AQTESOLV FOR WINDOWS TUTORIAL

TO START:
(1) LOG-ON TO COMPUTER
(2) START - PROGRAMS - MY COMPUTER
(3) FIND / OPEN FOLDER C:\AQTW
(4) CLICK ON "AQTESOLV" EXE ICON

Guided Tours

FOLLOW THE TUTORIAL INSTRUCTIONS BELOW

FOR TUTORIAL: CREATE A NEW FOLDER ON YOUR H:\ DRIVE
CALL IT "AQTEST"

Overview

The "guided tours" provide you with step-by-step instructions illustrating the use of AQTESOLV for Windows in the analysis of pumping tests and slug tests. The tours show you how to perform visual and automatic curve matching, change between plot and report views, open multiple windows for the same data set, obtain printed output, and much more. Regardless of whether you are a novice or an expert in analyzing aquifer test data, it is recommended that you take the time to go through the guided tours to become familiar with the use of AQTESOLV for Windows.

The on-line version of this User's Guide contains additional tutorials for the pumping test and slug test solutions found in AQTESOLV for Windows. Access Help to view the tutorial for a particular solution.

Analyzing a Pumping Test

The first stop in the guided tour shows you how to use AQTESOLV for Windows to analyze a constant-rate pumping test in a confined aquifer. This step-by-step example illustrates the use of visual and automatic curve matching to estimate the hydraulic properties of the aquifer.

Open a New Data Set

MINIMIZE "ERROR" WINDOW

Open a new data set by choosing **New** from the **File** menu. AQTESOLV for Windows opens a new window with an Error Log view that reports any errors identified in the data set.

Enter Data for Pumping Test

Units

GO TO EDIT MENU

Choose **Units...** from the **Edit** menu to open the **Units** dialog box for selecting units of measurement for the data set.

1. Select **ft** (feet) for **Length**, **min** (minutes) for **Time**, **consistent** for **Pumping Rate** and **consistent** for **Hyd. Conductivity**.
2. Click the **OK** button to close the **Units** dialog box.

Consistent units

For this data set, consistent units for pumping rate are cubic feet-per-minute; consistent units for hydraulic conductivity are feet-per-minute.

Title

GO TO EDIT MENU

Choose **Title...** from the **Edit** menu to open a dialog box for editing the data set title.

1. Enter **Theis Verification** for the **Title**.
2. Click the **OK** button to close the dialog box.

Aquifer data

EDIT MENU

Choose **Aquifer Data...** from the **Edit** menu to open a dialog box for editing aquifer data.

1. Enter **100.0** for the value of **Saturated Thickness**.
2. Click the **OK** button to close the dialog box.

Pumping well data

EDIT MENU

Choose **Pumping Well.../Edit...** from the **Edit** menu to open the **Pumping Well Data** dialog box for editing pumping well data.

1. Click the **Edit** button to open the **Pumping Period Data** dialog box for entering pumping rates.
2. In the **Time** and **Rate** edit controls, enter values of **0.0** and **3.14159** for time and rate, respectively, where time is in minutes and rate is in cubic feet-per-minute.
3. Click the **<<Add** button to transfer the values from the edit controls to the list box.
4. Click **OK** to close the **Pumping Period Data** dialog box.
5. Click **OK** to close the **Pumping Well Data** dialog box.

Observation well data

EDIT MENU

Choose **Obs. Well.../Edit...** from the **Edit** menu to open the **Observation Well Data** dialog box and edit data for the observation well.

1. Enter a value of **100.0** for the **X-Coordinate** location of the well.
2. Click the **Edit** button to open the **Observation Data** dialog box for entering observation data from the keyboard. Enter the following 10 measurements into the edit controls for **Time** and **Displacement** (set all weights equal to 1.0):

ENTER THIS DATA BY HAND

Time	Displacement
0.5	0.0489
1	0.2194
5	1.223
10	1.823
50	3.355
100	4.038
500	5.639
1000	6.332
5000	7.94
10000	8.633

3. Click the **<<Add** button to transfer values from the edit controls to the list box.
4. When you have finished entering the observations, click the **OK** button to close the **Observation Data** dialog box.
5. Click the **OK** button to close the **Observation Well Data** dialog box.

After you have completed the previous data entry steps, the **Error Log** displayed in the active window should show that the data set contains no errors. Now you are ready to display the data, choose a solution and estimate aquifer properties.

Save Data Set

Choose **Save As...** from the **File** menu to open a dialog box for saving the data you have entered into the current data set.

SAVE TO H:\AQTEST\TOUR1.AQT

1. Enter **TOUR1.AQT** for the file name.
2. Click the **OK** button to close the dialog box and save the data set.

Display Plot in Window

VIEW MENU

Choose **Displacement-Time** from the **View** menu to display a plot of displacement vs. time in the active window. The window displays a plot of the observation well data on semi-logarithmic axes.

Choose Theis Solution

Choose **Confined...** from the **Solution** menu to open a dialog box with solutions for analyzing pumping tests in a confined aquifer.

1. Choose the **Theis (1935)** solution.
2. Click the **OK** button to close the dialog box.

After you have selected the Theis solution for a pumping test in a confined aquifer, AQTESOLV for Windows updates the window by plotting the data on double logarithmic axes, superimposing the Theis type curve on the plot, and adding the current values of transmissivity (T) and storage coefficient (S) to the legend.

For details concerning the Theis solution, see "Theis (1935) Solution for a Pumping Test in a Confined Aquifer" on page 31.

Perform Visual Matching with Theis

The Theis type curve solution computes drawdown in a confined aquifer using the following equations:

$$s = \frac{Q}{4\pi T} \int_u^\infty \frac{e^{-y}}{y} dy$$

$$u = \frac{r^2 S}{4Tt}$$

where s is drawdown, Q is pumping rate, T is transmissivity, r is radial distance between pumping and observation wells, S is storage coefficient, and t is time.

Hydrogeologists commonly refer to the exponential integral in the drawdown equation as the *Theis well function*, abbreviated as **w(u)**. Therefore, we can write the Theis drawdown equation in compact notation as follows:

$$s = \frac{Q}{4\pi T} w(u)$$

To analyze a pumping test using the Theis type curve method, one plots drawdown as a function of time on double logarithmic axes. By matching a type curve drawn

by plotting w(u) as a function of 1/u, one can estimate the values of transmissivity and storage coefficient by visual analysis.

MATCH MENU

Choose **Visual** from the **Match** menu to perform visual curve matching of the Theis type curve to the observation well data.

1. To begin interactively moving the type curve, move the mouse cursor over the plot, click the left mouse button, and hold it down.
2. As you move the mouse, the type curve also moves. AQTESOLV for Windows updates the values of the aquifer properties, T and S, in the legend as the type curve position changes.
3. When you have finished matching the type curve to the observation well data, release the left mouse button to end visual curve matching.

Perform Automatic Matching with Theis

MATCH MENU

Choose **Automatic...** from the **Match** menu to open a dialog box for performing automatic matching of the Theis type curve solution to the observation well data.

AQTESOLV for Windows uses a nonlinear least-squares estimation procedure to match a solution to observation well data. The estimation procedure performs a sequence of iterations to minimize the residual sum of squares (RSS) criterion. The residuals are the errors between the computed and observed values of displacement.

1. Click the **Start** button to begin the automatic estimation procedure.
2. As the automatic estimation procedure completes iterations, the dialog box displays the changes in the residual sum of squares (RSS) criterion and the values of the aquifer properties. After the automatic estimation procedure finishes, AQTESOLV for Windows displays a message box containing residual summary statistics. Click the **OK** button to close the message box.
3. Click the **Close** button when the automatic estimation procedure has finished.

Print Results

FILE MENU

Choose **Print...** from the **File** menu to print a copy of the type curve solution. To select a printer other than the default, click the **Setup...** button and choose a new printer. Click the **OK** button to print the type curve plot.

Open a New Window for a Diagnostic Plot

WINDOW MENU

Choose **New Window** from the **Window** menu to open a second window for the active data set. The initial view in the second window is the same as the previously active window.

1. Select **Normal Probability** from the **View** menu to plot values of residuals (errors) plotted on normal probability axes in the new window. This view option is only available after you have performed automatic curve matching.
2. After you have inspected the normal probability plot, close the window.

Diagnostic test for normal distribution of residuals

If the residuals are normally distributed, they will fall on a straight line when plotted on normal probability axes. Deviations from a normal distribution may indicate that the chosen analytical solution is inadequate for the analysis.

Save Data Set

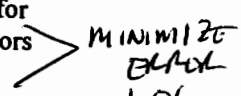
Choose **Save** from the **File** menu to save your work in the **TOUR1.AQT** data set.

Analyzing a Slug Test

The second sample in the guided tour illustrates the analysis of a slug test in a confined aquifer using a type-curve solution by Cooper, Bredehoeft and Papadopulos and a straight-line solution by Bouwer and Rice. The step-by-step instructions in this example lead you through the use of visual and automatic curve matching to estimate aquifer properties from slug test data.

Open a New Data Set

Open a new data set by choosing **New** from the **File** menu. AQTESOLV for Windows opens a new window with an Error Log view that reports any errors identified in the data set.



Enter Data for Slug Test

Units

Choose **Units...** from the **Edit** menu to open the **Units** dialog box for selecting units of measurement for the data set.

1. Select **m** (meters) for **Length**, **min** (minutes) for **Time**, and **cm/sec** (centimeters-per-second) for **Hyd. Conductivity**.
2. Click the **OK** button to close the **Units** dialog box.

Title

Choose **Title...** from the **Edit** menu to open a dialog box for editing the data set title.

1. Enter **Confined Slug Test** for the **Title**.
2. Click the **OK** button to close the dialog box.

Slug test data

Choose **Slug Test Well...** from the **Edit** menu to open a dialog box for entering slug test data.

1. Enter **0.56** for **Initial Displacement**.
2. Enter **0.076** for **Casing Radius**.
3. Enter **0.076** for **Wellbore Radius**.
4. Enter **100.0** for **Screen Length**.
5. Enter **100.0** for **Water Column Height**.
6. Enter **100.0** for **Saturated Thickness**.
7. Click the **Edit** button to open the **Observation Data** dialog box for entering observation data from the keyboard. Enter the following 21 measurements into the edit controls for **Time** and **Displacement** (set all weights equal to 1.0):

ENTER THIS DATA BY HAND

Time	Displacement
3	0.457
6	0.392
9	0.345
12	0.308
15	0.28
18	0.252
21	0.224
24	0.205
27	0.187
30	0.168
33	0.149
36	0.14
39	0.131
42	0.112
45	0.103
48	0.093
51	0.089
54	0.082
57	0.075
60	0.071
63	0.065

8. Click the **<<Add** button to transfer values from the edit controls to the list box.
9. When you have finished entering the observations, click the **OK** button to close the **Observation Data** dialog box.
10. Click the **OK** button to close the **Slug Test Data** dialog box.

After you have completed the previous data entry steps, the **Error Log** displayed in the active window should show that the data set contains no errors. Now you are ready to display the data, choose a solution and estimate aquifer properties.

Save Data Set

SAVE FILE TO H:\AQTEST\TOUR2.AQT

Choose **Save As...** from the **File** menu to open a dialog box for saving the data you have entered into the current data set.

1. Enter **TOUR2.AQT** for the file name.
2. Click the **OK** button to close the dialog box and save the data set.

Display Report in Window

VIEW MENU

Choose **Report** from the **View** menu to display a complete report of the data set in the active window.

Complete report

The complete report displays in report format all of the data contained in the active data set. The report also shows parameters estimated by visual or automatic curve matching. The report includes diagnostic statistics if you have performed automatic estimation.

Display Plot in Window

VIEW MENU

Choose **Displacement-Time** from the **View** menu to display a plot of displacement vs. time in the active window. The window displays the data plotted on semi-logarithmic axes.

Choose Cooper Et Al. Solution

SOLUTION MENU

Choose **Confined...** from the **Solution** menu to open a dialog box with solutions for analyzing slug tests in a confined aquifer.

1. Choose the **Cooper-Bredehoeft-Papadopulos (1967)** solution.
2. Click the **OK** button to close the dialog box.

For details concerning the Cooper-Bredehoeft-Papadopulos slug test solution, see "Cooper-Bredehoeft-Papadopulos (1967) Solution for a Slug Test in a Confined Aquifer" on page 40.

Perform Automatic Matching with Cooper Et Al.

MATCH MENU

Choose **Automatic...** from the **Match** menu to open a dialog box for automatically matching the Cooper-Bredehoeft-Papadopulos type curve solution to the slug test data.

1. Click the **Start** button to begin the automatic estimation procedure.
2. As the automatic estimation procedure completes iterations, the dialog box displays the changes in the residual sum of squares (RSS) criterion and the values of the aquifer properties. After the automatic estimation procedure finishes, AQTESOLV for Windows displays a message box containing residual summary statistics. Click the **OK** button to close the message box.
3. Click the **Close** button when the automatic estimation procedure has finished. PRINT RESULTS (FILE-PRINT)

Display Diagnostic Report in Window

VIEW MENU

Choose **Diagnostics** from the **View** menu to display a report containing diagnostic statistics for the estimated aquifer properties in the active window.

Diagnostic report

In the diagnostic report, the standard errors indicate the precision of the estimated parameters. Ideally, the standard errors should be small compared to the estimates. The correlation matrix shows correlations between the estimated parameters and may indicate estimation difficulties when strong correlations exist. The diagnostic report also displays summary statistics for the model residuals.

Display Plot in Window

VIEW MENU

Choose **Displacement-Time** from the **View** menu to display a plot of displacement vs. time in the active window.

Choose Bouwer-Rice Solution

Change the solution by choosing **Confined...** from the **Solution** menu.

1. Choose the **Bouwer-Rice (1976)** solution.
2. Click the **OK** button to close the dialog box.

After you have selected the Bouwer-Rice straight-line solution for a slug test in a confined aquifer, AQTESOLV for Windows updates the window by plotting the data on semi-logarithmic axes and superimposing a straight line predicted by the Bouwer-Rice solution on the plot.

For additional details on the Bouwer-Rice solution, refer to "Bouwer-Rice (1976) Solution for a Slug Test in an Unconfined Aquifer" on page 51.

Perform Visual Matching with Bouwer-Rice

Choose **Visual** from the **Match** menu to perform visual curve matching of the Bouwer-Rice solution to the slug test data.

1. To begin interactively matching the Bouwer-Rice solution to the data, click the left mouse button and hold it down to anchor a point along the new straight line you wish to match to the data.
2. As you move the mouse, AQTESOLV for Windows drags a straight line between the anchor point and the mouse cursor.
3. When you have finished matching the Bouwer-Rice solution to the observation well data, release the left mouse button. AQTESOLV for Windows computes new estimates of hydraulic conductivity (K) and y-axis intercept (y0) and updates the straight line displayed on the plot.

Estimation tip

For most slug tests, one should use visual matching to obtain the most meaningful estimate of K with the Bouwer-Rice solution because visual matching gives you greater control over the range of data that you want to match with the straight line. If you choose to attempt automatic matching with the Bouwer-Rice solution, you should assign weights of zero to the measurements not within the range of data that you want to match.

Save Data Set

Choose **Save** from the **File** menu to save your work in the **TOUR2.AQT** data set.