



CARStat 2.1.8

compliance assessment remediation statistics

DEMONSTRATION GUIDE

CARStat

Demonstration Guide

Version 2.1.8

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CARStat Overview 1

What is CARStat?

CARStat can share database and facility information with DUMPStat for a truly comprehensive, integrated solution.

Statistical methods for detection monitoring have been well studied in recent years (see Gibbons, 1994a, 1996; Davis and McNichols, 1994; USEPA 1992; and ASTM Standard D6312-98, formerly PS64-96). Although equally important, statistical methods for assessment sampling, ongoing monitoring and corrective action sampling and monitoring have received less attention.

The CARStat computer program provides the first completely integrated statistical analysis system that can be used to evaluate data collected as part of assessment monitoring and corrective action programs for environmental sampling of soil, groundwater, air, surface water, and waste streams. CARStat uses a common database and a similar user interface to the DUMPStat program (Gibbons, 1994b), which provides automated solutions for groundwater detection monitoring.

One may ask why statistical analysis is necessary in assessment and corrective action monitoring. Why not simply compare each measurement to the corresponding criterion? There are several reasons why statistical methods are essential in assessment and corrective action sampling programs. First, a single measurement indicates very little about the true concentration in the sampling location of interest, and with only one sample there is no way of knowing if the measured concentration is a typical or an extreme value. The objective is to compare the true concentration (or some interval that contains it) to the relevant criterion or standard. Second, in many cases the constituents of

interest are naturally occurring (*e.g.*, metals) and the naturally existing concentrations may exceed the relevant criteria. In this case, the relevant comparison is to background (*e.g.*, off-site soil or upgradient groundwater) and not to a fixed criterion. As such, background data must be statistically characterized to obtain a statistical estimate of an upper bound for the naturally occurring concentrations so that it can be confidently determined if on-site concentrations are above background levels. Third, there is often a need to compare numerous potential constituents of concern to criteria or background, at numerous sampling locations. By chance alone there will be exceedances as the number of comparisons becomes large. The statistical approach to this problem can ensure that false positive results are minimized.

All statistical modules were written by Dr. Robert Gibbons.

CARStat is an easy-to-learn system for performing state-of-the-art environmental statistical monitoring analyses. Its methodology is based on the research and work of Dr. Robert Gibbons. Its statistical procedures balance both false positive and false negative rates for the entire facility and offer complete consistency with USEPA Subtitle C and D regulations, and all USEPA guidance, and ASTM D6312-98.

CARStat can merge in data sets of any size, and it maintains the information in a site-specific database. When subsequent monitoring events occur, the data are simply appended to the database and analyses can be performed at a click of your mouse.

Why use CARStat?

- Users need not understand the complexities of environmental statistics in order to produce statistically rigorous analyses.
- Both site-wide false positive (indicating contamination where there is none) and false negative (missing contamination when it is present) rates are optimally balanced at minimal levels, computed via Monte Carlo simulation and displayed.

- Costly corrective action can be avoided through the use of better statistical screening in assessment and compliance monitoring.

CARStat allows you to group your sampling locations into potential areas of concern (PAOCs) and run Comparison to Background, Comparison to Standard and Natural Attenuation analyses. Results can be shown over time or by sampling location. You set the confidence levels you want and the type of distribution to fit the data to—or let the program automatically fit the data to the most appropriate distribution.

In addition to the statistical modules, CARStat also includes time series graphs, analytical data summary tables and electronic data exporting functionality to help you review and characterize your data.

Questions?

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1-877-374-7744 or
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Types of Analyses

Comparison to Background

After the analysis is complete, the results are available in tabular, graphical and worksheet forms.

If you select the Comparison to Background button, CARStat compares onsite/downgradient data to background concentration distributions obtained from offsite/upgradient locations using the current database. The analysis determines:

- Normal, lognormal, and nonparametric prediction limits computed from the offsite/upgradient data for individual onsite/downgradient measurements. **OR**
- The mean of a series of measurements collected from a single location. **OR**
- The mean of a series of onsite/downgradient locations for a specified time interval.

All computations are automatically conducted based on specifications from the Statistical Options item of the Settings Menu:

- Confidence levels of 90%, 95% and 99% can be selected.
- Prediction limits can be adjusted for various resampling protocols if required.
- For nonparametric limits, the focus is on individual onsite/downgradient measurements or the median onsite/downgradient measurement of one or more locations over time.
- If desired, data are also automatically tested for increasing and/or decreasing trends using Sen's nonparametric test.

Comparison to Background Statistical Power

If you choose the Statistical Power (for Comparison to Background) button, CARStat will compute the statistical power for your site as a whole, based on the comparison to background analysis results. It is necessary to run Comparison to Background analysis first as this analysis creates the input file required for the statistical power. During analysis, CARStat will:

After the analysis is complete, a line based on the six points is displayed on the statistical power chart.

- Determine the site-wide false positive rate (*i.e.*, the percentage of failures when the upgradient versus downgradient true mean difference equals zero).
- Determine the false negative rates for effect sizes ranging from 1 to 5 standard deviation units.

Comparison to Standard

After the analysis is complete, the results are available in tabular, graphical and worksheet forms.

If you choose the Comparison to Standard button, CARStat compares the onsite/downgradient data to a fixed regulatory standard (*e.g.* an ACL or MCL). The analysis is based on:

- Confidence limits for the mean, median, 90th, 95th or 99th upper or lower percentiles of the onsite/downgradient distribution.
- A required minimum of four onsite/downgradient measurements. This requirement can be satisfied with four samples from one location over time or four locations at one

point in time or any other combination yielding four independent measurements.

All computations are automatically conducted based on specifications from the Statistical Options item of the Settings Menu:

- ▶ Confidence levels of 90%, 95% and 99% can be selected.
- ▶ Normal, lognormal and nonparametric forms of the limits are available. In the nonparametric case, confidence limits are only available for percentiles of the distribution (*i.e.* median or 50th percentile and the upper percentiles, 90th, 95th and 99th). For the lognormal case, exact confidence limits for both the mean (Land, 1971) and median can be computed.
- ▶ Both lower (LCL) and upper (UCL) confidence limits can be selected. LCLs are used in assessment or compliance monitoring to determine if a standard has been exceeded whereas UCLs are used in corrective action monitoring to determine if a standard has been achieved.
- ▶ The data are also automatically tested for increasing and/or decreasing trends if desired using Sen's nonparametric test.

CARStat indicates if remediation efforts are making the situation better or worse by testing for increasing or decreasing trends in the measurements

Comparison to Standard Statistical Power

If you choose the Statistical Power (for Comparison to Standard) button, CARStat will compute the statistical power for every combination of constituent and location, based on the comparison to standard analysis results. It is necessary to run the comparison to standard analysis first as this analysis creates the input file required for the statistical power.

Comparison to Standard statistical power charts show one of two things, depending on the "Type of Confidence Limit" selection on the Standards tab of the Statistical Options dialog.

When Upper Confidence Limit (UCL) is selected, the power chart shows the likelihood that the UCL of the mean will be below the regulatory standard, for the various values of the true mean concentration shown on the horizontal axis. For Lower Confidence Limit (LCL), the chart shows the likelihood that the LCL of the mean will be above the regulatory standard for different values of the true mean concentration. The concentrations shown on the horizontal axis are expressed both as a fraction of the regulatory standard and in natural concentration units.

Natural Attenuation

CARStat determines if concentrations have significantly increased or decreased relative to the background time-period for a particular location. The analysis is based on a prediction interval computed from the background data for that location and applied to the individual new measurements from that same location. Values below the lower prediction limit are indicative of a significant improvement in quality whereas values above the upper prediction limit are indicative of a significant degradation. The data are also automatically tested for increasing and/or decreasing trends if desired using Sen's nonparametric test.

Time Series

Time Series graphs will also display significant increasing and/or decreasing trends if you select the appropriate Test for Trends checkboxes on the Common card of Statistical Options.

If you choose the Time Series button, CARStat will generate a series of graphs plotting the results over time from the records matching:

- Constituents specified in the Select for Time Series item of the Constituents Menu. **AND**
- Locations specified in the Select for Time Series item of the Locations Menu.

Analytical Data Summary

The data summary can group samples taken over several days or weeks as a single event. See [Select Summary Dates](#) on the Settings Menu for more information.

If you choose the Analytical Data Summary button, CARStat will create a series of tables based on the locations, constituents and dates you have selected. You can easily change the way the table is ordered by selecting [Data Summary Layout](#) on the Settings Menu. CARStat will show you a preview of the tables (displaying a sample of real data) and you can alter which items to use as the column or row headings.

Getting Started 2

Hardware & Software

To run CARStat you must have certain hardware and software installed on your computer.

- ▶ An IBM®-compatible machine with a Pentium® processor or higher.
- ▶ A hard disk with at least 30 megabytes of available space. More may be required if your system does not already have Microsoft® database access components installed.
- ▶ 8 megabytes of system memory.
- ▶ A CD-ROM drive.
- ▶ Windows® 95, 98, Me, NT 4.0, 2000, or XP.
- ▶ A mouse or other pointing device is recommended.
- ▶ A Windows-compatible printer is recommended. CARStat supports both color and monochrome printers.

Installation

Removing CARStat

If you wish to remove CARStat from your computer, use the Add/Remove Programs item from Control Panel (found in the Settings option from the Start Menu).

CARStat is installed on your computer using the program INSTALL.EXE. The install program installs CARStat itself, the statistical processing modules, the support files, and the online help system from the CD-ROM to your hard disk.

Important

Windows requires that two additional components be available for CARStat work properly. If the installation program detects the absence of one or both of these components, it will install them for you. Simply follow the instructions provided on the screen during the installation process—and be patient! Do not reboot your computer until you are told to do so. Leave the CD-ROM in the drive while the system reboots, and if the installation program doesn't continue on its own after the reboot, just start it again and it will pick up where it left off.

To install CARStat:

1. Shut down all Windows applications that are running.
2. Insert the CD in your CD-ROM drive (in this case we assume it to be Drive D).
3. From the Start Menu, choose Run.
4. Type **d:\install** and follow the instructions on the screen.

In addition to CARStat itself, the installation program can install:

- CARStat file converters. These programs, DUMPMate and GritConv, convert CARStat site files to a format readable by GRITS/STAT and vice versa.
- Adobe® Acrobat® Reader. Acrobat Reader is required to view the User's Guide PDF and, once you've registered, the Statistical Guide PDF. These are both accessible from CARStat's Help Menu.

If you do not have Acrobat Reader installed on your computer, the box will be checked automatically. However, both of these components are optional, and you may proceed with both boxes unchecked if you wish.

Using CARStat

Starting the Program

To start CARStat, choose 'CARStat' from the CARStat Folder in the Programs Folder in the Start Menu.

Please keep in mind that this booklet merely outlines the basic information required to use CARStat. For more details, consult the online help system or the User's Guide PDF. Both of these reference all aspects of CARStat, and can be accessed through the Help Menu. Within the Help Menu, you may search for specific topics with the Help Search tool or you may press F1 to get context-sensitive help in CARStat or its viewers.

Help Contents

For information on Help topics choose Contents from the Help Menu or press F1 and click on the Contents button. You can use the Contents screen to jump to items in the CARStat menus.

Help Search

If you need help on a topic, but don't know specifically what menu it falls under, you can find it by searching for its keywords.

1. Click on the Search button from any Help topic window or choose Search for Help On from the Help Menu.
2. In the Search dialog box type a keyword or select one from the list by scrolling up or down. Press ENTER or click on Show Topics (or Display) to display a list of topics related to the word(s) you specified.
3. Select a topic name and then press ENTER or click on Go To (or Display) to view the topic.

Context-Sensitive Help (F1)

All the menu items, dialog screens and some of the entries on those screens contain context-sensitive help. Context-sensitive means you can get help on topics directly without having to go through the Help Menu. For example, if you want further information on an item listed in a menu, highlight the menu item and press F1. Information on that menu item will be immediately displayed. If you open Help topics in this manner you still have access to the Help functions listed above.

Loading the Demonstration Site

CARStat comes with a predefined demonstration site that allows you to become familiar with some of its features. A complete set of analyses has already been prepared for this site, and you may view the output by opening any of the companion viewers.

To load the demonstration site:

1. Click on Load Another Site from the Site Menu.
2. Click on Predefined Demo Data.
3. Click on OK.

You may now view the various settings for this site by accessing the different menu items. You may also view the analysis results that have been prepared for this site.

Viewing Output

CARStat comes with four related companion applications which allow you to view and print the results of statistical calculations. The Graph, Table, Worksheet, and Statistical Power Chart Viewers can be accessed through CARStat itself, or independently through the Windows desktop.

Viewer buttons



Graphs



Tables



Worksheets



Statistical Power

To start a viewer:

- ▶ Select the type of viewer from the Functions Menu of CARStat. **OR**
- ▶ Click on the viewer button on the CARStat toolbar. **OR**
- ▶ Click on the desired viewer in the CARStat Folder under Programs on the Start Menu (depending on your version of Windows). **OR**
- ▶ Double click on the viewer button beside an analysis on Perform Analyses to directly open the viewer with the results for that analysis.

The analyses' results remain available for viewing even after you exit CARStat or a viewer. However, some operations in CARStat will result in your output being automatically cleared:

- ▶ Merging new data
- ▶ Editing your data
- ▶ Changing any of the statistical settings

If one of the analyses listed is grayed out, then that particular analysis has not been run since your settings were altered.

Using a viewer:

- ▶ Selecting Open from the File Menu of any viewer allows you to choose which analysis result you want to view. You may have the results for several analyses open at a time in any viewer.
- ▶ The appearance of the output, both on screen and on your printer, can be controlled through options found in the File Menu of each viewer.
- ▶ Some analyses produce many pages of output. You can move through these pages either by using the scroll bars displayed on screen or by using items found on the Navigate Menu.
- ▶ If you have opened multiple results within the same viewer, you can use items found on the Window Menu to display all the results.
- ▶ To close the active analysis results, select Close from the File Menu. This will not shut down the viewer itself.
- ▶ To shut down the viewer, select Exit from the File Menu.

Graph Viewer

You may choose to restrict the display and printing to 'interesting' graphs (labeled Significant Differences). These include, but are not limited to, exceedances, verified exceedances, and trends in background.

A graph is a pictorial representation of the concentration of a constituent over time, or as part of a group, which may be compared to a standard or limit. Also represented on the graph is the time period over which the background characteristics of the concentrations were determined if applicable. Exact values for points and lines on graphs can be found in the appropriate tables.

Table Viewer

A tabular analysis result may contain a single table or a series of tables which give detailed results based on statistical calculations and/or queries of the database. The rows of the table may be grouped by bands of color to indicate related items.

Worksheet Viewer

A worksheet is a series of calculations with accompanying explanations which describes which statistical methods were applied, which equations were used, and any constants or values 'looked up.' All intermediate calculations are shown so that you can follow along the process by which limits and other important values are determined.

Statistical Power Chart Viewer

Typically, an increase for a single constituent is accompanied by an increase in other constituents and/or locations making it easier to detect exceedances than would be expected from the values on the curve.

CARStat produces different types of statistical power charts for Comparison to Background and Comparison to Standard.

Comparison to Background

A single statistical power chart is produced for Comparison to Background, which shows the chance of detecting contamination at a single well for a single constituent, for effect sizes ranging from 1 to 5 standard deviation units above background. That is, if the concentration of a single constituent in a single well were to become elevated by the number of standard deviations above background shown on the horizontal axis, the curve shows how likely you would be to spot it. The values shown are somewhat conservative, as true exceedances tend to involve more than one well and constituent, and so are more likely to be detected. The false negative rate is the likelihood that a genuine elevation of concentration of the size shown on the horizontal axis will not be identified by CARStat, and can be read off the chart as 100% minus the power for a given exceedance size. The false positive rate is the likelihood of CARStat reporting an exceedance when the true mean difference equals zero, and is read off the graph as the percentage where the curve intersects the y-axis (zero effect size).

Comparison to Standard

Multiple statistical power charts are produced for Comparison to Standard, corresponding to every combination of constituent and location (Fig. 11-7). Comparison to Standard statistical power charts show one of two things, depending on the "Type of Confidence Limit" selection on the Standards tab of the Statistical Options dialog. When Upper Confidence Limit (UCL) is selected, the power chart shows the likelihood that the UCL of the mean will be below the regulatory standard, for the various values of the true mean concentration shown on the horizontal axis. For Lower Confidence Limit (LCL), the chart shows the likelihood that the LCL of the mean will be above the regulatory standard for different values of the true mean concentration. The concentrations shown on the horizontal axis are expressed both as a fraction of the regulatory standard and in natural concentration units.

Print Pre-Analyzed Output

You may print any analysis output which exists when you load the demonstration site. Analysis results that you create cannot be printed until you register the program. To restore the original output of the demonstration site, simply choose Restore Current Site from the Site Menu.

Evaluating CARStat 3

To try out CARStat with your own data you should first clear the current data from the CARStat database and then add in (or merge) your own data. At any time, you may reinstate the original demonstration site settings by selecting Restore Current Site from the Site Menu, or by loading the Predefined Demo Data site again.

To clear the database:

1. Choose Clear Database from the Database Menu.
2. CARStat will ask for confirmation twice before proceeding. At each prompt, click on Yes.

Now you are ready to add your own data.

Adding Your Own Data

Initially, you must have an ASCII file of the site's historical data. The structure, or data format, of this file is defined to CARStat, and then the file is merged into the database. Future samplings will be added to the database simply by merging each new ASCII file.

Included with the program are the files CASE1.DAT, CASE2.DAT, and CASE3.DAT, which are samples of a site's historical data and have been used to create the demonstration database. These files have been prepared in fixed column format. This format has been defined to CARStat via the Merge Data item on the Database Menu.

If the file is not present in the scrollable list, try looking in other directories, or use the list box to show additional file types.

To merge data files:

1. Choose Merge Data from the Database Menu.
2. Click on Select File to choose the file to merge.
3. Click on the name of your data file and click on OK to display the file.
The name of the selected file (including the path) is displayed in the Merge Data window. If the text exceeds the length of the field, you can scroll to the end of field using the arrow keys.
4. Look at the flow of your data to determine its format, and click on the appropriate radio button to set the segmentation style:
 - ▶ delimited
 - ▶ fixed columns

Delimited data

1. In a delimited data file each field in a record will be separated from surrounding fields by the use of one unique character.
 - a. Find the delimiting character within the data.
 - b. Choose that character from the delimiter box, or type it in if it does not appear in the selection.
2. Make sure the column headers are ordered correctly. You may change the order one of two ways:
 - ▶ By clicking and dragging the headers. **OR**
 - ▶ By entering the correct sequence in the Format Details dialog.
3. Select the correct date format from the Date Format box.
4. Choose the correct qualifier.
5. Select Ignore "TBK" Records if necessary.

Syntax check

The syntax check column checks each record's format.

- ▶ 'OK' and 'nondetect' statuses appear in black.
- ▶ Error messages appear in red. These indicate a formatting problem in one or more of the data fields.

6. Scroll through the syntax check column to search for error messages, and check those records that have been flagged. Most errors are self-explanatory, and can be easily fixed.
7. Click on Merge when you are satisfied with the format of your records. CARStat informs you of events as they occur during the merge; *e.g.*, if any new constituents or sample points are encountered, or if some records are invalid, *etc.*
8. If any action is required following these events, *i.e.*, setting aliases, enter unit equivalences, or reviewing leftover records, CARStat will prompt you accordingly.
9. When the merge process is complete, click on Close to leave the dialog box.

Fixed columns

1. Click on the black bar between the data window's horizontal scroll bars and drag it to the right. This allows more room to view all of the column headings.
2. The column headers can be moved to fit the corresponding columns by clicking in the heading area, holding, and dragging.
3. The column borders can be moved to the left or right by clicking on top of them, holding, and dragging.
 - a. Starting on the leftmost column, scroll down to find the widest entry in that column. This is how wide that column must be.
 - b. Widen the column (that is, drag the column border) to accommodate this entry.
 - c. Repeat for the rest of the columns, working from left to right.
4. The Qualifier column should be as wide as possible.
 - ▶ The qualifiers themselves can be quite short, and it may not be readily apparent that there are any qualifiers if the column is not wide enough to 'catch' them.

- ▶ Scroll through as much of the datafile as possible to look for any qualifiers, and adjust your columns accordingly.
 - ▶ Choose the correct qualifier.
5. Select the correct date format from the Date Format box.
 6. Select Ignore 'TBK' Records if necessary.
 7. If you have adjusted your column widths correctly, all or most of the records should be labeled 'OK' in the syntax check column, with the nondetects and ignores indicated. Scroll through the syntax column to search for error messages. Generally, these should be correctable by adjusting the column widths.
 8. Click on Merge when you are satisfied with the format of your records. CARStat informs you of events as they occur during the merge; *e.g.*, if any new constituents or sample points are encountered, or if some records are invalid, *etc.*
 9. If any action is required following these events, *i.e.*, setting aliases, enter unit equivalences, or reviewing leftover records, CARStat will prompt you accordingly.
 10. When the merge process is complete, click on Close to leave the dialog box.

Invalid records are saved to an automatically-named leftover records file.

The Database

The contents of the database can be viewed in two ways depending on your needs. Both allow you to choose the order in which records are shown and search for records based on either specific or general criteria. However, View Database shows (read-only) records individually while Edit Database provides a grid view of all records which can be edited as required.

However, if you wish to look at your records while using other dialogs, View Database can be left open.

Since Edit Database allows you to alter records, you cannot leave this dialog open on your desktop. You must complete your actions before moving on to other areas of CARStat.

View Database

To view or search the contents of the current database, select View Database from the Database Menu.

To view records using the data scroll control (labeled Lab Results):

- ▶ Click on the left or right inside arrow buttons to move backward or forward one record at a time.
- ▶ Click on the buttons at the extreme ends of the data scroll control to move directly to the first or last record.
- ▶ To change the order in which records are displayed, use the list box to indicate which field should be the major key (*i.e.*, sorted first). Then reset the middle and minor keys as required.

To search for specific records:

1. Enter the first few letters of the item you want search for in the Search Filter boxes. When entering dates, CARStat will provide a sample of what format the date should be entered in, *e.g.* mm-dd-yyyy.
2. Click on Update.

The records corresponding only to the search criteria will be selected by CARStat and can be viewed using the data scroll control.

To view all records after performing a search:

Click on Defaults. All records can now be viewed as before.

Edit Database

The database editor is displayed in tabular form. Field headings are displayed at the top of the table, and horizontal and vertical scroll bars will appear as needed.

To view or edit the contents of the current database, select Edit Database from the Database Menu. Note that the database editor cannot be minimized and left on the Windows Desktop. If you choose Edit Database, you must complete your editing actions before CARStat will allow you to move on.

All changes to the column display of records affect only that session of the grid viewer.

Using the grid viewer

- To change the order in which records (rows) are displayed, use the list box to indicate which field should be the major key (*i.e.*, sorted first). Then reset the middle and minor keys as required. The table is automatically reordered when changes are made to the ordering options.
- To change the order in which the fields (columns) are displayed, place the cursor over the column heading, depress the left mouse button, and drag the column to its new position.
- To change the width of a column, place the cursor anywhere on a vertical line on either side of the column. The cursor will become a double-sided arrow. Depress the left mouse button and drag the column boundary to its new width. If you make the column too small, it will 'disappear' from the grid. The column still exists, but you must exit and re-open the grid viewer to view it.

Using the editor

- To find a specific record or area in the database enter the first few letters of the item you want search for. Pressing the Find button will take you to the first record which matches or exceeds any combination of constituent, well, or date.
- To edit a record, including marking or un-marking a manual outlier, highlight the record and then click on Edit.
- To add a record, click on Add.
- To delete a record, highlight the record and then click on Delete.
- To display the log of all changes made to the database, click on Log.

Data Export/Print

CARStat allows you to export data from the database for use with other programs or for conforming with electronic reporting regulations in some states. You may choose a subset by constituents, sample points, a date range, or any combination of these. The data are output in a fixed column width ASCII text format, which is easily read into most spreadsheets. You may also choose to print the selection of data in a format similar to the tabular output. Choose Print/Export Records from the Database Menu.

The Monitoring Network

Constituents

We have provided an outline of the steps required to run any of the analyses or reports.

In order to operate, CARStat needs to know which constituents you want to use in your analyses. Your selections will remain intact for that site until you choose to change them.

To select constituents for analyses:

1. Choose Select for your desired analysis from the Constituents Menu. All selections operate in the same manner except for Select for Standards Comparison which is described later.
2. A constituent can be moved from the Available List to the Selected List by clicking on the desired constituent(s) in the Available List and then clicking on Add.
3. A constituent can be moved from the Selected List to the Available List by the same method; click on the desired constituent(s) in the Selected List and then click on Remove.
4. When you are satisfied with the Selected List, save the list by clicking on OK.

OR

If you have made changes to your Selected List and do not wish to save them, click on Cancel. A message will appear asking if you wish to save your changes. Click on No.

Locations

CARStat automatically remembers all of your preferences and settings. Each time you start the program it's just like you never left.

Comparison to Background

If you wish to perform a comparison to background analysis, CARStat needs to know which locations you want to use in your analysis and whether they reflect background locations, onsite locations, or both. Your selections will remain intact for that site until you choose to change them.

Unlike some of the other Available Lists, the items are not physically removed from the list once selected. Instead, the Available List reflects how a location has been defined by placing an indicator beside its name. A location in the Available List is marked with the designation of [B] if it is included in the Background List, [O] for the Onsite List, [&] for both, or [] for neither.

To select locations for Background to Comparison:

1. Choose Select for Background Comparison from the Locations Menu.
2. Move the desired locations to the Background List or the Onsite List by clicking on the location(s) in the Available List and click on the appropriate Add button.
3. A location can be removed from either the Background List or the Onsite List by the same method; click on the desired location(s) in either list and click on appropriate Remove button.
4. When you are satisfied with the lists, save them by clicking on OK.

OR

If you have made changes to your lists and do not wish to save them, click on Cancel. A message will appear asking if you wish to save your changes. Click on No.

Other Location Selections

Use the standard technique for defining the Selected Lists as described above for the constituents.

To perform the other analyses, CARStat needs to know which locations you want to use. Your selections will remain intact for that site until you choose to change them. Choose Select for the appropriate analysis from the Locations Menu.

Groups

Groups allow you to combine a series of locations into a single entity which contains all the sampling results of the individual locations that together constitute an area of interest or PAOC.

You can define an unlimited number of groups to fully characterize all of your PAOCs from initial investigation to fully refined.

To define a new group:

- 1.** Choose Define Groups from the Locations Menu.
- 2.** Click on New Group, enter a name of up to 16 characters for the group in the dialog which appears and click on OK.
- 3.** Select the desired location(s) from the Available Locations list and click Add.

To view the components of a group, including one you've just created, click on the picture to the left of the group you are interested in. The list of locations included in that group will appear below the group. If you wish to alter the group you may select an entry and click Remove. You can also remove an entire group using the Remove button. If you have made changes to your lists and do not wish to save them, click on Cancel. A message will appear asking if you wish to save your changes. Click on No. Once a group has been defined it can be selected just as any other individual location would be throughout the program.

Set Time Windows

With CARStat you can independently control the period of time used for establishing your background (that is, your benchmark) and the period of time over which to perform your comparisons. There are three separate time periods:

- ▶ Comparison to Background—indicates the period over which we are characterizing the site (*i.e.*, what is considered normal).
- ▶ Onsite/Downgradient—indicates the period over which you do the comparison. This period applies to both the Comparison to Background and the Comparison to Standards analyses.
- ▶ Natural Attenuation—indicates the period over which you would set the background for an onsite or downgradient (*i.e.*, impacted) location.

To set the time windows:

1. Choose Set Time Window from the Locations Menu.
2. Select the Time Period for Location that you wish to set a time window for. Make sure that it is the only list item highlighted unless you wish to set the same window for multiple selections.
3. Enter the appropriate dates for Start Display, Start Analysis and End Analysis.
4. Click on Update Selected Locations to copy the changes displayed on the detailed time bar to the selected/highlighted wells in the Time Periods for Locations box.
5. When you're happy with your settings, save the lists by clicking on OK

OR

If you have made changes and do not wish to save them, click on Cancel. A message will appear asking if you wish to save your changes. Click on No.

Time windows allow you to easily change from analyzing your site historically to a snapshot at any particular time.

Standards

A Comparison to Standard analysis cannot be performed until all selected constituents have been assigned MCLs or other appropriate regulatory criteria.

Constituents

If you wish to perform a Comparison to Standard analysis CARStat needs to know which constituents are to be assessed, **and** what standard concentration to use for each constituent (as defined by your state or other regulatory agency).

The Comparison to Standard constituent list reflects the status of the constituents as either unselected, selected with a standard, or selected without a standard. Selected constituents with no standard will have a red 'X' beside the constituent name. Selected constituents with a standard will have a green light beside the constituent name.

To select constituents for Comparison to Standard:

1. Choose Select for Standards Comparison from the Constituents Menu.
2. A constituent can be selected for analysis by clicking on the desired constituent in the Constituents List and then clicking on Select.
A constituent can be deselected by the same method; click on the desired constituent in the Constituents List and then click on Deselect.
3. Define the standard concentration for each selected constituent.
 - a. Click on the constituent and then click in the Standard box.
 - b. Type the number, then press the ENTER key.
4. When all desired constituents have been selected, save the list by clicking on OK.

OR

If you have made changes to your list and do not wish to save them, click on Cancel. A message will appear asking if you wish to save your changes. Click on No.

CARStat also allows you to set standards to comply with state or regional regulatory limits. The drop-down list boxes at the top of the dialog allow you to set all of your constituents to the mandated concentrations at once. The State list box is used to select the state or region from which the standard comes. Once the state has been selected by either tabbing off the control or pressing ENTER a list of available choices will be displayed for the selected State. This continues for Matrix, Land Use, Exposure and Author until an Author is selected. Once this has been selected the concentrations stored in the database for that standard are automatically applied to all of your constituents. Please note that if there is only one selection for the next step in the selection process that CARStat will automatically select it. This behavior will continue until an Author is automatically selected or a user selection is required. Once a new standard has been selected, the list boxes have their background colors set to white. A yellow background color indicates that at least one concentration has been changed from those defined by the displayed standard.

Standards Manager

But what if you would like to define a new standard or incorporate values from a local agency? CARStat includes a Standards Manager which allows you to define a new standard which contains the concentrations listed in the Standards dialog. Simply enter descriptors for all of the text entry boxes used to describe the standard and press Update Database Info. When you close the Standards Manager you will see that the newly defined standard is displayed in the list boxes at the top of the standards dialog.

The Standards Manager can also be used to import new standards from an ASCII text file. If you wish to incorporate a set of concentrations from a text file click Import Standard and follow the instructions below.

Importing

A standards file from a regulatory body can be incorporated into CARStat through the Standards Import function which is accessed through the Standards Manager described above. The Standards Import dialog is similar to Merge Data in what it does—importing values from a text file and Edit Database in how you use it.

A sample fictitious standards file (demo.std) is included with the CARStat installation.

The “CSV” selection correctly interprets files which not only use commas as delimiters but may also contain commas within each item. The items are enclosed within quotation marks to separate internal commas from delimiting commas.

To merge in a new standard:

1. Select the file you wish to import. The file must contain a constituent name, concentration, and unit on each line. The unit need not be the one used by CARStat for that constituent; the concentration will automatically be converted to the unit used by your database. If one has not already been defined, you will be prompted for a conversion factor.
2. Choose Fixed Column or Delimited for the format; if Delimited, choose the delimiter from the list box, or else enter your own.
3. Organize the columns until the field are segmented appropriately.
4. Click on Import to incorporate the values.

The columns can be manipulated as described for Edit Database on page 25 except that new columns can be created by double clicking to the right of the column where you wish to insert, and the three ‘titled’ columns have a minimum width of two characters—they cannot be completely hidden.

Once a set of standards has been imported you will return to the Standards Manager, where you can define that standard to CARStat and save all the concentrations to its database of standards.

Statistical Options

CARStat’s statistical options are found on the Settings Menu. You can alter these settings and rerun the analyses to see the

effect of your changes. To illustrate the consequences of these options, there are some sample exercises on page 37. Note that when you change the settings, CARStat will automatically erase all output. Therefore, we recommend that you follow the exercises in order (**before** you alter any settings in CARStat), as we have ensured that analysis results are available for viewing as required.

You can set values for ‘Common’ settings (applicable to all analyses), Comparison to Background, Comparison to Standard, and Natural Attenuation; just select the appropriate tab. The online help provides details on what effect each option has. Detailed statistical explanations are available in the CARStat Statistical Guide which is included with the licensed version of the software.

Performing Analyses

A brief description of each analysis begins on page 7.

With CARStat you can perform analyses in two ways, either individually or by running a group of analyses together. You choose which analysis or analyses to run from the Perform Analyses item on the Functions Menu. Each analysis is represented by a button. To run an individual analysis, simply double click on that button. Or, you may wish to set up a series of analyses to run with automatically-activated output viewers upon completion.

To set up multiple analyses with specifically-activated output viewers:

1. Choose Perform Analyses from the Functions Menu.
2. Click once on the buttons of the analyses you wish to have performed. All buttons can be depressed, even if the title appears grayed out. If the ‘go sign’ (the green light ●) appears, all the necessary steps have been taken to run that

particular analysis (*i.e.*, the monitoring network is defined, the statistical options completed, *etc.*).

3. If the green light does not appear on one of your selections, double click on that button. CARStat will state why the analysis cannot be run at this time.
4. If you wish, indicate the type of output you would like automatically displayed after the analyses are complete. Single click on the desired output button to the right of each analysis button. Output choices include graphical, tabular, worksheets and a statistical power chart.
5. In the Comprehensive frame, select As Marked to ensure that the output choices you have made are automatically shown upon completion of the analyses.
6. Click on the 'Do those with ●' button. All possible selected analyses will be run in sequence. The statistical power chart for Comparison to Background cannot be created until the preceding Comparison to Background analysis is run.
7. Click on Close or Cancel to leave the Perform Analyses dialog.

As the analyses are running, CARStat will show you which analysis in the sequence it is currently working on.

Perform Analyses can also be used to see which results are available and to act as a launch point for directly opening the viewers with the desired results. You can also access Print Results (see Print Pre-Analyzed Output on page 19) from this dialog.

Practice Exercises

4

Remember

When you alter any statistical settings in CARStat, all current output is erased.

Following are a few exercises that can be done with our sample database to illustrate some of CARStat's features and capabilities.

We recommend that you follow these exercises in order, as we have ensured that analysis results are available for viewing as required.

Comparison to Standard

Our first analysis is a comparison of monitoring data to a state-issued regulatory standard, where the data from individual sampling locations are compared location-by-location to that standard. At each location, the confidence limit for the mean is compared to that standard.

In assessment monitoring you typically compare the lower confidence limit for the mean against a standard to establish with a reasonable certainty if the true concentration exceeds a standard. In remediation or corrective action monitoring, you compare the UCL for the mean to a fixed regulatory standard. If the UCL is less than the standard we are now confident that the remediation has reduced the true concentration to a level that is below the regulatory standard.

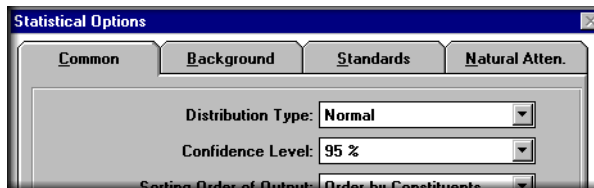
Exercise

In this example, the sampling data is considered to be normally distributed. You can let CARStat determine the distributional form automatically, or you can manually specify the distribution as normal, lognormal, or nonparametric.

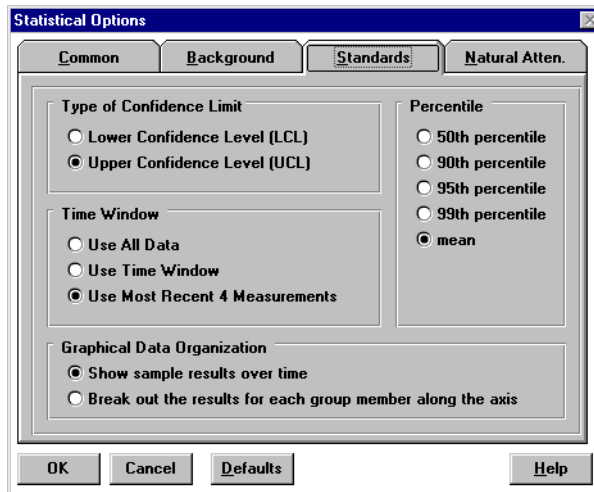
Note that for a symmetric distribution such as the normal, the mean and 50th percentile (median) are the same. This is not true for the lognormal distribution. For a nonparametric confidence limit, only confidence limits for percentiles exist.

CARStat allows you to compare the upper or lower confidence level for a percentile of the distribution to a state-issued standard. In this case we are in corrective action monitoring and need to determine if the true mean concentration is below the regulatory standard

1. Choose Statistical Options from the Settings Menu.
2. On the Common tab note that the Distribution Type is set to Normal and that the Confidence Level is 95%.



3. Click on the Standards tab to review the options for this specific analysis. The Type of Confidence Limit is Upper and the Percentile is the mean since we are testing to see if the true mean concentration is below the standard with 95% confidence. Click on Cancel.



You can also change the scaling of the vertical axis by clicking on the axis.

4. Rerun the Comparison to Standard analysis by double clicking on that button on the Perform Analyses dialog of the Functions Menu.
5. Bring the Graph Viewer to the front by clicking on its entry in the task bar. The first entry Hex chrome for location HA1-ROW has large values for its samples and confidence limit.
6. Use the scroll bar at the bottom of the viewer window to view other graphs.
7. Try changing the vertical axis scaling to Logarithmic by choosing it from the Scaling options from the File Menu and observe how the axis labels change and the smaller values become easier to read.
8. Bring the Worksheet Viewer to the front and review the calculation of the confidence limit for each location and constituent. This limit is the thick green line on the graphs which exceeds the thin blue line of the standard.
9. Close the viewers and return to CARStat.

Comparison to Background

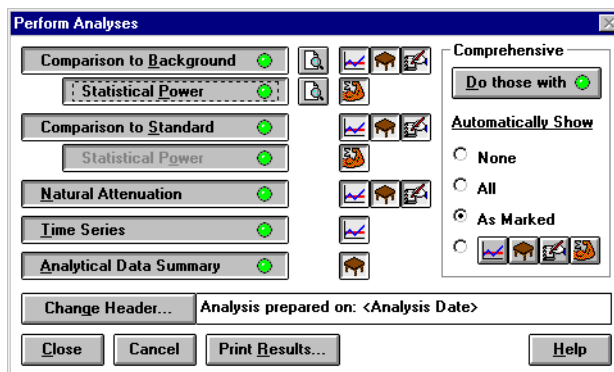
The demonstration site includes predefined groups, some of which have already been selected for the Comparison to Background analysis.

CARStat allows you to pool data that belong together when evaluating a potential area of concern (PAOC). Collections of sampling locations can be specified and named as a group using Define Groups found on the Locations Menu. Groups can be included in selection lists for analyses just like individual sampling locations. They also allow some additional statistical and output options.

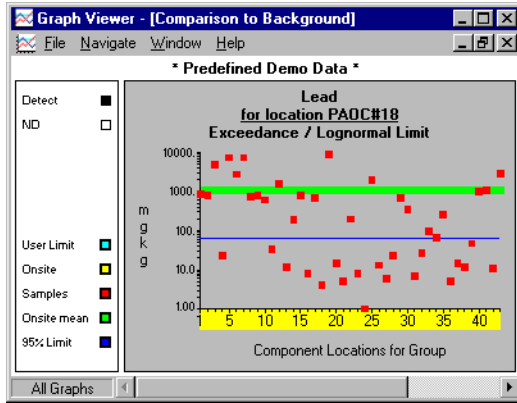
Exercise

This is an opportunity to see how CARStat can display samples at locations as collections of groups rather than as concentrations over time to help you characterize the spatial properties of your site.

1. Choose Statistical Options from the Settings Menu.
2. Change the Distribution Type to Best Fit on the Common tab.
3. Click on the Background tab and note that the Comparison Type is Onsite/Downgradient Mean indicating that the mean of the sample data for each group will be compared to a prediction limit for the mean computed from the background data. Click OK.
4. In the Perform Analyses dialog, single click on all the analysis buttons except for Comparison to Background and its Statistical Power so that only those two have the ● showing.

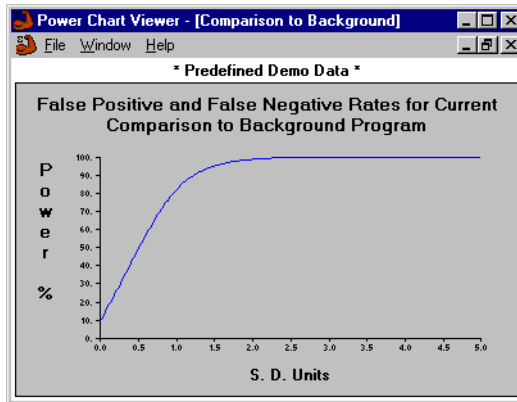


5. Click on the 'Do those with ●' button to rerun those two analyses.
6. Use the scroll bars to move between the displays for the two predefined groups in the graph and worksheet viewers.
7. The graph shows the mean concentration at each location plotted on the Y axis, with the sampling locations that make up each group along the X axis. To see the location name that goes with each number, right click on the axis itself. The onsite mean for the group is shown as a thick green line.



A good statistical power curve has a false positive rate ($X=0$) close to 5% and power of 90% or more at less than 4 standard deviation units over background ($X \leq 4$).

- Bring the Power Chart Viewer to the front and review the curve. It displays the effectiveness of your current settings. Select Statistical Power Chart Overview from the Power Chart Help Menu for a detailed explanation.



Examining and Defining Groups

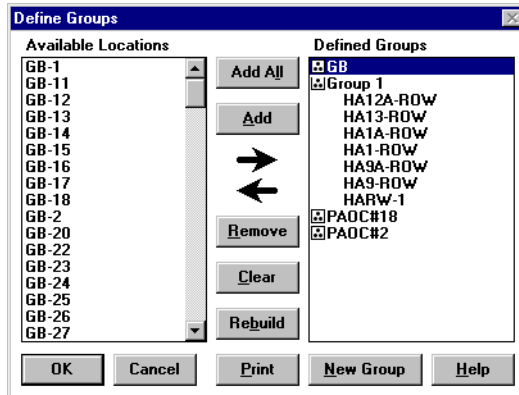
The groups of locations which were used in the previous exercise were easily defined in CARStat using Define Groups from the Locations Menu. In Define Groups you can quickly

define new groups or examine and edit the contents of existing groups.

Exercise

In this exercise you will add new groups, edit existing ones and see how to delete groups you no longer need. The Define Groups dialog contains list boxes similar to those used for selecting constituents and locations but has a little twist: the list of already defined groups appears on the right, each with a 'container' symbol (☐) beside it to indicate that it is a group with locations already specified.

1. Choose Define Groups on the Locations Menu.



2. View the component locations of Group 1 by clicking on the container symbol beside its name. The group members appear under the group's name. The container symbol also changes to indicate that you are viewing the contents.
3. Add a member to Group 1 by selecting it in the Defined Groups list, choosing the location HA12-ROW in the Available Locations list on the left and clicking Add. You'll see the new location appear under the selected heading on the right. HA12-ROW is not removed from the Available list, however, since a location may be a member of more than one group

The component locations of groups can be changed at any time and new groups can be added as required.

4. Delete a member from Group 1 by selecting HA13-ROW in the Defined Groups list under Group 1 and click Remove to remove it. For all future analyses involving Group 1 HA12-ROW will be included and HA13-ROW will not.
5. Create a new group by clicking on New Group and enter Group 2 in the text box which appears. After clicking OK, select HA12-ROW, HA12A-ROW, HA2-ROW and HARW-2 and click Add. You can click on the symbol next to Group 2 to expand the group for viewing.
6. Click on OK to save your newly defined and edited groups.
7. Choose Select for Natural Attenuation on the Locations Menu, add Group 2 to the Selected Locations list and click OK to save and exit.
8. Rerun the Natural Attenuation analysis by double clicking it in the Perform Analysis dialog from the Functions Menu. When the viewers launch you will see results for both Group 1 and Group 2.
9. Close the viewers and return to CARStat.

Importing Regulatory Standards

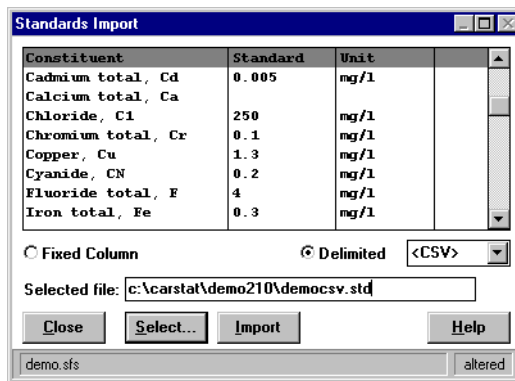
Complete sets of state standards will be available for purchase as optional components.

CARStat maintains a database of regulatory standards that you can select before running your analyses. Though it is possible to manually enter concentrations for each of the constituents, an import feature makes it easy to bring in lists of regulatory standards concentrations from a text file.

Exercise

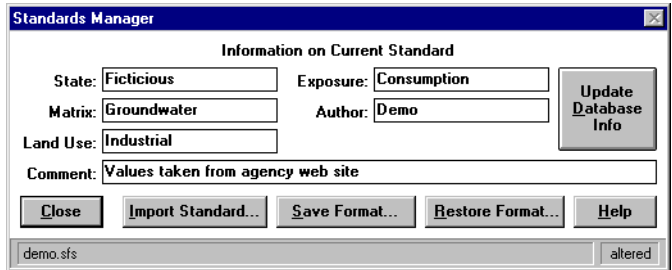
In this exercise you will import a text file containing regulatory standards. Such files may be available on the Internet or from state or other regulatory agencies.

1. Choose Select for Standards Comparison on the Constituents Menu.
2. Click on the Standards Manager button which opens a new dialog with data entry boxes to describe the current set of regulatory limits.
3. Click on the Import Standard button which opens the dialog where you select and import standards after checking/setting the format. To learn more about importing standards text files, click on Help.



4. Select the “Delimited” option button, and choose “<CSV>” from the drop-down list that appears. Click on Select.
5. In the Select Standards File to Import dialog, confirm that the current directory is the CARStat demo directory and select DEMOCSV.STD.
6. You should now see a preview of how the input file will be interpreted. Confirm that there are three columns, and that the Constituent column contains the names of analytes, the Standard column contains numerical values for the concentration limits, and that the “Units” column contains the units of measurement for the Standard. Note that not all constituents have limits defined for them.

-
- Click on Import and you will be returned to the Standards Manager to enter a description of your newly imported standard. Make the following entries: State = Fictitious, Matrix = Groundwater, Land Use = Industrial, Exposure = Consumption, Author = Demo, and any comment you wish.



The screenshot shows a window titled "Standards Manager" with a sub-header "Information on Current Standard". The form contains the following fields and buttons:

- State: Fictitious
- Exposure: Consumption
- Matrix: Groundwater
- Author: Demo
- Land Use: Industrial
- Comment: Values taken from agency web site

Buttons at the bottom include: Close, Import Standard..., Save Format..., Restore Format..., and Help. A status bar at the bottom shows "demo.sfs" and "altered".

- When all the fields are entered, click on Update Database Info and then Close to return to the main Standards dialog.

We have now changed the current standards values to those imported from the text file. You will see that the green lights beside Hex chrome and Total chrome have changed to red X's indicating that the standards we imported did not include values for them. To return to the standards you were using at startup, click on the State list, choose Demo and press ENTER. You should see the rest of the list boxes change back to the Demo settings, and the red X's beside Hex chrome and Total chrome change back to green lights.