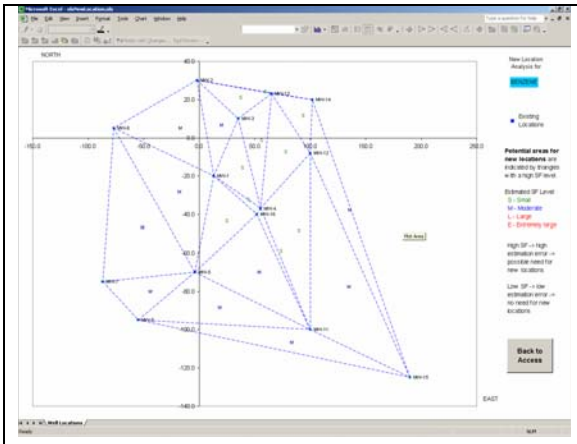
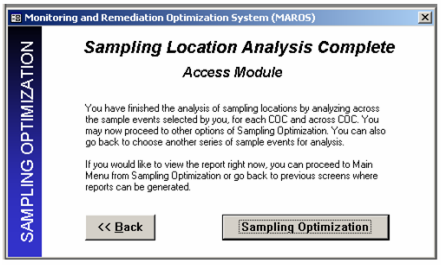
6) Slope Factor Values

This screen presents the Minimum, Maximum and Average Slope Factor Values for each well for the COC chosen. Low slope factors (~0) indicate a well may be removed without loss of information.

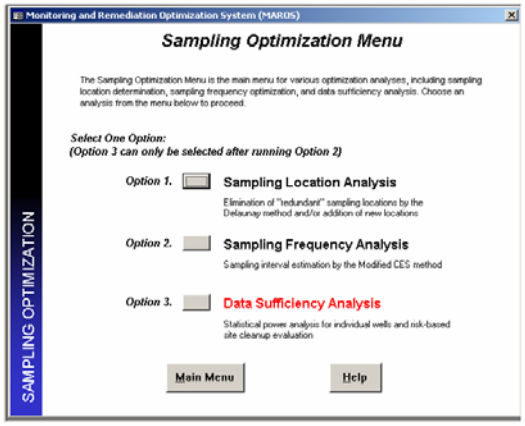
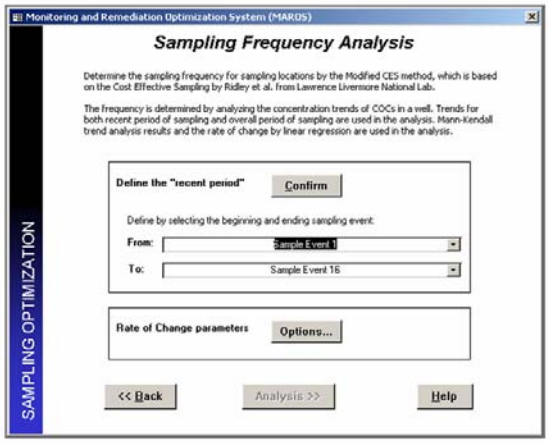
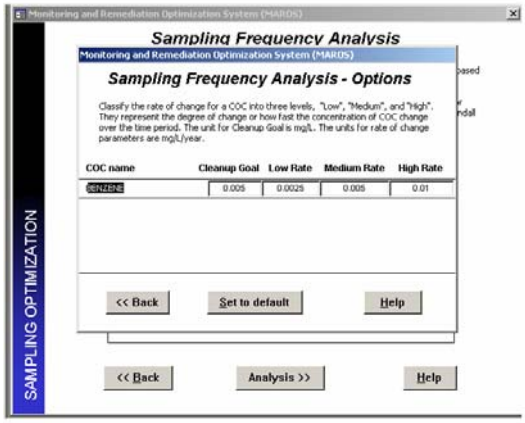
Look over the data. Find the wells with the lowest SF.

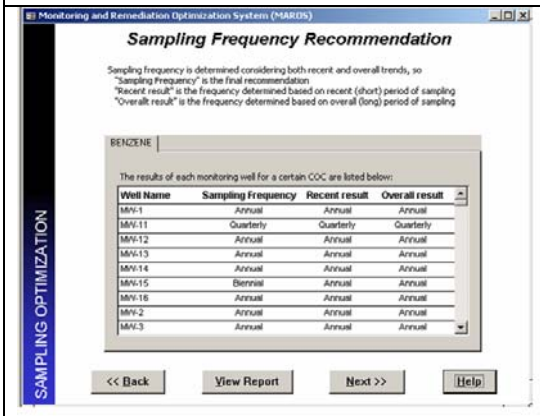
Choose 'Optimize by COC'.

	**7) Redundancy Results** *The screen indicates which wells could be removed with no apparent loss of information.* Explore the screen. Choose 'Compare Across COCs'**.**
	**8) Redundancy Results—Across COCs** *The screen indicates which wells could be removed with no apparent loss of information considering all of the COCs in the analysis.* Explore the screen. Choose 'Next'**.**
	**9) Well Sufficiency – New Locations** *The Delaunay Analysis is now used to suggest possible locations for new wells. This module uses Excel to visualize the results. The Excel file uses Macros to do the analysis, so the computer security setting should be 'Medium'. Other Excel applications should be closed before using this module.* Choose 'Benzene' as the COC. Choose 'Analysis'**.**
	**10) Excel Dialog Box** Choose 'Enable Macros'. *Excel will launch xlsNewLocation.xls.*

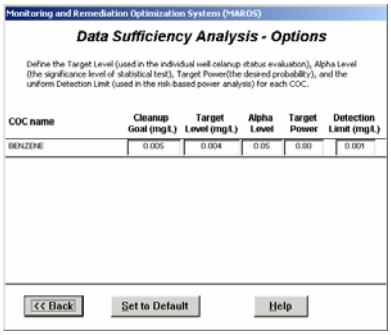
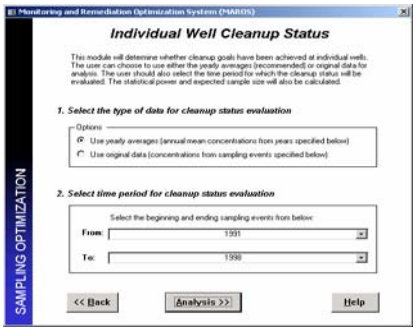
	**11) Excel Well Sufficiency Diagram** *Areas with Extremely Large uncertainty are suggested locations for new wells. A good choice would be to put the well in the center of the triangle, but this is not always possible.* *Areas with Large uncertainty may also benefit from a new well or increased monitoring frequency.* *The User may choose 'Save As' and save the diagram under a new name or, the file can be printed to Acrobat and saved as a pdf.* Choose 'Back to Access' or close application.
	**12) Sample Location Analysis Complete** Choose 'Sampling Optimization'.

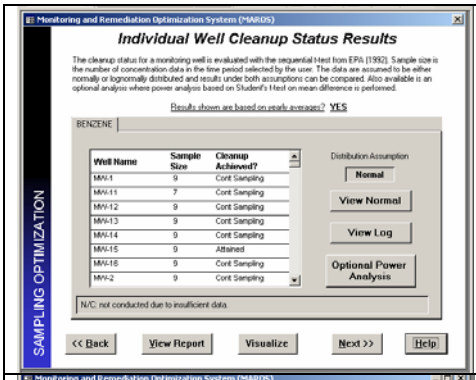
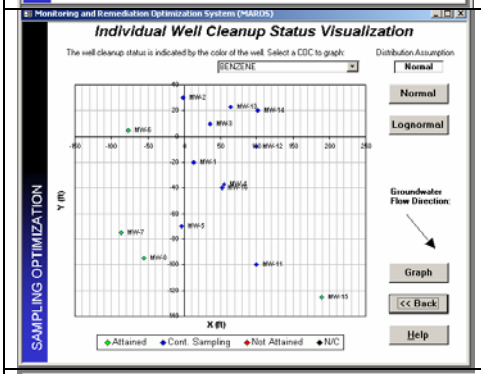
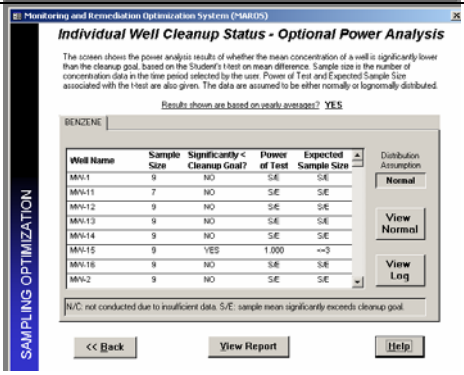
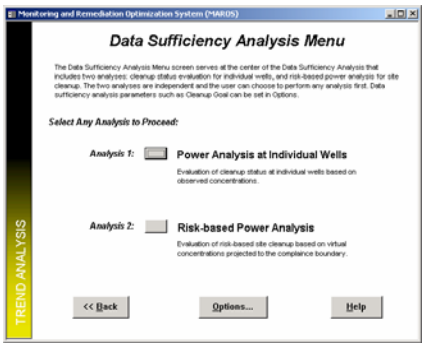
Activity 9

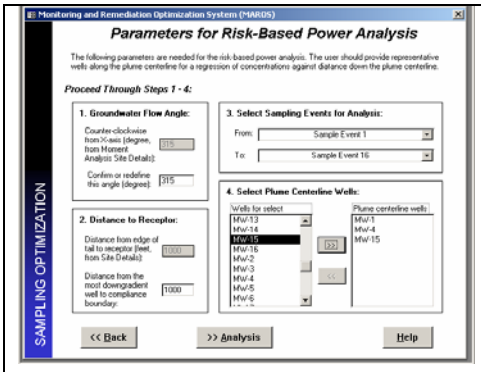
Sampling Optimization	
Sampling Frequency Analysis	
	**1) Sampling Optimization Menu** From the Sampling Optimization Menu Choose 'Sampling Frequency Analysis'. *The Frequency Analysis Module recommends temporal sampling intervals based on a modified Cost Effective Sampling Algorithm.*
	**2) Sample Frequency Analysis:** Under 'From' choose Sample Event 10 from the drop-down box. Under 'To' choose Sample Event 16. Choose 'Options.
	**3) Sample Frequency Options** *This window allows the User to choose the remedial goal and define significant rates of concentration change for each COC.* Choose 'Set to default'. Choose 'Back'. Select 'Confirm' from the Sampling Frequency Analysis menu. Choose 'Analysis'.

	**4) Sample Frequency Recommendations** *This window presents the results of the modified CES analysis of sample frequency.* *The 'Sampling Frequency column represents the final frequency after considering recent and long-term trends.* *Note: All Frequency recommendations must be reviewed to check for non-detects, values below regulatory levels, and length of monitoring history.* Choose 'Next'.

Activity 10

Sampling Optimization	
Data Sufficiency Analysis	
	**1) Sampling Optimization Menu** Choose 'Data Sufficiency Analysis'. *The Data Sufficiency Analysis uses rigorous statistical methods to confirm wells that have attained regulatory limits for cleanup and projects cleanup for the plume*.
	**2) Data Sufficiency Analysis Menu** Choose 'Options'. *The 'Options' menu allows the user to select parameters for the statistical analysis.*
	**3) Data Sufficiency Options** *The User can choose the statistical parameters such as power and statistical significance values used in the analysis.* Choose 'Set to default'. Choose 'Back'. Choose 'Power Analysis at Individual Wells' from the Data Sufficiency Menu.
	**4) Individual Well Cleanup Status** Choose 'Yearly Averages'. Choose the data range for the analysis, 1991-1998. Choose 'Analysis'.

	**5) Individual Well Cleanup Status Results** Results of the sequential t-test to determine cleanup status of well. Choose 'Visualize'.
	**6) Individual Well Cleanup Status** *This screen shows the statistical results of each well in the monitoring system.* Choose 'Back'. Choose 'Optional Power Analysis' from the Cleanup Status Results Screen.
	**7) Individual Well Cleanup Status—Optional Power Analysis** The Power Analysis estimates the number of samples needed to provide statistical support for attainment of the remedial goal. Choose 'Back' to return to the Individual Well Cleanup Status Results then choose 'Next'. Go to the Data Sufficiency Analysis Menu.
	**8) Data Sufficiency Menu** Choose 'Risk-based Power Analysis'. *The Risk-Based Power Analysis analyzes the well network to assess concentrations at a downgradient Hypothetical Statistical Compliance Boundary.*

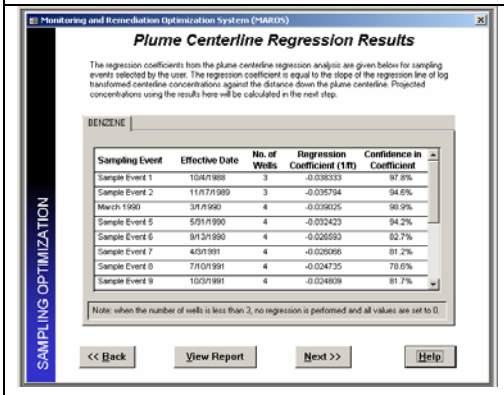
<table>
<tr>
<td> 
</td>
<td>9) Parameters for Risk-Based Power Analysis

Check the groundwater flow angle, it should be 315.

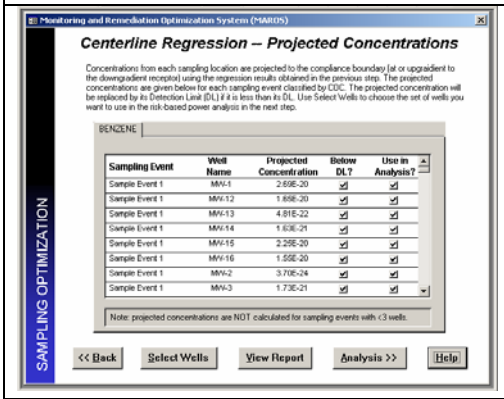
Distance to the downgradient receptor should be 1000.

Include all sample events.

Choose centerline wells: MW-1, MW-4, MW-11 and MW-15

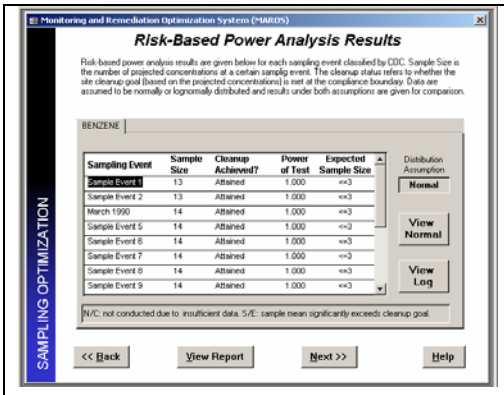
Choose ‘Analysis’</td>
</tr>
<tr>
<td> 
</td>
<td>10) Plume Centerline Regression Results

This screen displays the results of the regression of centerline wells for each sample event along with the confidence in the trend.

Choose ‘Next’.</td>
</tr>
<tr>
<td> 
</td>
<td>11) Projected Concentrations

This screen shows results of projected concentrations at the receptor point calculated for each well and sample event using regression results from the previous screen.

Explore the screen and choose ‘Analysis’.</td>
</tr>
</table>

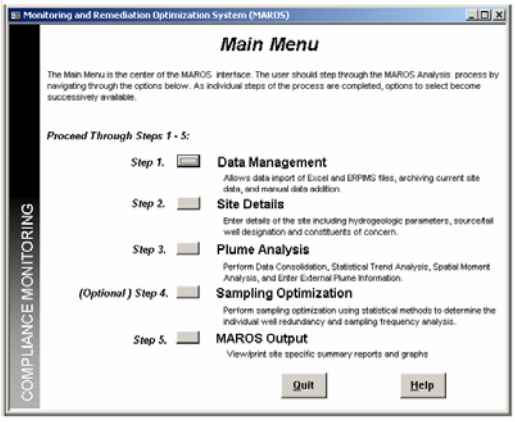
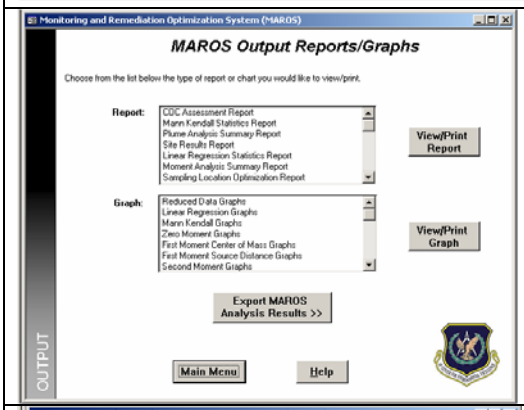


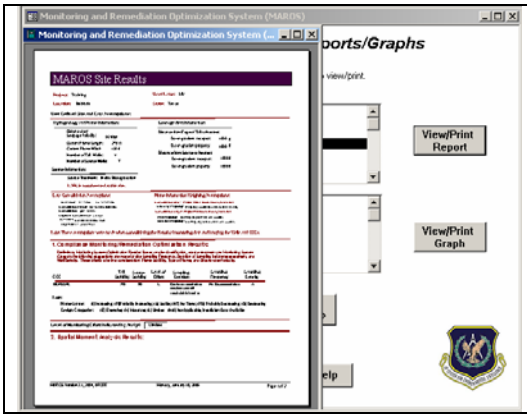
12) Risk-Based Power Analysis Results

The cleanup status refers to whether the plume cleanup goal (based on the projected concentrations) is met at the compliance boundary.

Explore the screen and choose 'Next'.
Choose 'Data Sufficiency Analysis Menu'
Choose 'Back'
Choose 'Main Menu'

Activity 11

MAROS Output	
	**1) Main Menu** To see all of the reports generated, Choose 'MAROS Output Step 5' from the Main Menu.
	**2) MAROS Output Reports** *The User can View or Print MAROS Reports and Graphs from this screen. Reports and graphs are not saved with the Output or Archive files.* Choose 'Export MAROS Analysis Results'.
	**3) Export MAROS Analysis Results** *Browse for a file folder and choose a name for your Output file. Output files can be handled like any Access database to create tables.* *Note: Never confuse your Archive file with your Output file—if you try to import an Output file MAROS will crash.* Choose 'Create'. Choose 'Back'



4) Browse through the reports and graphs.

The reports can be printed or saved as pdf files using Acrobat.

Hint: The underlying tables, forms and programming of MAROS can be viewed at any time by using the 'F11' function key.