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HydroExcel 1.1.2

Software Manual

June, 2009

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Funding

Funding for this document was provided by the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) under National Science Foundation Grant No. EAR-0622374. In addition, much input and feedback has been received from the CUAHSI Hydrologic Information System development team. Their contribution is acknowledged here.

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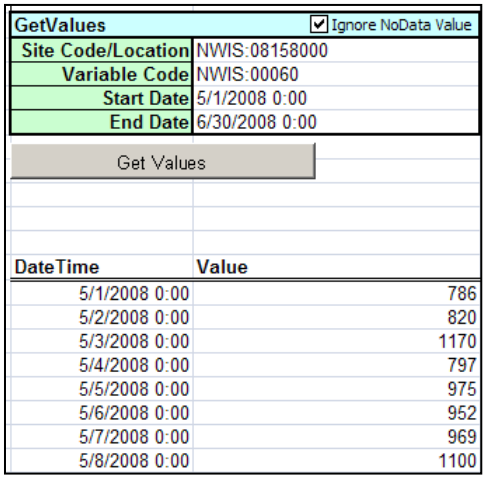
1 Introduction and Software Description

HydroExcel is a Microsoft Excel spreadsheet that uses macros and HydroObjects to download hydrologic observations data from WaterOneFlow web services. This means that you can query for observation sites, variables, and time series data from online resources directly within Excel. As long as a web service follows WaterOneFlow specifications, HydroExcel will be able to communicate with it. Thus, HydroExcel provides a window into the nation's water data from within one of the most widely used applications within the hydrologic science community.



GetValues	☑ Ignore NoData Value
Site Code/Location	NWIS:08158000
Variable Code	NWIS:00060
Start Date	5/1/2008 0:00
End Date	6/30/2008 0:00

Get Values

DateTime	Value
5/1/2008 0:00	786
5/2/2008 0:00	820
5/3/2008 0:00	1170
5/4/2008 0:00	797
5/5/2008 0:00	975
5/6/2008 0:00	952
5/7/2008 0:00	969
5/8/2008 0:00	1100

Figure 1.1 Daily streamflow values (cfs) downloaded in HydroExcel

This software manual provides a walkthrough and reference for using HydroExcel.

1.1 What's New for Version 1.1.2

HydroExcel version 1.1.2 is a minor upgrade from version 1.1.1. Version 1.1.2 includes a fix for a bug that occurs in version 1.1.1 when selecting a record on a row higher than row 32,767.

Key enhancements for version 1.1.1 of HydroExcel over version 1.1 include:

- The **Data Source** worksheet now has a **Get All** button to populate all worksheets with data from the active web service with just a single click.
- Many worksheets now allow you to **right-click** on a row to operate on data within that row. For example, you can right-click on the description of a time series in the Series Catalog worksheet to download that time series into the Time Series worksheet.
- A **HydroExcel menu item** has been added to the Excel **Add-Ins** menu. You can now check the version and set other options via this menu, such as the option to save downloaded WaterML files to disk.
- Using the **Add-Ins | HydroExcel | Options** menu item, you can choose to **save downloaded WaterML files to disk**. This lets you store the exact data as retrieved from web service requests before the data are translated and written to the Excel spreadsheet.

- When getting a list of sites from a service, you can now choose to **only retrieve sites if they fall within a box** defined by latitude and longitude coordinates.

1.2 What is WaterOneFlow

Web services are computer applications that interact with and exchange information with other applications over the internet. The CUAHSI web services, named WaterOneFlow, have been developed to be a standard mechanism for flow of hydrologic data between hydrologic data servers (databases) and users. Web services streamline the often time-consuming tasks of extracting data from a data source, transforming it into a usable format and loading it in to an analysis environment. WaterOneFlow web services are designed to access information from:

1. Third party servers for national databases, such as the USGS National Streamflow Information Program and National Climate Data Center (NCDC);
2. Observatory servers holding data from hydrologic or environmental observatories;
3. CUAHSI Servers holding general collections of CUAHSI data.

WaterOneFlow standardizes the way hydrologic information is accessed by supporting specific methods (function signatures) for data access, and by providing data in a consistent format known as WaterML. WaterOneFlow methods include:

- GetSites – Get a list of sites available from the web service.
- GetSiteInfo – Get details about a site, including what variables are measured at the site.
- GetVariableInfo – Get a list of variables available from the web service, including information about each variable.
- GetValues – For a given site, variable, and date range, download a time series of data.

These methods return data in WaterML format. WaterML is an XML language for describing water data. As long as a web service includes WaterOneFlow methods and returns data in WaterML format, HydroExcel will be able to retrieve data from the web service.

For more information about WaterOneFlow, see http://his.cuahsi.org/wofws.html.

1.3 What is HydroObjects

HydroObjects is a .NET DLL with COM classes that support hydrology applications. The key class in the library is WebServiceWrapper, which provides a method for calling web services from a COM environment (e.g., Visual Basic for Applications (VBA)). This class can be used to call WaterOneFlow web services for downloading hydrologic time series.

Excel does have some capabilities for calling web services, such as via the Office Web Services Toolkit. However, HydroObjects allows Excel to handle complex objects returned from web services, as well as make dynamic connections to web services. For this reason, HydroExcel uses HydroObjects to communicate with WaterOneFlow web services.

For more information about HydroObjects, see http://his.cuahsi.org/hydroobjects.html.

1.4 OUTLINE

This software manual includes the following sections:

1. Introduction and Software Description
2. Installation Information
3. Walkthrough: Downloading Data from a Web Service into HydroExcel
4. Software Reference
5. Frequently Asked Questions (FAQ)
6. Troubleshooting

To quickly get started with HydroExcel, make sure you have met all prerequisites as described in the Installation Information section, and then read the Walkthrough. For detailed information about a particular worksheet or piece of functionality, see the Software Reference.

2 Installation Information

2.1 Installation Prerequisites

2.1.1 Software Prerequisites

Prior to using HydroExcel, you must have the following software installed:

- **Microsoft Excel** version 2003 Service Pack 3, or Microsoft Excel version 2007 or later. (For instructions about how to check your version of Excel, see Frequently Asked Questions (FAQ).)
- **HydroObjects** (freely available at http://his.cuahsi.org/hydroobjects.html).
- **A KML viewer such as Google Earth** (optional).

Some worksheets in HydroExcel can generate KML files for KML viewers (such as Google Earth), which display geospatial data. This lets you see the sites that you download on a map. To use this functionality, you will first need to have a KML viewer installed.

2.1.2 Enabling Macros

HydroExcel uses Excel VBA macros. Therefore, you will need to enable macros in order for HydroExcel to work.

To enable macros for Excel 2003:

1. Open Excel 2003 and click **Tools | Macro | Security**.

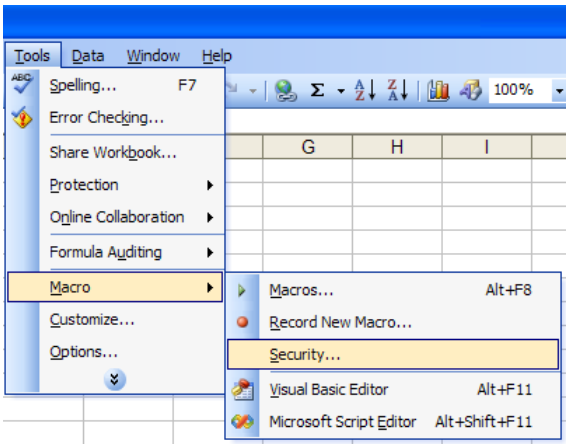


Figure 2.1 Accessing macro security in Excel 2003

2. In the Security Level tab of the Security window, choose a macro setting. **"Medium"** is recommended.

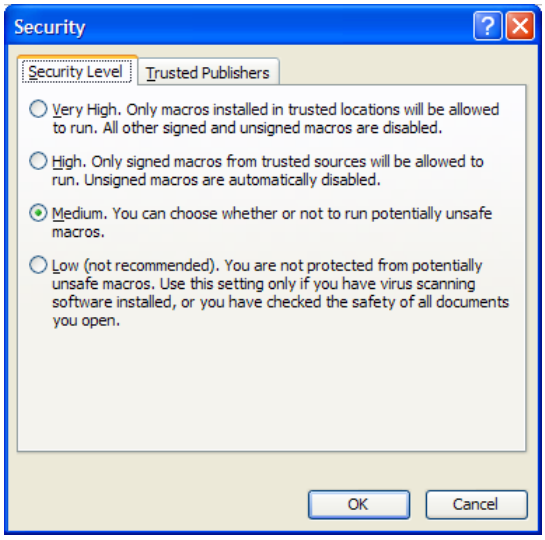


Figure 2.2 Setting macro security in Excel 2003

3. Click **OK** to close the Security window.
4. Close Excel. Excel must be closed in order for the new macro settings to take effect.
5. Open the Excel file with macros, e.g., HydroExcel.xls.
6. If prompted about macro security, choose to enable macros. Your spreadsheet can now use macros.

To enable macros for Excel 2007:

1. Open Excel 2007 and click the **Office Button** in the upper left corner.
2. At the bottom of the menu that opens, click **Excel Options**.

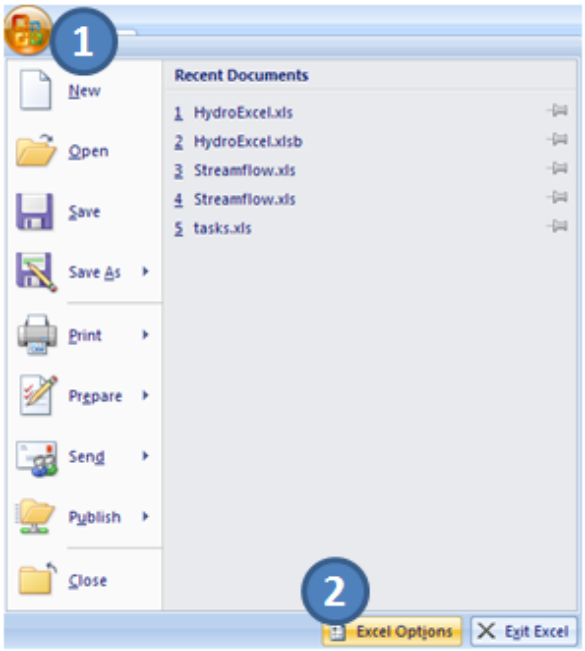


Figure 2.3 Accessing Excel Options in Excel 2007

3. In the Excel Options window, click the **Trust Center** button on the left.
4. At the bottom right, click **Trust Center Settings**.

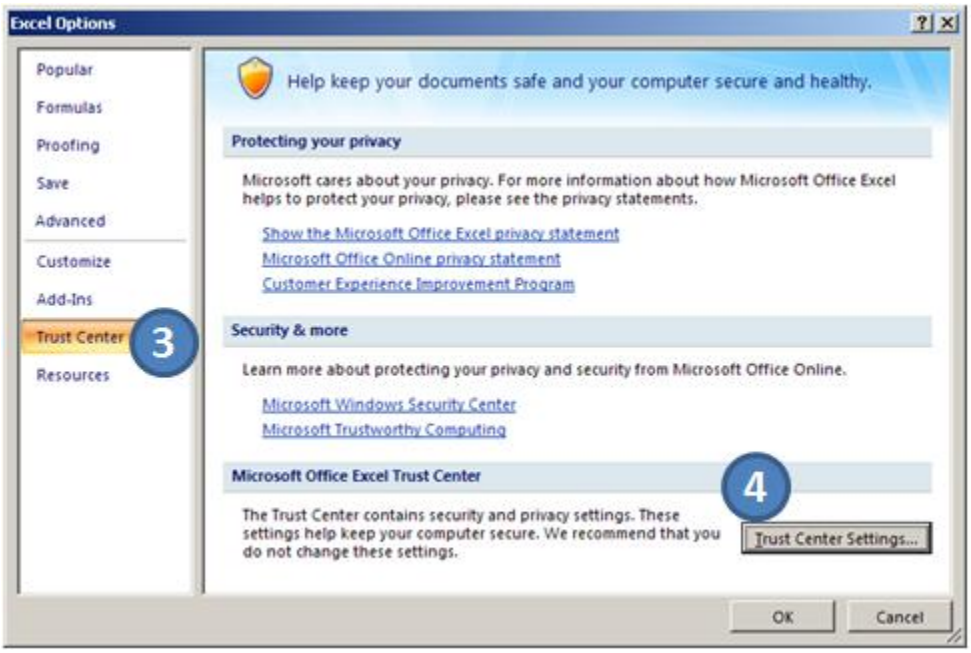


Figure 2.4 Accessing the Trust Center in Excel 2007

5. In the Trust Center window, click **Macro Settings** on the left.
6. Choose a macro setting. **"Disable all macros with notification"** is recommended. This option keeps macros disabled but notifies users when macros attempt to run, allowing users to decide on a case-by-case basis which macros to enable.
7. Click **OK** to confirm and close the Trust Center window.

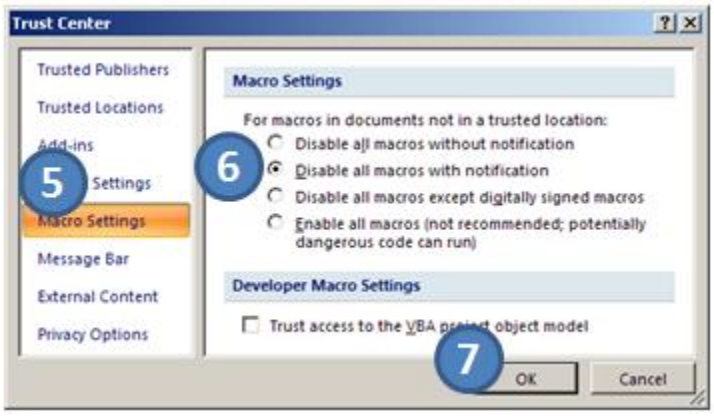


Figure 2.5 Choosing macro settings in Excel 2007

8. Click **OK** to close the Excel Options window.
9. Close Excel. Excel must be closed in order for the new macro settings to take effect.
10. Open the Excel file with macros, e.g., HydroExcel.xlsb.

11. If you see the Security Warning above the cells in the spreadsheet, click **Options**.
12. In the window that opens, choose to **"Enable this content."**
13. Click **OK**. Your spreadsheet can now use macros.

Figure 2.6 Enabling macros in Excel 2007

2.2 INSTALLING HYDROEXCEL

HydroExcel is simply an Excel file with macros. Once the prerequisites above are met, you use HydroExcel by opening the file. However, once you populate HydroExcel with data, you may want to preserve that version of the spreadsheet before downloading new data. Therefore, the recommended workflow is:

1. Download HydroExcel from http://his.cuahsi.org/hydroexcel.html.
2. Save the file with a name that relates to the data you want to download, e.g., "NWIS_HydroExcel."
3. Remember to use "Save As" as you are working with HydroExcel if you want to preserve the data currently in the spreadsheet.

2.3 UNINSTALLING HYDROEXCEL

HydroExcel is just a file on disk. To "uninstall" it, simply delete it. If you installed prerequisites specifically for HydroExcel and you no longer want them, you can uninstall them using the instructions with which they were provided. Typically, this means using the Add or Remove Programs item from Control Panel.
HydroExcel can also save KML/WaterML files to disk. Deleting HydroExcel has no impact on these files.

3 Walkthrough: Downloading Data from a Web Service into HydroExcel

This section provides a walkthrough to demonstrate what HydroExcel can do. After completing this walkthrough, you should be familiar with each worksheet in HydroExcel, what types of information HydroExcel gathers from web services, and how to use each worksheet to download that information. For more detailed information about each component of HydroExcel, please read the Software Reference section of this document.

In this walkthrough, you will download hydrologic observations data for the Little Bear River in Utah. These water quality and atmospheric data are recorded by Utah State University (USU) and published as a WaterOneFlow Web service. More information about this USU research effort and their web service can be found at http://his02.usu.edu/littlebearriver/.

You will begin by querying for a list of observation sites and variables available through the web service. If you have a KML viewer installed, you can then view the sites in a map. Finally, you will download a time series of temperature data and analyze the result.

This walkthrough is designed to be worked through in sequence. If you skip steps or sections of the walkthrough, HydroExcel may not produce the same results as shown in the screenshots in this document.

This walkthrough assumes that you are familiar with Excel.

3.1 Getting Started

You'll begin by opening HydroExcel and viewing its introductory text.

1. If necessary, "install" HydroExcel as per the instructions in the previous section.
2. Open HydroExcel. If prompted about macro security, enable macros as per the instructions in the previous section.
3. HydroExcel is an Excel spreadsheet with several worksheets for working with different aspects of WaterOneFlow data. If necessary, click the **Introduction** tab at the bottom of the spreadsheet to activate the Introduction worksheet.

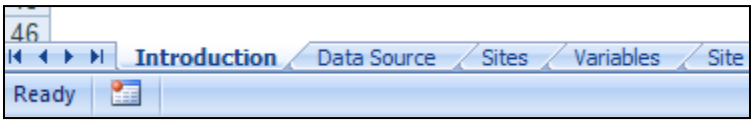


Figure 3.1 Worksheets are activated by clicking tabs at the bottom of the spreadsheet

4. Each worksheet has informative text boxes in the top left corner to guide you. Skim through the Introduction text box. Notice that the text includes the version of your spreadsheet. You will also find license and other useful information in this text box.

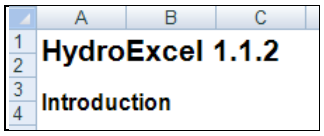


Figure 3.2 Introduction text box includes the version number

5. If you are going to save this spreadsheet for a specific project or data source, you should edit the text in these text boxes to reflect your project.

> **Note:**
> The Introduction worksheet does not contain any special functionality. It just provides introductory text.

3.2 Selecting and Retrieving Information for a Data Service

To begin reaching out to WaterOneFlow web services, you first activate the Data Source worksheet to tell HydroExcel which web service you want to work with.

1. Activate the **Data Source** worksheet (by clicking the Data Source tab at the bottom).
2. Take a moment to view the layout of this worksheet.

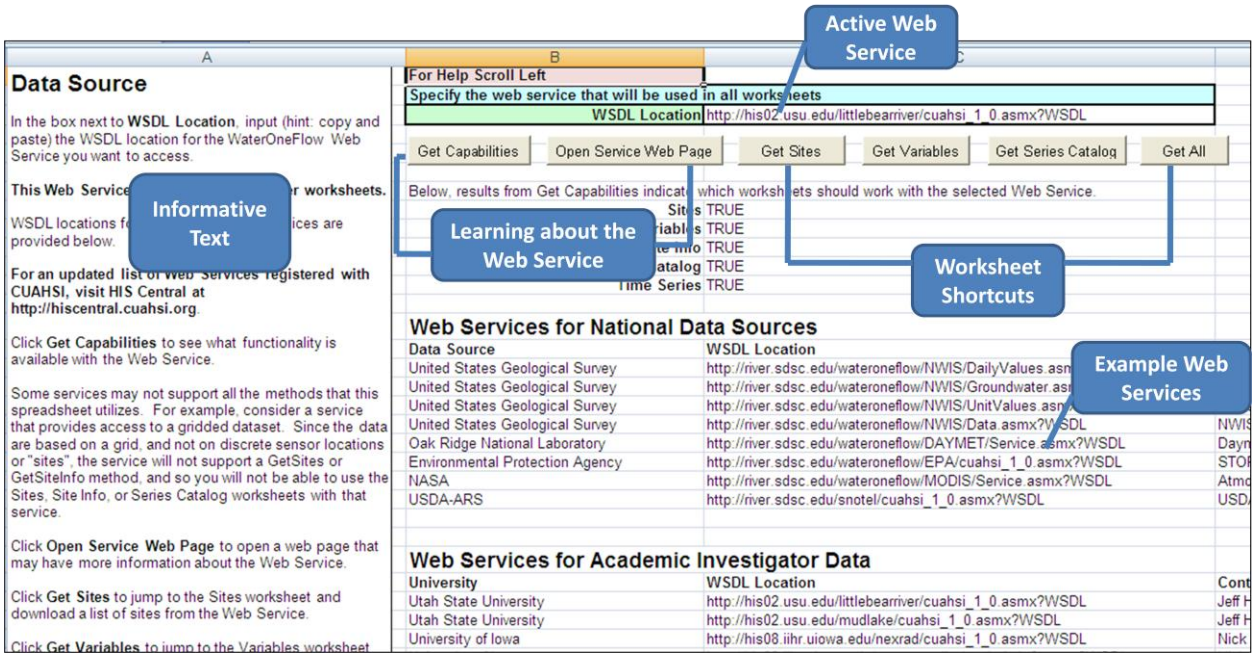


Figure 3.3 Data Source worksheet layout

On the left you see a text box explaining the worksheet (Figure 3.3). All worksheets in HydroExcel have a similar text box on the left. At the top of the worksheet you see a place for you to enter the location of the WSDL that defines the web service you want to work with. In HydroExcel, the places where you supply inputs are marked by colored cells as shown here.

Tip:
A WSDL is a document that lists the functions, inputs, and outputs for a web service. Before a program works with a web service, it first reads the WSDL to figure out what the web service can do and how to interact with the web service.

Below the cell for the active web service (WSDL), there are several buttons. The first two buttons are used for learning about the active web service, while the last five are shortcuts to other worksheets in HydroExcel. The shortcuts jump to a given worksheet, and call the web service to populate that worksheet with data from the service.

Below the buttons, several web services are listed, including services for national data sources and also for academic investigator data. All of these services are WaterOneFlow web services; therefore, HydroExcel can communicate with them. If you know of another web service that is not listed in this spreadsheet, you can still use it with HydroExcel as long as it is a WaterOneFlow web service.

3. To set the active web service for HydroExcel, right-click on any of the cells in the row for the Little Bear River web service (Figure 3.4). From the drop down box displayed, choose the **HydroExcel** option and select the **Set Active Web Service** option to set the web service to the Little Bear River web service.

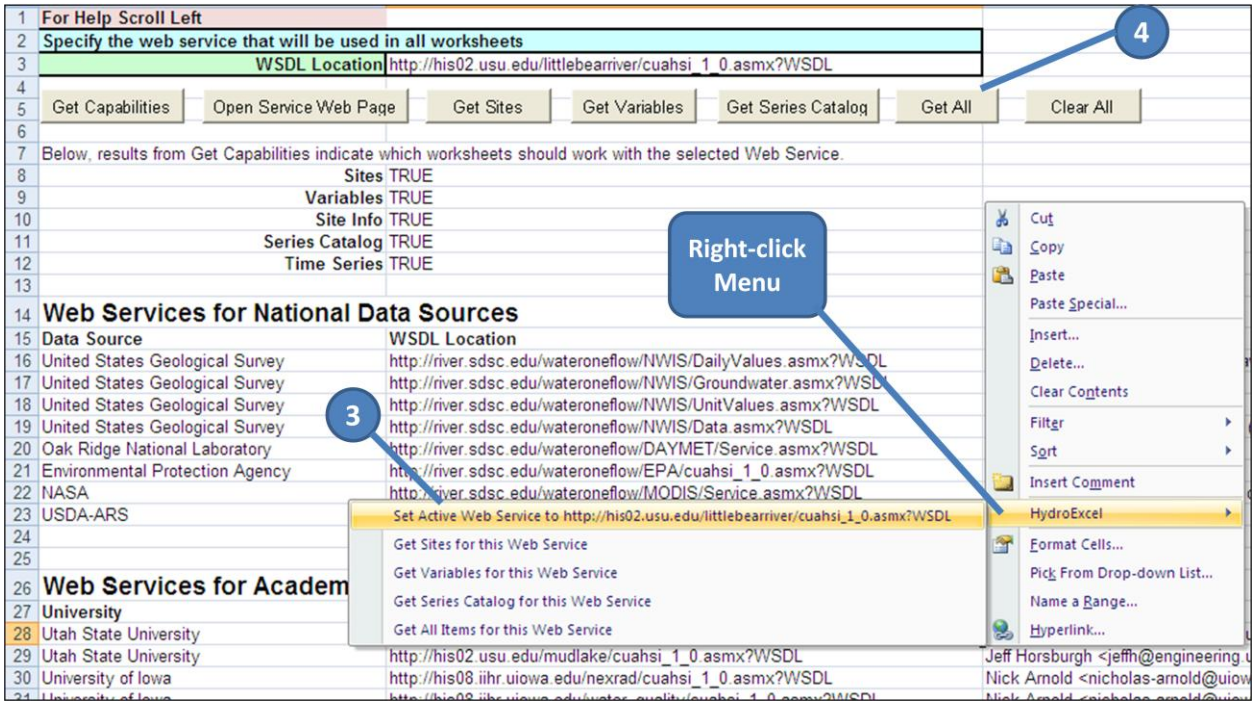


Figure 3.4 Selecting a data source

4. Click the **Get All** button. HydroExcel will populate all the worksheets with data from the Little Bear River and stop on the **Time Series** worksheet. A message box appears to indicate that the download has completed. Click **OK** to dismiss the message box.

3.3 BUILDING A SERIES CATALOG

1. Switch to the **Series Catalog** worksheet. Information for all the sites in the Little Bear River should already be present as a result of clicking the **Get All** button earlier. The next steps are just to familiarize you with the Series Catalog worksheet.

The Series Catalog worksheet provides information for a list of sites instead of just one site. The worksheet can either get a list of all sites available from the web service, or operate from a filtered list of sites from the Sites worksheet. You'll use the Series Catalog worksheet to download site information for every site in the Little Bear River network.

2. In cell G3 (next to the cell marked "Max sites to get"), make sure this number is greater than or equal to the total number of sites in the Little Bear River network, as shown on the Sites worksheet. At the time of this writing, there were about a dozen sites, so the default maximum value of 100 should be fine.

Tip:
Getting site information for every site can be slow. To only gather site information for a limited number of sites, you can specify that number next to "Max sites to get."

3. In cell G4 (next to the cell marked "Obtain site list from"), use the drop down box to change this option to **"Sites Worksheet."** (The Sites worksheet was populated when you clicked **Get All** earlier.)

When the list of sites is obtained from the web service, this means that **all sites** (up to the maximum number of sites to get) will be processed. This also requires an initial call to the web service to get the list of sites to process. If this option is set to "Sites Worksheet," then the list of sites is obtained from the Sites worksheet. If you had set up a filter or deleted some sites from the Sites worksheet, then only the sites that are still visible would be processed. This is a handy way of generating the series catalog for just those sites you are interested in, and also improving performance.

4. If you have a KML viewer installed, set the KML viewer option to **TRUE**. Otherwise, leave it as FALSE.
5. Click **Get Series Catalog.**

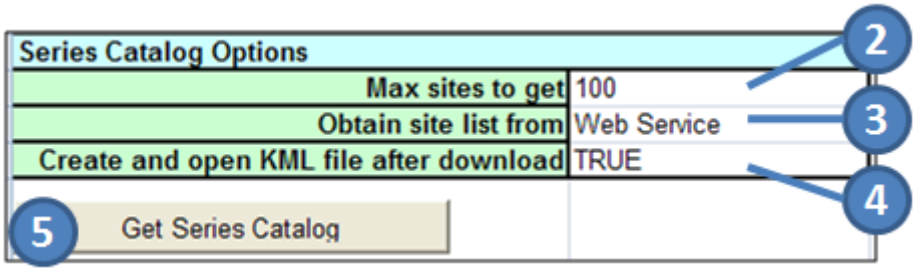
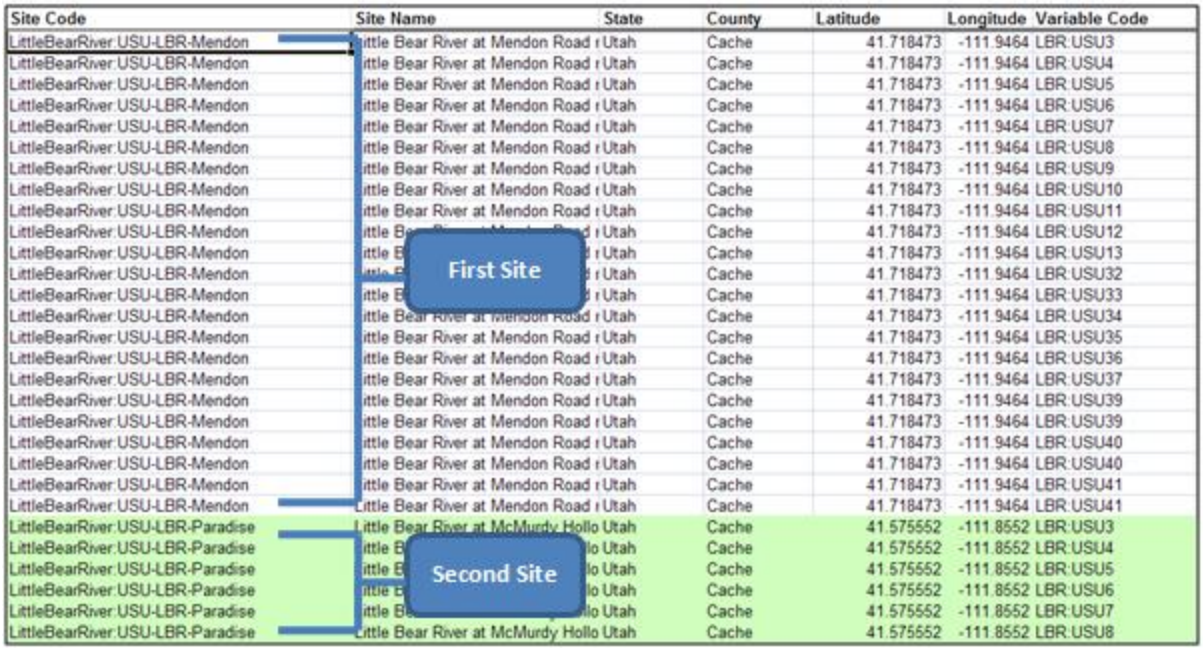


Figure 3.5 Getting the Series Catalog

After a moment, the worksheet is populated with sites and variables measured at each site. If the KML viewer takes focus, switch back to Excel. Take a moment to peruse the output.



Site Code	Site Name	State	County	Latitude	Longitude	Variable Code
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU3
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU4
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU5
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU6
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU7
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU8
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU9
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU10
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU11
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU12
LittleBearRiver:USU-LBR-Mendon	ittle B	r Utah	Cache	41.718473	-111.9464	LBR:USU13
LittleBearRiver:USU-LBR-Mendon	ittle B	r Utah	Cache	41.718473	-111.9464	LBR:USU32
LittleBearRiver:USU-LBR-Mendon	ittle B	r Utah	Cache	41.718473	-111.9464	LBR:USU33
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU34
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU35
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU36
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU37
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU39
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU39
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU40
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU40
LittleBearRiver:USU-LBR-Mendon	ittle Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU41
LittleBearRiver:USU-LBR-Mendon	Little Bear River at Mendon Road r	Utah	Cache	41.718473	-111.9464	LBR:USU41
LittleBearRiver:USU-LBR-Paradise	Little Bear River at McMurdy Hollo	Utah	Cache	41.575552	-111.8552	LBR:USU3
LittleBearRiver:USU-LBR-Paradise	ittle B	lo Utah	Cache	41.575552	-111.8552	LBR:USU4
LittleBearRiver:USU-LBR-Paradise	ittle B	lo Utah	Cache	41.575552	-111.8552	LBR:USU5
LittleBearRiver:USU-LBR-Paradise	ittle B	lo Utah	Cache	41.575552	-111.8552	LBR:USU6
LittleBearRiver:USU-LBR-Paradise	ittle B	lo Utah	Cache	41.575552	-111.8552	LBR:USU7
LittleBearRiver:USU-LBR-Paradise	Little Bear River at McMurdy Hollo	Utah	Cache	41.575552	-111.8552	LBR:USU8

Figure 3.6 Series Catalog includes site and variable information for all desired sites

From the output (Figure 3.6), you see that each row represents the unique combination of one site and one variable. At the beginning of the row, you have basic site information as in the Sites worksheet, while the end of the row contains information about a given variable measured at the site as in the Site Info worksheet. This means that a given site name is repeated several times. Since there is one record per site-variable combination, the basic site information will be repeated as many times as there are variables at the site.

To help distinguish different sites, an alternating fill of white and green is used. Cells for a given site will always appear with the same color.

Now you'll take a look at these sites in Google Earth. If you have Google Earth 5.0 installed, please continue with the next step. Otherwise, you may skip to section 3.4: Analyzing the Series Catalog.

6. Switch to Google Earth.

The site placemarks have much information associated with them. This is because the KML was generated from the series catalog.

7. Click a placemark in the map to bring up information about the placemark.

Notice that in addition to the basic site information, you also have a list of all variables measured at the site (Figure 3.7). Basically, this is the same information from the spreadsheet, but presented in an HTML view in Google Earth.

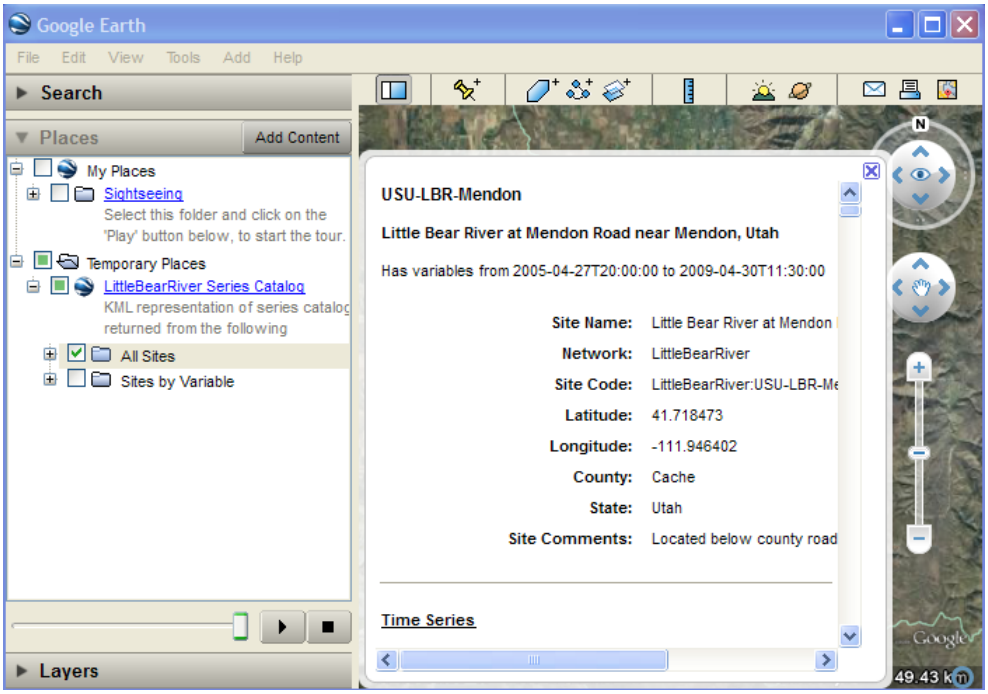


Figure 3.7 Placemarks built from the Series Catalog include variable information

8. Close the popup window with the placemark information.

The placemarks can be handled from the folders shown in the Places panel (at left). There is an “All Sites” folder, which is currently visible, and also a “Sites by Variable” folder. The “All Sites” folder shows all sites in the catalog. The “Sites by Variable” folder only shows sites that measure a certain variable. Additionally, each placemark in the “Sites by Variable” folder has a time span associated with it. The time span corresponds to the period of record of measurement for a given variable at a given site. This means that you can use Google Earth’s time slider to only show sites that have a certain variable over a certain time period.

9. In the Places panel, uncheck **“All Sites.”** This hides placemarks in the “All Sites” folder.
10. Expand the **“Sites by Variable”** folder. You’ll see a list of variable names.

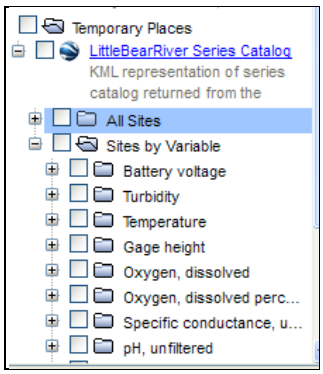


Figure 3.8 The "Sites by Variable" folder is organized into subfolders by variable name and then variable code

11. Expand the **Temperature** folder

Within each variable name folder, there are subfolders for each variable that matches that variable name. Remember that a "variable" is not only defined by a variable name, but by several other properties as well, such as data type or units of measure. Because variable code is unique across all variables, the variable code is used as the name for these subfolders.

For this exercise, you'll show sites that have any kind of Temperature measurements.

12. Check the **Temperature** folder to display sites with temperature data.

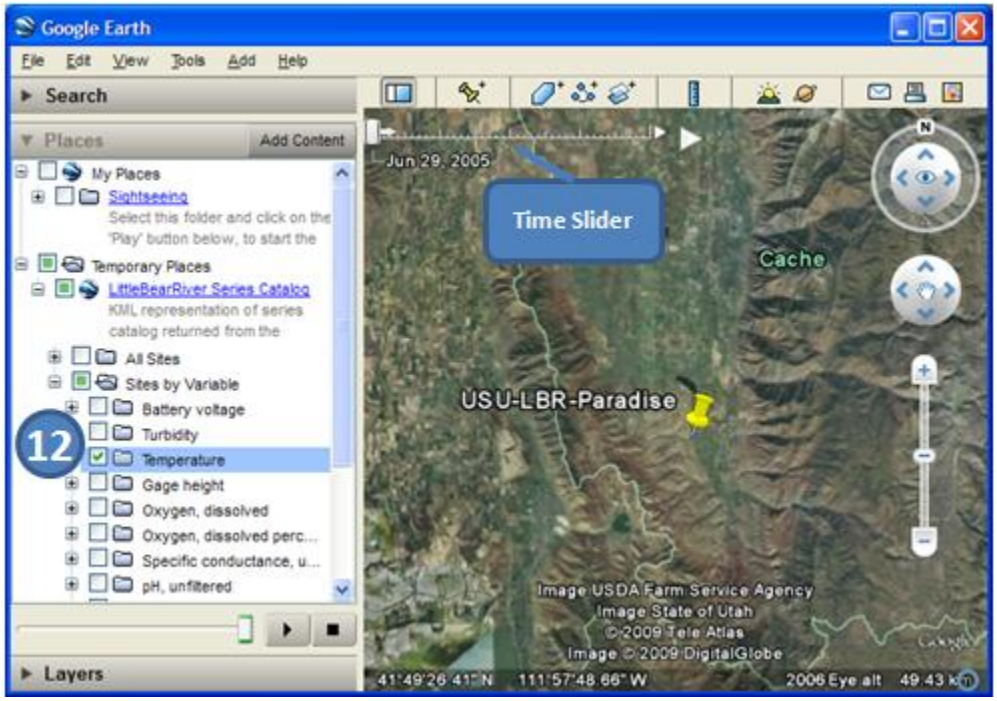


Figure 3.9 Showing sites for a certain variable

Notice that a time slider appears at the top of the map, and that the map has been updated to only show placemarks for sites that measure temperature at the current datetime in the time slider.

Tip:
If you can't see the time slider, click **View | Show Time | Always**. (This command is for older versions of Google Earth; later versions have the time slider appear automatically when features have a time feature.)

13. Drag the time slider to view sites that measure temperature at different datetimes. As you move forward in time, notice that more sites have temperature data available.

The map is currently showing sites for a single datetime. You can also use the time slider to show sites for a time period, by dragging the range markers to the right or left to re-define the time range of data displayed.

14. Drag the range markers on the time slider to show sites for a time period.

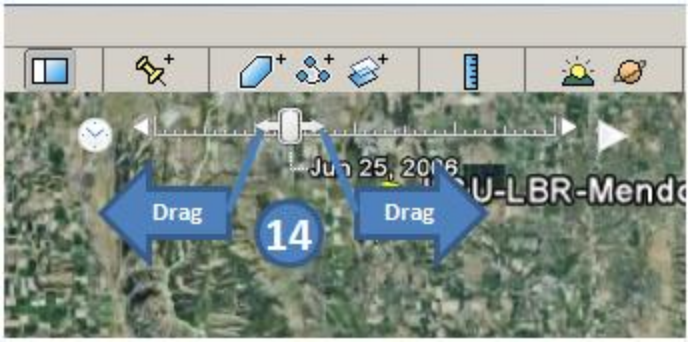


Figure 3.10 Setting the time period in the time slider

At this point, you have a mapping application that lets you find out which sites have certain variables for a certain time period.

Note:
You may notice that a given site name is repeated in the map. This happens because a given site may measure several variables with the same variable name. For example, if the Little Bear River at Mendon Road reports maximum, minimum, and mean hourly temperatures, and if you checked Temperature in the Places panel, there would actually be three placemarks for the Mendon Road site visible in the map. Since Google Earth doesn't realize that these placemarks actually represent the same site, it tries to show as many labels as it can, even if there are multiple sites in the same location.

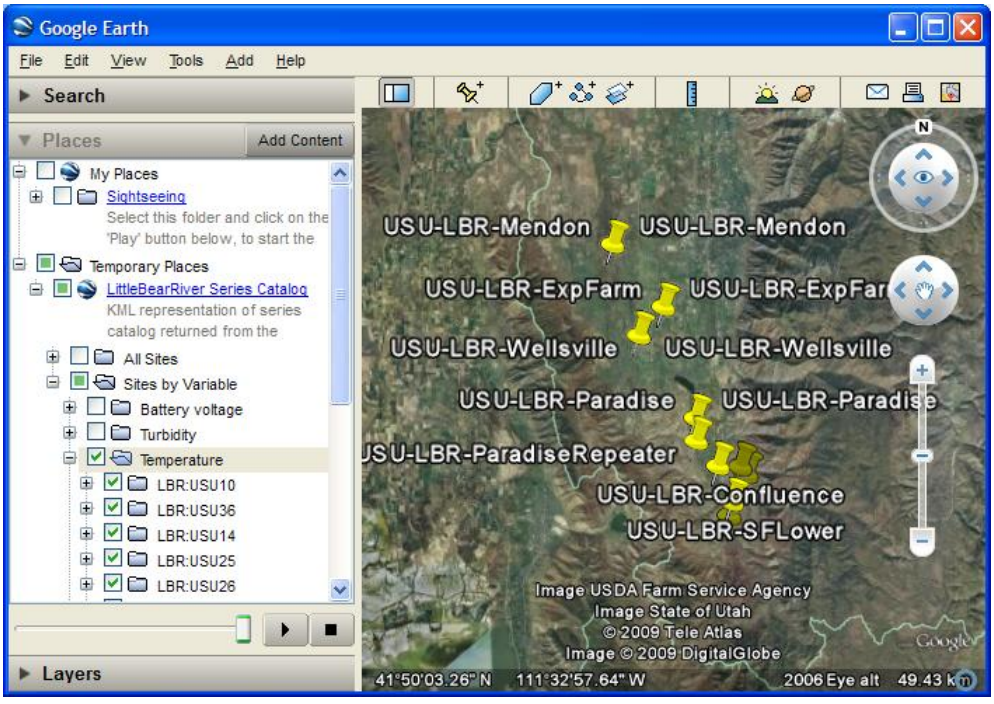


Figure 3.11 Little Bear River sites measuring temperature for a given time period

15. Close Google Earth. Click **No** when prompted to save items in the Temporary Places folder. Remember that if you want to show these sites in the future, you can always double click the KML file that was generated for the series catalog in the same folder as HydroExcel.

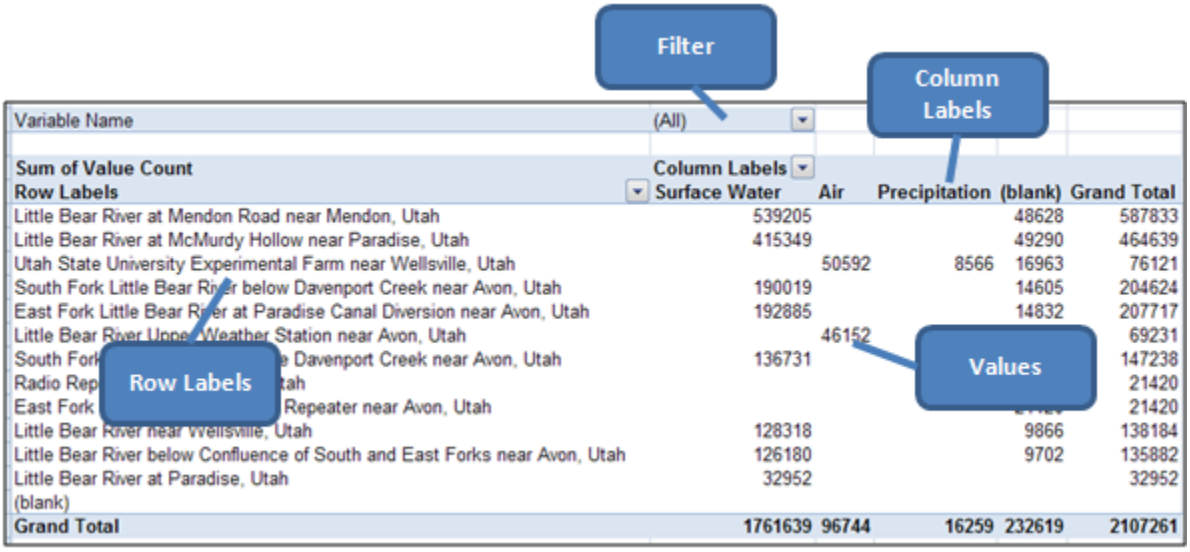
You've just seen how Google Earth can help you visualize the information coming from the web service. Excel also has some functionality that can help you analyze the data, so you'll take a look at that next.

3.4 Analyzing the Series Catalog

Once a series catalog has been downloaded, its contents can be analyzed using a pivot table. If you don't know about pivot tables, click the Excel help to search for documentation about them. They are a very powerful tool, and any Excel user should get to know them.

For HydroExcel, a pivot table has been set up which analyzes the series catalog to produce a table that shows the number of measurements of a certain variable at each site. This helps you identify which sites you might want to work with (we tend to like sites with more data).

1. Activate the **Site Summary** worksheet.
2. Take a moment to examine the pivot table.



Variable Name	(All)				
Sum of Value Count	**Column Labels**				
Row Labels	**Surface Water**	**Air**	**Precipitation**	**(blank)**	**Grand Total**
Little Bear River at Mendon Road near Mendon, Utah	539205			48628	587833
Little Bear River at McMurdy Hollow near Paradise, Utah	415349			49290	464639
Utah State University Experimental Farm near Wellsville, Utah		50592	8566	16963	76121
South Fork Little Bear River below Davenport Creek near Avon, Utah	190019			14605	204624
East Fork Little Bear River at Paradise Canal Diversion near Avon, Utah	192885			14832	207717
Little Bear River Upper Weather Station near Avon, Utah		46152			69231
South Fork Davenport Creek near Avon, Utah	136731				147238
Radio Rep tah					21420
East Fork Repeater near Avon, Utah					21420
Little Bear River near Wellsville, Utah	128318			9866	138184
Little Bear River below Confluence of South and East Forks near Avon, Utah	126180			9702	135882
Little Bear River at Paradise, Utah	32952				32952
(blank)					
Grand Total	**1761639**	**96744**	**16259**	**232619**	**2107261**

Figure 3.12 Series Catalog pivot table layout

The pivot table (Figure 3.12) includes four components. Each of these components is linked back to a column from the Series Catalog worksheet:

- **Filter –** Restricts the values that are used in the table. This is currently set to "Variable Name."
- **Row Labels –** Values are summarized for each unique instance of a row label. This is currently set to "Site Name."

- **Column Labels –** Provides a means of categorizing values for each row label. This is currently set to "Sample Medium."
- **Values –** Numerical items summarized for each row label. A variety of statistics are available for summarization, e.g., mean, min, max. This is currently set to "Value Count."

Note:
You might have noticed that one of the column labels is "(blank)." This happens because for variables such as battery voltage, sample medium is not applicable and thus not provided.

Columns from the series catalog are assigned to each of these components to show a certain type of information in the table. Currently, the table is set up to show the number of time series values at each site, for each sample medium. The table is showing the value count for all variables, but it can be filtered to show only the value count for a particular variable.

3. Click the drop down box for the **Filter**, choose **Temperature**, and click **OK**.

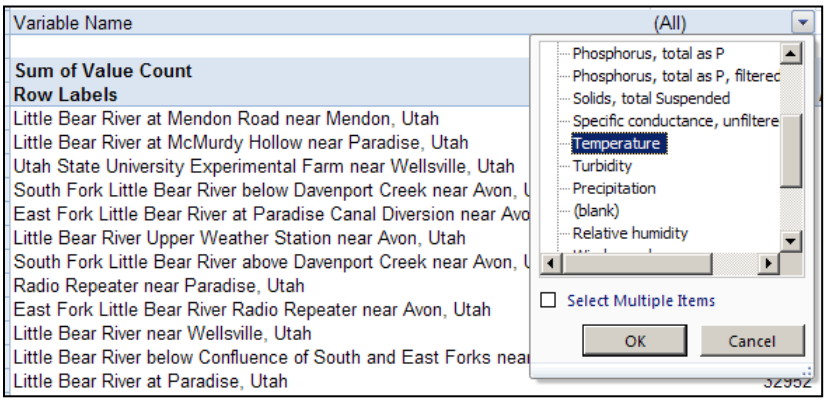


Figure 3.13 Setting a filter in the Series Catalog pivot table

The pivot table is updated to just show value counts of temperature at each site. Notice that most of the measurements occur in the surface water sample medium.

Variable Name	Temperature
Sum of Value Count	**Column Labels**
Row Labels	**Surface Water**
Little Bear River at Mendon Road near Mendon, Utah	61729
Little Bear River at McMurdy Hollow near Paradise, Utah	63229
Utah State University Experimental Farm near Wellsville, Utah	
South Fork Little Bear River below Davenport Creek near Avon, Utah	29210
East Fork Little Bear River at Paradise Canal Diversion near Avon, Utah	29663
Little Bear River Upper Weather Station near Avon, Utah	
South Fork Little Bear River above Davenport Creek near Avon, Utah	21014
Radio Repeater near Paradise, Utah	
East Fork Little Bear River Radio Repeater near Avon, Utah	
Little Bear River near Wellsville, Utah	19732
Little Bear River below Confluence of South and East Forks near Avon, Utah	19404
Grand Total	**243981**

Figure 3.14 Counts of temperature measurements in the Little Bear River Network

Tip:
To reassign or modify any of the components of the pivot table, see the informative text box in the top left corner of the Site Summary worksheet.

Using the pivot table, you can see that the site on the Little Bear River at Mendon Road has a lot of temperature data. Next you'll use the Time Series worksheet to download a time series of temperature data for this site.

3.5 Downloading Time Series

So far, you've used HydroExcel to explore data available in the Little Bear River sensor network. You've discovered that the site on the Little Bear River at Mendon Road has a lot of temperature data, so now you're ready to download a time series of temperature and see what's really happening at this site. You'll use the Time Series worksheet to download temperature data from August to December, 2007.

1. On the **Series Catalog** worksheet, right-click on the row containing the variable LBR:USU10 at the Little Bear River at Mendon Road (Figure 3.15) and select the HydroExcel menu from the displayed menu. Click the **Populate Time Series Parameters for LBR:USU10** option. This will fill out parameters for downloading temperature time series on the Time Series worksheet.

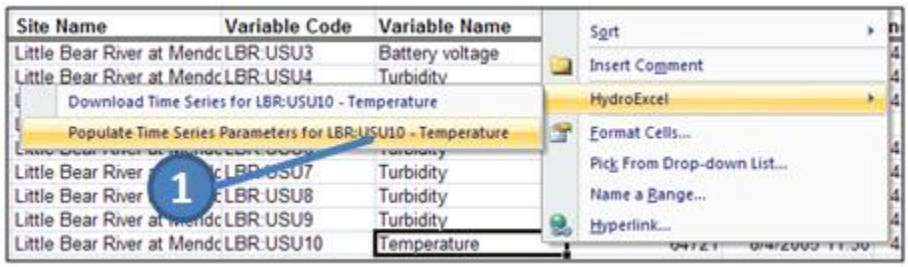


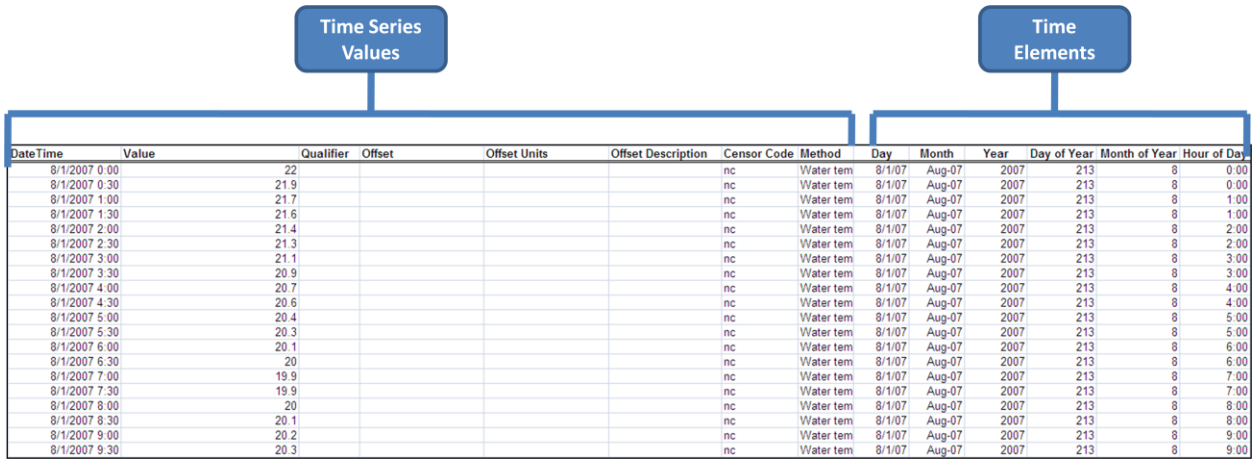
Figure 3.15 Populating Time Series Parameters

2. Activate the **Time Series** worksheet. This worksheet lets you download a time series of data for a single site and a single variable, over a certain time period.
3. Make sure "Ignore NoData Value" is checked. This specifies that you do not want HydroExcel to write NoData values to the worksheet. This helps you filter out periods when the sensor may have been down.
4. In cell G5 (next to the cell marked "Start Date"), input "**8/1/2007**."
5. In cell G6 (next to the cell marked "End Date"), input "**12/31/2007**."
6. Click the **Get Values** button.

Figure 3.16 Setting parameters for time series download

As the time series is retrieved, remember that you can watch the progress in the status bar in the bottom left corner of Excel. After a moment, the time series values are written to the worksheet. The time series not only includes properties sent back by the web service, but also additional fields which parse time elements from the DateTime for each value (Figure 3.17). These time elements are used in a pivot table for time series, which you will work with in the next section. For now you'll take a look at the time series information returned by the web service. These columns include:

- **DateTime –** The datetime at which a time series value is recorded.
- **Value –** The time series value.
- **Qualifier** – Indicates some peculiarity of a time series value, e.g., the value has been flagged as pending for further review by the data source.
- **Offset –** An offset from the sensor or some datum where the measurement was taken.
- **Offset Units** – Units of measure for the offset.
- **Offset Description –** Description of the offset, e.g., "depth below water surface."
- **Censor Code –** If not equal to "nc" (i.e., "not censored"), this indicates that the time series values are censored in some way. For example, "lt" would indicate that the magnitude of the measured phenomenon was less than what the sensor could measure. When this happens, the time series value reported is usually the lower limit of measurement of the sensor. Thus, the value of the phenomenon is actually less than (hence, "lt") the time series value reported.
- **Method –** The method by which the measurement was taken.



DateTime	Value	Qualifier	Offset	Offset Units	Offset Description	Censor Code	Method	Day	Month	Year	Day of Year	Month of Year	Hour of Day
8/1/2007 0:00	22					nc	Water tem	8/1/07	Aug-07	2007	213	8	0:00
8/1/2007 0:30	21.9					nc	Water tem	8/1/07	Aug-07	2007	213	8	0:00
8/1/2007 1:00	21.7					nc	Water tem	8/1/07	Aug-07	2007	213	8	1:00
8/1/2007 1:30	21.6					nc	Water tem	8/1/07	Aug-07	2007	213	8	1:00
8/1/2007 2:00	21.4					nc	Water tem	8/1/07	Aug-07	2007	213	8	2:00
8/1/2007 2:30	21.3					nc	Water tem	8/1/07	Aug-07	2007	213	8	2:00
8/1/2007 3:00	21.1					nc	Water tem	8/1/07	Aug-07	2007	213	8	3:00
8/1/2007 3:30	20.9					nc	Water tem	8/1/07	Aug-07	2007	213	8	3:00
8/1/2007 4:00	20.7					nc	Water tem	8/1/07	Aug-07	2007	213	8	4:00
8/1/2007 4:30	20.6					nc	Water tem	8/1/07	Aug-07	2007	213	8	4:00
8/1/2007 5:00	20.4					nc	Water tem	8/1/07	Aug-07	2007	213	8	5:00
8/1/2007 5:30	20.3					nc	Water tem	8/1/07	Aug-07	2007	213	8	5:00
8/1/2007 6:00	20.1					nc	Water tem	8/1/07	Aug-07	2007	213	8	6:00
8/1/2007 6:30	20					nc	Water tem	8/1/07	Aug-07	2007	213	8	6:00
8/1/2007 7:00	19.9					nc	Water tem	8/1/07	Aug-07	2007	213	8	7:00
8/1/2007 7:30	19.9					nc	Water tem	8/1/07	Aug-07	2007	213	8	7:00
8/1/2007 8:00	20					nc	Water tem	8/1/07	Aug-07	2007	213	8	8:00
8/1/2007 8:30	20.1					nc	Water tem	8/1/07	Aug-07	2007	213	8	8:00
8/1/2007 9:00	20.2					nc	Water tem	8/1/07	Aug-07	2007	213	8	9:00
8/1/2007 9:30	20.3					nc	Water tem	8/1/07	Aug-07	2007	213	8	9:00

Figure 3.17 Time series of temperature data for the Little Bear River at Mendon Road

3.6 Analyzing the Time Series

Similar to the series catalog pivot table from before, HydroExcel includes a pivot table for time series. You'll use this pivot table to help you understand the time series of temperature data that you just downloaded for the Little Bear River at Mendon Road.

Note:
The pivot table for the Excel 2003 version of HydroExcel is set up a bit differently than for the 2007 version. If you are using Excel 2003, you should still be able to follow along this exercise to get an idea of what can be done with the pivot table.

1. Activate the **Statistics and Charts** worksheet. Take a moment to examine the pivot table.

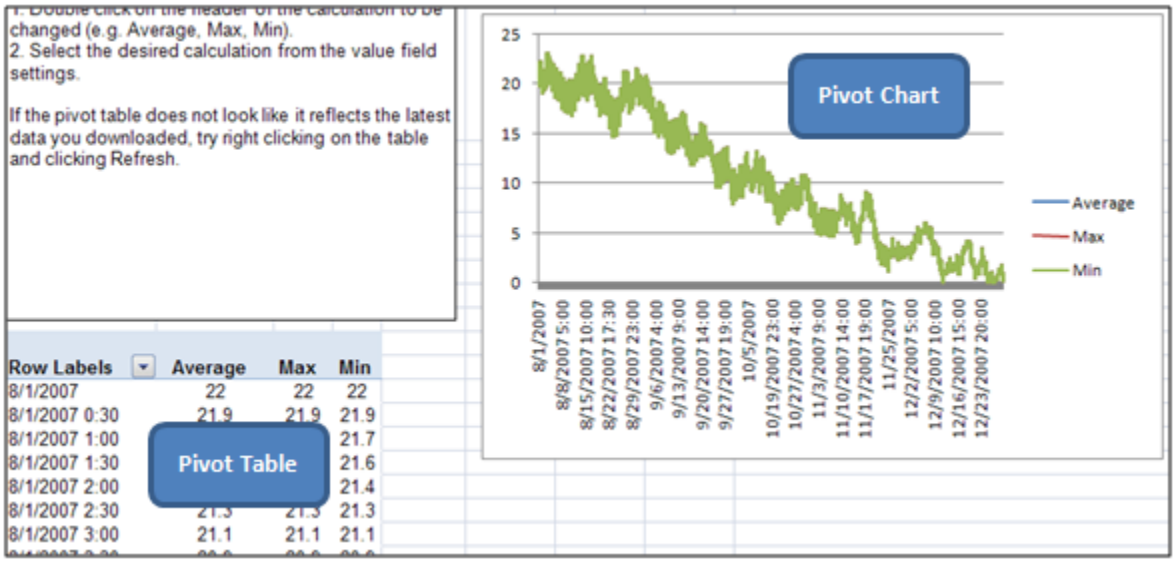


Figure 3.18 Pivot table and chart for time series data

2. This pivot table (Figure 3.18) uses a time element as the Row Labels. By default, the time element is the actual datetime for each time series value.

Note:
By default, the pivot table for the Excel 2003 version is showing Hour of Day as the time element.

The pivot table values are statistics on the time series values, such as average, max, and min. The pivot chart shows a chart of the pivot table. From the chart, you can gather that the temperature at this sensor location drops from August to December. But now take another view of the data, to see how temperature tends to change throughout the day.

Note:
If you are using Excel 2003, please follow the instructions in the informative text box in the Statistics and Charts worksheet in order to work with the pivot table.

3. Click anywhere on the data table to bring up the pivot table field list. The field list tends to show up on the right side of the application window.
4. In the pivot table field list, uncheck **DateTime**.
5. Drag **Hour of Day** to the Row Labels box.

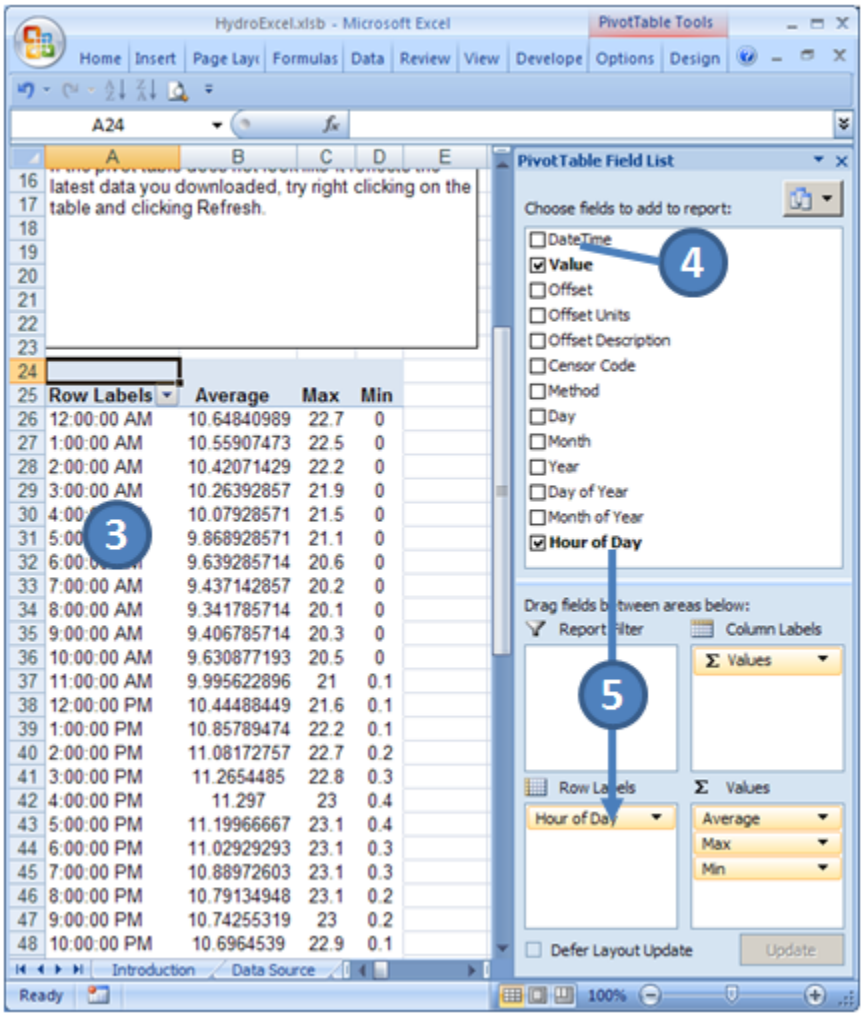


Figure 3.19 Changing row labels to show Hour of Day

The pivot table and chart are automatically updated to show the data summarized by hour of day. This means that, for each hour of the day, all the time series values that occur within that hour are summarized. Even though this process combines values from August and December into the same summary statistic, one can still clearly see the diurnal variation of temperature throughout the day in the pivot chart.

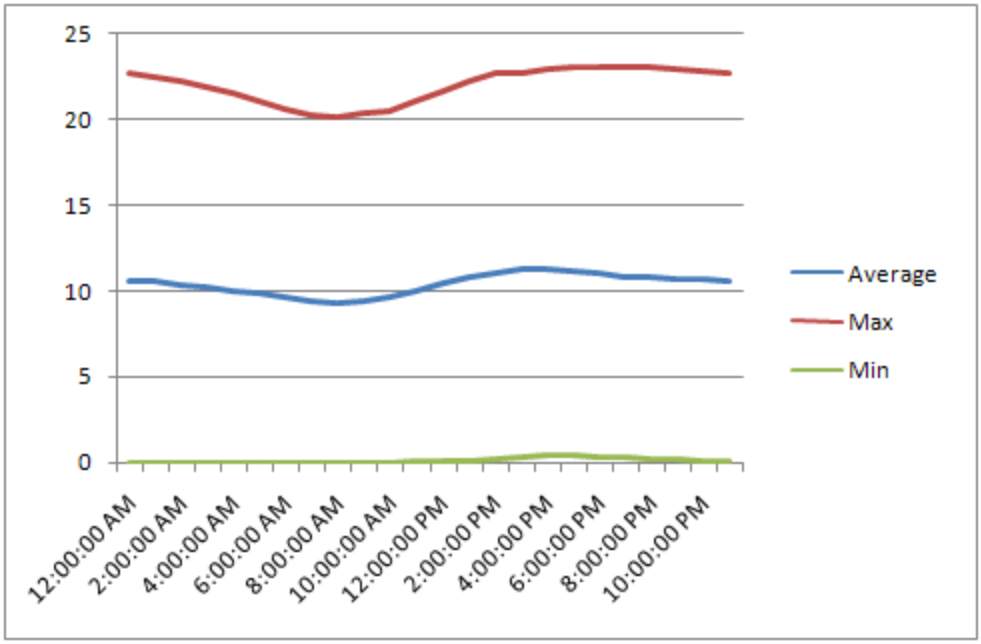


Figure 3.20 Diurnal variation of temperature (degrees C) at the Little Bear River at Mendon Road

As you can see from the PivotTable Field List, there are other fields which parse out various aspects of the time stamp. These refer to the Time Element fields as shown in Figure 3.17.

Congratulations! You have completed the last step in this walkthrough. You have used HydroExcel to download information from the WaterOneFlow web service describing the Little Bear River sensor network. You obtained site and variable information, showed sites in Google Earth, and analyzed a time series of Temperature data for the Little Bear River at Mendon Road.

At this point, you should have a basic understanding of how to operate HydroExcel. For more details about how HydroExcel works, please see the Software Reference section.

4 Software Reference

This section provides details about the operation of the HydroExcel software. **This section assumes that you have completed the walkthrough in the previous section, and are familiar with HydroExcel.** Details in this section supplement details given in the walkthrough. General tips for working with HydroExcel are followed by descriptions of each worksheet.

4.1 General Guidelines and Tips

This section provides general guidelines and tips that apply to HydroExcel.

4.1.1 Working with Macros

HydroExcel uses macros. If you want to modify HydroExcel to suit your needs, or if you just want to see how HydroExcel works, then the macros are a good place to start. This document won't go into the details of every macro in HydroExcel, but will rather give a sense for how the macros are organized. You'll now examine the macros for the Variables worksheet.

1. In HydroExcel, press **ALT+F11** on your keyboard. This opens the Visual Basic for Applications (VBA) editor.

Tip:
To view macros in Excel, you can either use the shortcut (press **ALT+F11**), or right-click the sheet's tab (at the bottom of the window) and choose **View Code**.

2. On the left, you should see the Project Explorer. This lists the main Excel objects and modules in HydroExcel. If you can't see the Project Explorer, click **View | Project Explorer** from the VBA window.

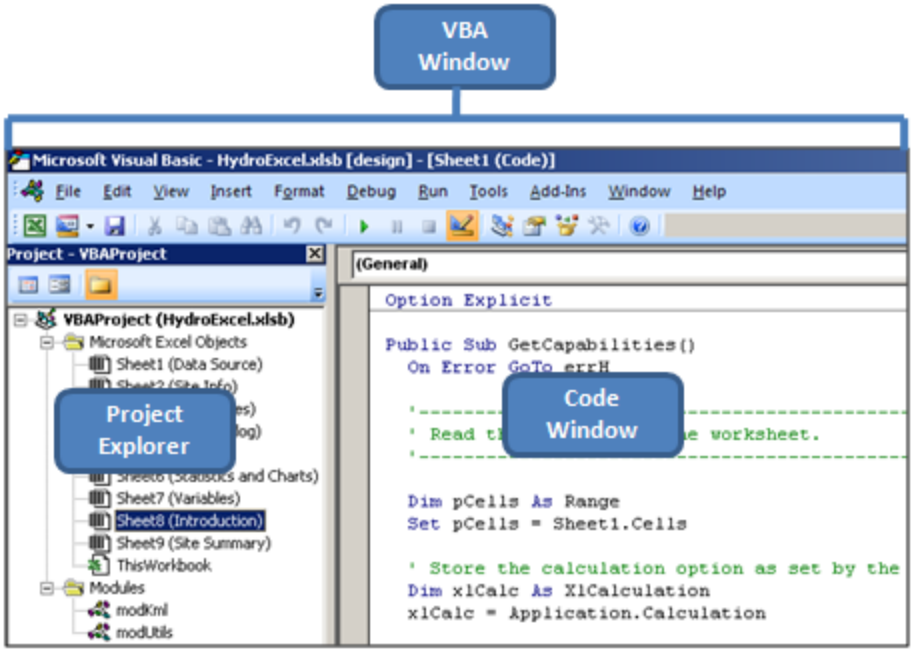


Figure 4.1 VBA window

For the most part, the macros for a given worksheet are located within the worksheet itself. There are also a couple of modules that provide functions commonly used by all worksheets:

- **modKml** – Contains functions for generating KML files.
- **modUtils** – Contains general functions.

Now you'll view the code for the Variables worksheet. The general workflow of the macros here is how macros for all worksheets tend to work.

3. In the Project Explorer, double click **Sheet 7 (Variables)** to open the macros for the Variables worksheet.
4. In the Code Window, scroll to the bottom to find the **GetVariablesButton_Click** procedure.

```
Private Sub GetVariablesButton_Click()
On Error GoTo errH

  Application.Cursor = xlWait
  GetVariables
  Application.Cursor = xlDefault

  Exit Sub

errH:
  MsgBox "Error: " & Err.Description
  Application.Cursor = xlDefault
End Sub
```

Figure 4.2 GetVariablesButton_Click procedure

The *_Click() procedures are the ones associated with button clicks from the worksheets. The GetVariablesButton_Click procedure is called when you click Get Variables on the Variables worksheet. The basic workflow here is:

A. Set the mouse cursor to the hourglass.
B. Call another procedure to perform the major work.
C. Set the mouse cursor back to the pointer.

If any unhandled errors occurred, the error handler in this procedure would catch them and report them.

Now you'll take a look at what the GetVariables procedure does.

5. Left click on **GetVariables** to place the mouse cursor within the context of that function name.
6. Press **SHIFT+F2** to jump to the definition of that procedure (or right-click on the function name and choose **Definition**).

Now you're looking at the main procedure which calls the web service and writes the output to the spreadsheet. As you can see, there are comments in the code (the green text) to help you understand what's going on. The basic workflow for these types of procedures is:

A. Read inputs from the worksheet.
    a. Read values from the cells where the user supplies inputs.
    b. Reformat values if necessary.
    c. Set the calculation option for Excel to manual. This speeds up processing. Later, this option is set back to the initial setting.
    d. Clear the cells that may have output from a previous call to the web service. When we clear cells, we just clear the contents of the cells, preserving any formatting. The exception is the Series Catalog, in which we clear everything (in order to remove the green tint on some cells).
B. Download XML from the web service.
    a. Create a WebServiceWrapper object from HydroObjects. This is the object that will call the web service.
    b. Make sure we can talk to the web service.
    c. If this is the first time that we've accessed the web service in this instance of Excel, clear the cache for the web service. The cache will be rebuilt, which insures that we're using the most up-to-date version of the service. If this isn't the first time, then don't clear the cache. We'll assume our existing cache is ok, which enhances performance since we're not rebuilding anything.
    d. Call the method to get back data from the web service.
    e. Make sure something was returned.
C. Determine some options about how we should process the output.
    a. Determine the maximum row we can write to. (If we try to write data to a row that is higher than the maximum row in Excel, we'll get an error.)
    b. Set up a counter so that the user can see progress.
D. Parse information out of the XML and write it to the spreadsheet. This usually involves XPath queries to find the data we're after in the XML. For more information about XPath, search online for an XPath reference by W3Schools.
E. Report the Result.

a. Provide a message box indicating success/failure of download.
b. Reset the calculation option to the initial setting.

As you follow that workflow, you should get a good understanding of how each worksheet works.

Feel like modifying macros?
If you're thinking of modifying the macros, first you should make sure you have a backup of HydroExcel. Next you should make sure you understand the scope of your edits. You don't want to edit one worksheet, and discover that the edit broke another worksheet. The worksheets tend to work fairly independently of each other. Exceptions include:

- The Data Source worksheet looks for and calls the main procedures in the Sites, Variables, Site Info, and Series Catalog worksheets.
- The Series Catalog worksheet can obtain a list of sites from the Sites worksheet.
- The Site Summary worksheet listens for a switch from the Series Catalog worksheet to know when the pivot table needs to be refreshed. The name of the variable it looks for is "g_sitePivotTableDirty."
- The Statistics and Charts worksheet listens for a switch from the Time Series worksheet to know when the pivot table needs to be refreshed. The name of the variable it looks for is "g_tsPivotTableDirty."

4.1.2 Saving Web Service Responses

The macros in HydroExcel receive XML responses when they call web services. Data from these responses are parsed and written to cells in the spreadsheet. If you want to modify how these values are written, or if you want to maintain a log of data downloaded, you may want to save these XML responses to disk. To do this, perform the following steps.

1. From the Add-Ins toolbar tab, select the **HydroExcel** menu and chose the **Options** button (Figure 4.3).

Figure 4.3 The HydroExcel Menu

2. From the dialog box that is displayed, select the checkbox **Save downloaded WaterML files to disk**.
3. Click **OK** to dismiss the dialog box.

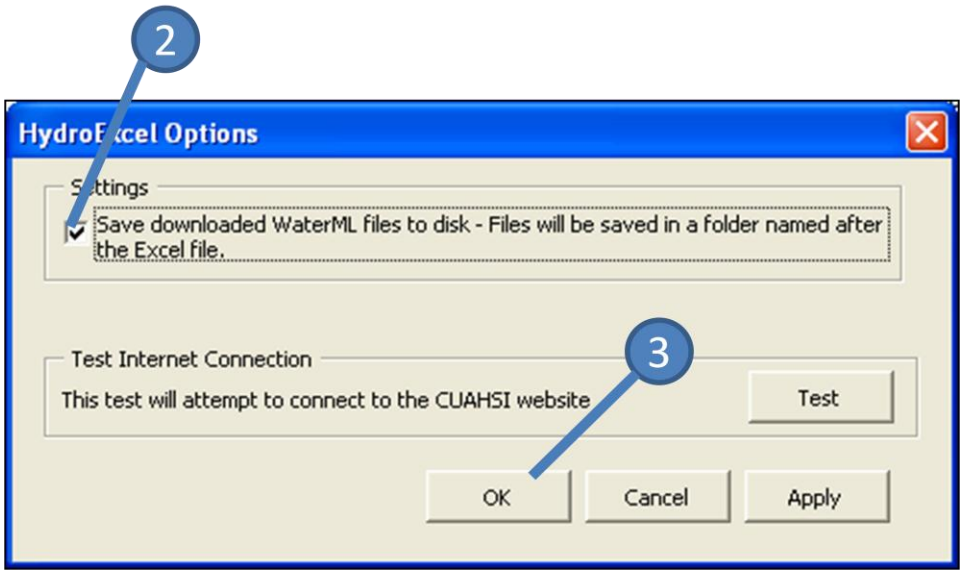


Figure 4.4 The HydroExcel Options

HydroExcel saves the downloaded WaterML and KML files to disk in a directory named after the Excel sheet. In this example the HydroExcel sheet was named HydroExcel and thus the folder created was also called HydroExcel. Observe the directory structure in Figure 4.5. A separate folder is created for each web service. WaterML and KML files are stored under the WaterML and KML directories respectively. Under the WaterML folder, a separate folder is created to store the WaterML generated by each method such as GetSites, GetValues etc.

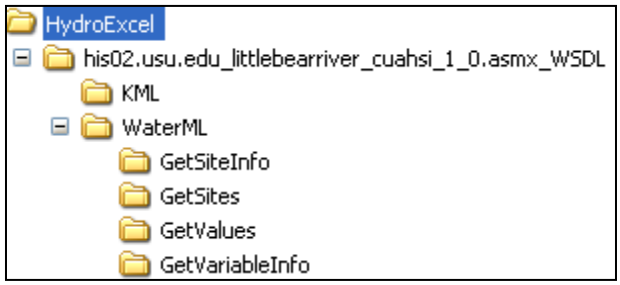


Figure 4.5 Directory Structure of downloaded responses

If you want to modify the macros to return variable information in a different way, it's a good idea to open a WaterML file from within one of these folders to see where the various bits of information are located, and then construct the right XPath queries in the macros to navigate to those elements in XML.

Viewing the WaterML files can also be useful to debug HydroExcel. For example, if HydroExcel is not displaying information that you think it should, you can look in the WaterML file to see whether or not that information was returned from the web service.

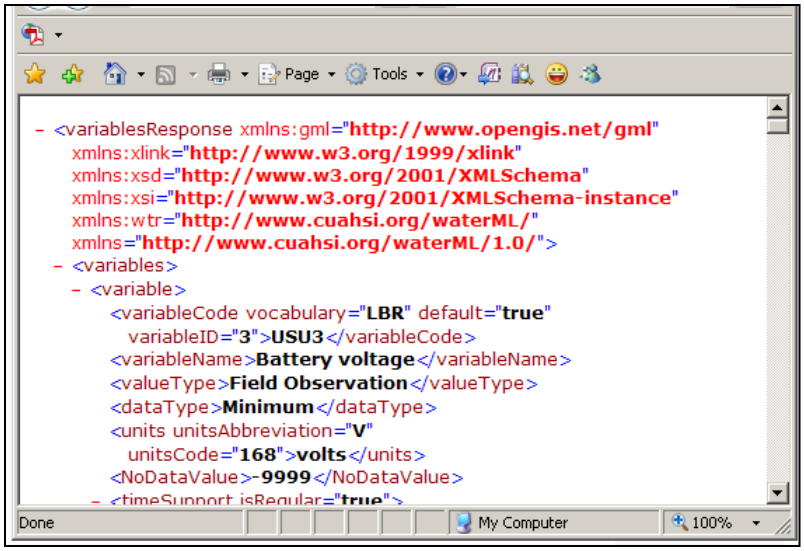


Figure 4.6 GetVariableInfo web service response

4.1.3 Preserving Cell References

HydroExcel reads and writes data from specific cell references. If you change these cell references, HydroExcel will most likely not work correctly. Therefore, if you want to add your own edits to the spreadsheet, you should know which cells the macros in HydroExcel work with.

For the most part, these cells should be obvious. Any of the input cells (the ones next to **green** colored cells at the top of a worksheet) must remain in their current locations. For output cells that write a series of data, such as time series values or a list of sites, the range of cells to avoid modifying extends all the way to the last row in the worksheet.

As for other cells, you should be able to modify them to add your own content without any negative impacts to HydroExcel's macros.

Tip:
If adding your own content to HydroExcel, be **very** careful when inserting rows and columns. The cells that HydroExcel uses may be shifted over, but the macros have no way of knowing this shift occurred, and so they will read the wrong cells.

As a visual aid in determining which cells HydroExcel reads and writes, the following figures highlight these areas in **yellow** for each worksheet.

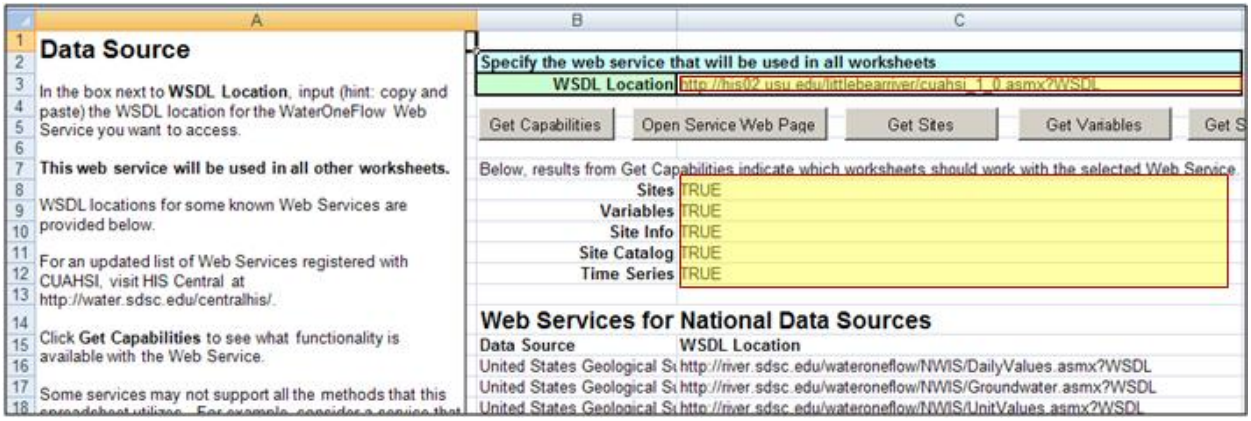


Figure 4.7 Active cells in the Data Source worksheet

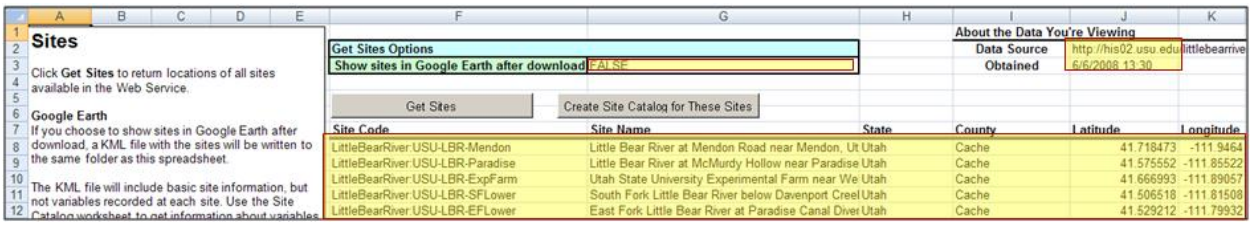


Figure 4.8 Active cells in the Sites worksheet

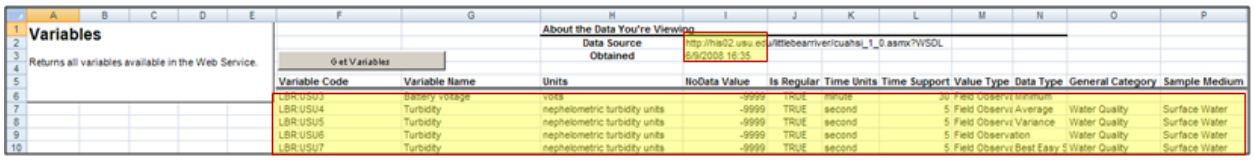


Figure 4.9 Active cells in the Variables worksheet

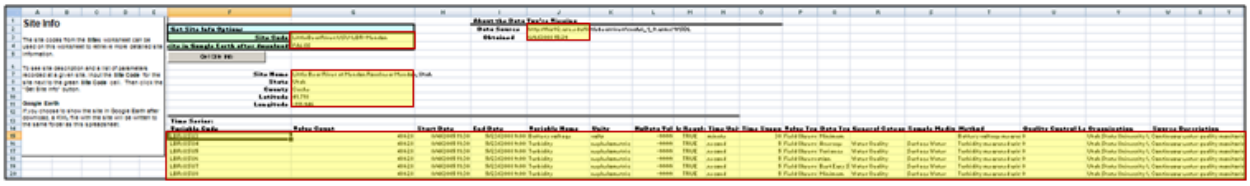
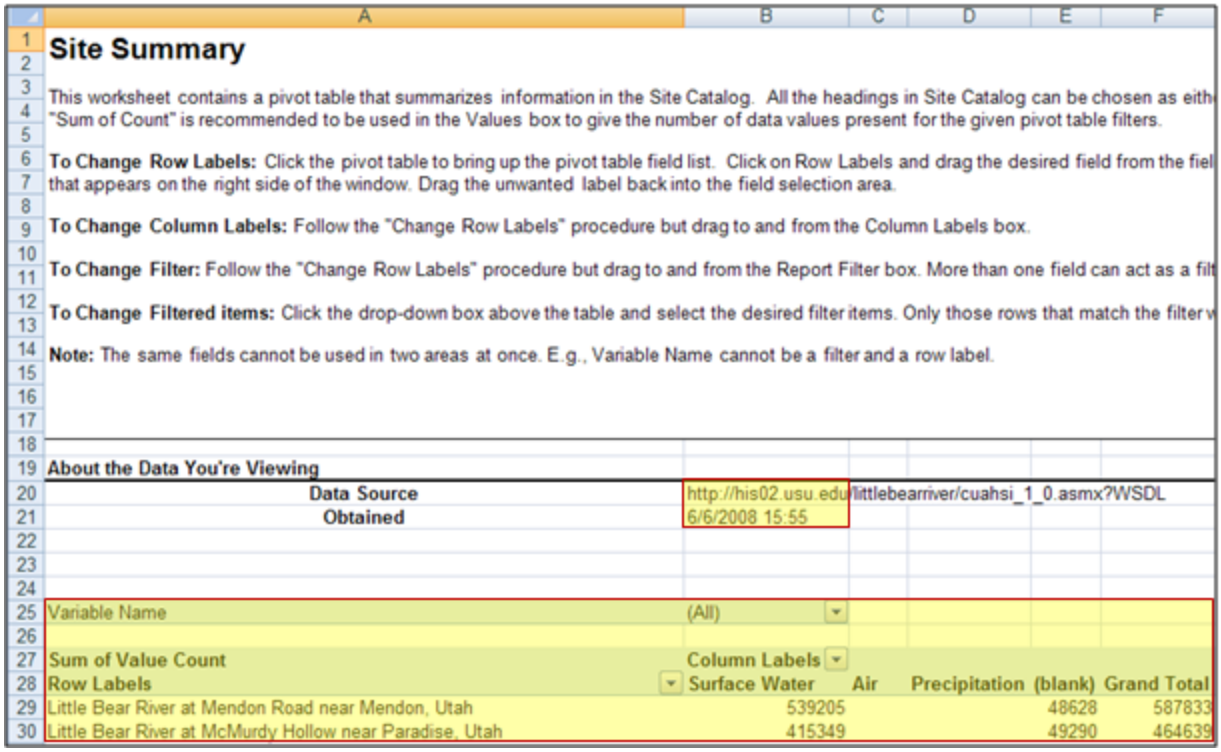


Figure 4.10 Active cells in the Site Info worksheet

Figure 4.11 Active cells in the Series Catalog worksheet



Site Summary

This worksheet contains a pivot table that summarizes information in the Site Catalog. All the headings in Site Catalog can be chosen as eith
"Sum of Count" is recommended to be used in the Values box to give the number of data values present for the given pivot table filters.

To Change Row Labels: Click the pivot table to bring up the pivot table field list. Click on Row Labels and drag the desired field from the fiel
that appears on the right side of the window. Drag the unwanted label back into the field selection area.

To Change Column Labels: Follow the "Change Row Labels" procedure but drag to and from the Column Labels box.

To Change Filter: Follow the "Change Row Labels" procedure but drag to and from the Report Filter box. More than one field can act as a filt

To Change Filtered items: Click the drop-down box above the table and select the desired filter items. Only those rows that match the filter w

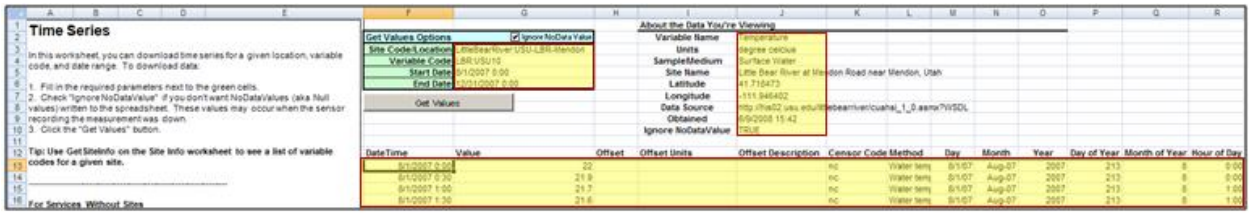
Note: The same fields cannot be used in two areas at once. E.g., Variable Name cannot be a filter and a row label.

About the Data You're Viewing

Data Source	http://his02.usu.edu/littlebearriver/cuahsi_1_0.asmx?WSDL
Obtained	6/6/2008 15:55

Variable Name	(All)				
Sum of Value Count	**Column Labels**				
Row Labels	**Surface Water**	**Air**	**Precipitation**	**(blank)**	**Grand Total**
Little Bear River at Mendon Road near Mendon, Utah	539205			48628	587833
Little Bear River at McMurdy Hollow near Paradise, Utah	415349			49290	464639

Figure 4.12 Active cells in the Site Summary worksheet



Time Series

In this worksheet, you can download time series for a given location, variable code, and date range. To download data:

1. Fill in the required parameters next to the green cells.
2. Check "Ignore NoDataValue" if you don't want NoDataValues (aka Null values) written to the spreadsheet. These values may occur when the sensor recording the measurement was down.
3. Click the "Get Values" button.

Tip: Use GetSiteInfo on the Site Info worksheet to see a list of variable codes for a given site.

For Services Without Sites

Get Values Options	
Ignore NoData Value	
Site Code/Location	LittleBearRiver:USU-LBR-Mendon
Variable Code	LBR:USU10
Start Date	8/1/2007 0:00
End Date	8/31/2007 0:00

Get Values

About the Data You're Viewing

Variable Name	Temperature
Units	degree celcius
SampleMedium	Surface Water
Site Name	Little Bear River at Mendon Road near Mendon, Utah
Latitude	41.710473
Longitude	-111.946402
Data Source	http://his02.usu.edu/littlebearriver/cuahsi_1_0.asmx?WSDL
Obtained	6/6/2008 15:42
Ignore NoDataValue	TRUE

DateTime	Value	Offset	Offset Units	Offset Description	Censor Code	Method	Day	Month	Year	Day of Year	Month of Year	Hour of Day
8/1/2007 0:00	22				nc	Water temp	8/1/07	Aug-07	2007	213	8	0:00
8/1/2007 0:30	21.9				nc	Water temp	8/1/07	Aug-07	2007	213	8	0:00
8/1/2007 1:00	21.7				nc	Water temp	8/1/07	Aug-07	2007	213	8	1:00
8/1/2007 1:30	21.6				nc	Water temp	8/1/07	Aug-07	2007	213	8	1:00

Figure 4.13 Active cells in the Time Series worksheet

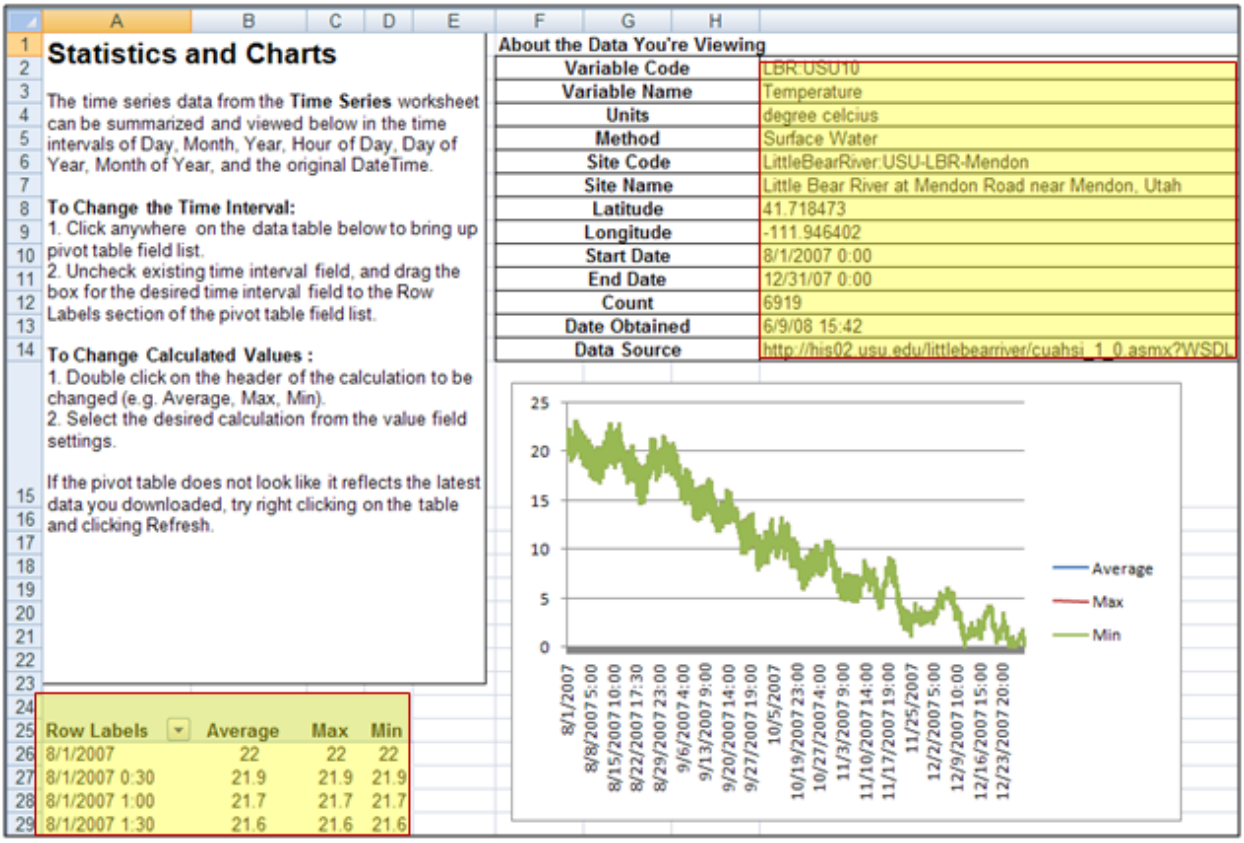


Figure 4.14 Active cells in the Statistics and Charts worksheet

4.1.4 SOFTWARE LIMITATIONS

In addition to the prerequisites associated with installing and running HydroExcel, the user should also be aware of software limitations. These limitations are related to limitations within Excel, and also with the way the macros were programmed.

No dates before 1/1/1900

Excel does not handle dates before 1/1/1900. You might see odd dates, or #VALUE!, if you ask for data before 1/1/1900, or if the period of record for a variable at a site begins before 1/1/1900.

No data past row limits

Excel allows a finite number of rows, so be careful when asking for a lot of data. For Office 2003, the limit is 65,536 rows. For Office 2007, the limit is 1,048,576 rows. You might get "Run-time error '1004'" if the macros in this spreadsheet attempt to write to rows beyond the row limits of Excel.

Time zone is ignored

Time zone information is ignored when parsing datetimes. In other words, the datetime returned from the web service is used, without considering any time zone information returned from the web service. This is because Excel does not include time zone information in its date format.

Invalid KML characters

Some worksheets in HydroExcel produce KML files which represent information from the web service in a format that can be read by Google Earth. Each site placemark in a KML file includes a site description. A web service may return information about a site that includes the "<" or "&" characters, as in "Site 42 at the intersection of Parmer Lane & Mopac Blvd." When this happens, the site descriptions may not show up correctly, because "<" and "&" are special characters in KML. The site placemark will still be visible in the map, but the site description for the placemark may appear to be incomplete.

4.1.5 Canceling Long Operations

Downloading and processing data from web services may take a long time. For long operations, HydroExcel shows progress in Excel's status bar, which is typically located in the bottom left corner of Excel.

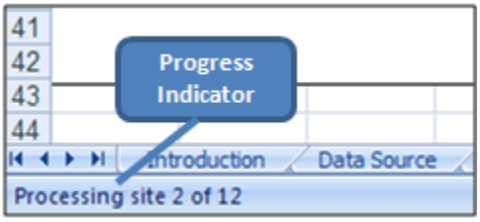


Figure 4.15 Progress for long operations is shown in the Excel status bar

If you click one of the buttons in HydroExcel and find that the operation is taking too long, you can cancel an operation by interrupting the macro running it. However, this will also prevent the macro from performing the normal cleanup at the end of an operation, which involves tasks like resetting the status bar and mouse cursor. In this case, you would need to run a special macro that has been built just for cleanup purposes.

The procedure to cancel an operation is:

1. Press **CTRL+PAUSE/BREAK** or **ESC** on your keyboard. (The PAUSE/BREAK key is usually located next to the SCROLL LOCK key.) This pauses macro execution, and displays a message box stating that the execution was interrupted. Click **OK** to dismiss the box.

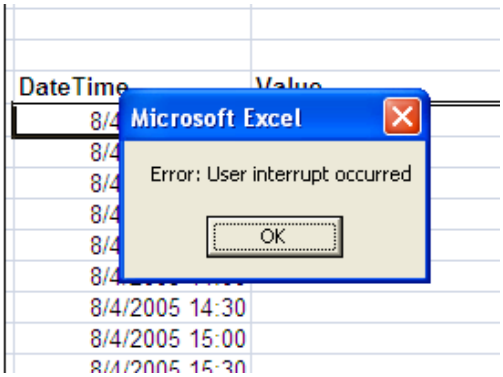


Figure 4.16 Interrupting code execution

2. In the event of a box such as Figure 4.17 being presented, perform the steps 3-6

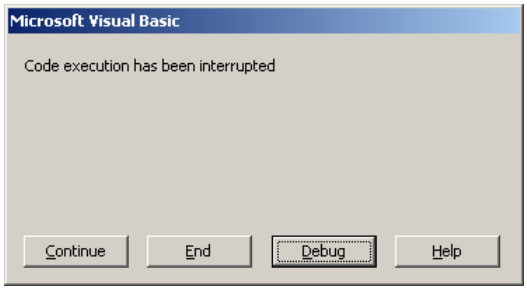


Figure 4.17 Interrupting code Execution

3. Click **End** to stop the operation. (You could also click Continue to continue the operation, or Debug to jump into the VBA code and execute the code line by line.) At this point, your mouse cursor is probably still an hourglass. You will reset the mouse cursor with another macro.
4. Press **ALT+F8** to open the macros window.
5. Highlight the **ResetCursor** macro and click **Run**.

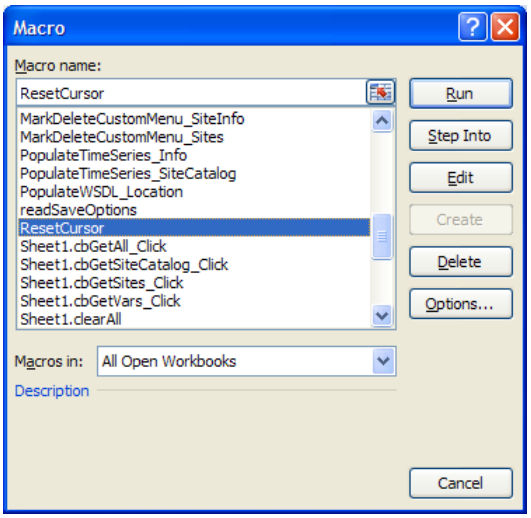


Figure 4.18 Running the macro to reset the mouse cursor after canceling an operation

6. HydroExcel changes the Excel calculation option to Manual in order to speed up processing. If the ResetCursor macro detects that the spreadsheet is currently under manual calculation mode, it will prompt you to change it to Automatic calculation mode. Most likely, you will want to click **Yes** here to change it back to Automatic calculation mode.

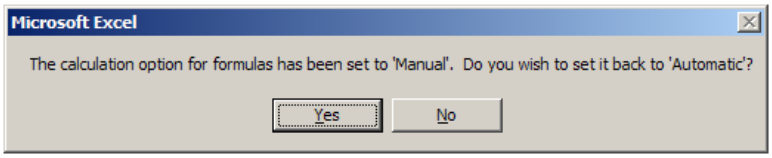


Figure 4.19 Resetting the calculation option

The spreadsheet should now be “back to normal” and ready for operation.

This procedure for canceling operations and the other tips provided in this section apply to the spreadsheet in general. Additional tips for working with each worksheet are provided in the following sections.

4.2 Introduction Worksheet

The introduction worksheet does not possess any special functionality.

4.3 Data Source Worksheet

4.3.1 Get Capabilities

To check capabilities of a web service, HydroExcel simply reads the WSDL for the service and looks for text that matches certain WaterOneFlow methods. These are the methods called by the worksheets in HydroExcel. The methods that are checked are shown in Table 4.1.

Table 4.1 WaterOneFlow web methods used by worksheets in HydroExcel

Worksheet	WaterOneFlow Web Methods Used
Sites	GetSites
Variables	GetVariableInfo
Site Info	GetSiteInfo
Series Catalog	GetSites, GetSiteInfo
Time Series	GetValues

HydroExcel indicates if a worksheet should work with the selected web service by writing TRUE or FALSE to the Data Source worksheet.

HydroExcel does not check if a given method will work. It only looks for the presence of the method. Thus, even if HydroExcel indicates that a given worksheet should work with the selected web service, HydroExcel may still report an error if the method is broken or invalid inputs are provided to the method.

4.3.2 Open Service Web Page

To find a more human-friendly text description of a web service, HydroExcel attempts to open the .asmx page for the service. It first looks for a cuahsi_1_0.asmx page, which is the pattern used by WaterOneFlow services attached to an Observations Data Model (ODM) database. If it cannot find cuahsi_1_0.asmx, it just looks for a page with the .asmx extension.

4.3.3 Get Sites

When the Get Sites button is clicked, HydroExcel activates the Sites worksheet and triggers the Get Sites button.

4.3.4 GET VARIABLES

When the Get Variables button is clicked, HydroExcel activates the Variables worksheet and triggers the Get Variables button.

4.3.5 GET SERIES CATALOG

When the Get Series Catalog button is clicked, HydroExcel activates the Series Catalog worksheet and triggers the Get Series Catalog button. It also sets the option to obtain the site list from the web service (as opposed to the list of sites on the Sites worksheet). The reason for this is that the Sites worksheet may still contain a site list from a previous web service and not be valid for the current web service in the Data Source worksheet.

4.3.6 GET ALL

When the Get All button is clicked, HydroExcel performs all the above actions, from determining the capabilities to populating the Series Catalog worksheet. It also populates parameters on the Time Series worksheet to download a time series. The time series is not automatically retrieved as one might want to change the date range rather than fetching all the available data.

4.3.7 CLEAR ALL

When the Clear All button is clicked, the data on all the worksheets pertaining to the active web service is cleared.

4.3.8 RIGHT-CLICK MENU

As seen in Figure 3.4, right-clicking on a row containing a web service WSDL URI displays the HydroExcel right-click menu. This menu gives the option of setting the currently selected web service as the active one. It also provides the option of retrieving information regarding that web service, such as information about sites, variables, and the series catalog.

Tip:
Besides using the right-click menu to select the data source, you can also directly edit cell C3 (next to the cell marked “WSDL Location”), and type or paste the address of a web service.

4.4 SITES WORKSHEET

For most web services listed in the Data Source worksheet, time series values are provided at discrete observation sites. You can get a list of those sites from the web service.

The layout of the Sites worksheet is shown in Figure 4.20.

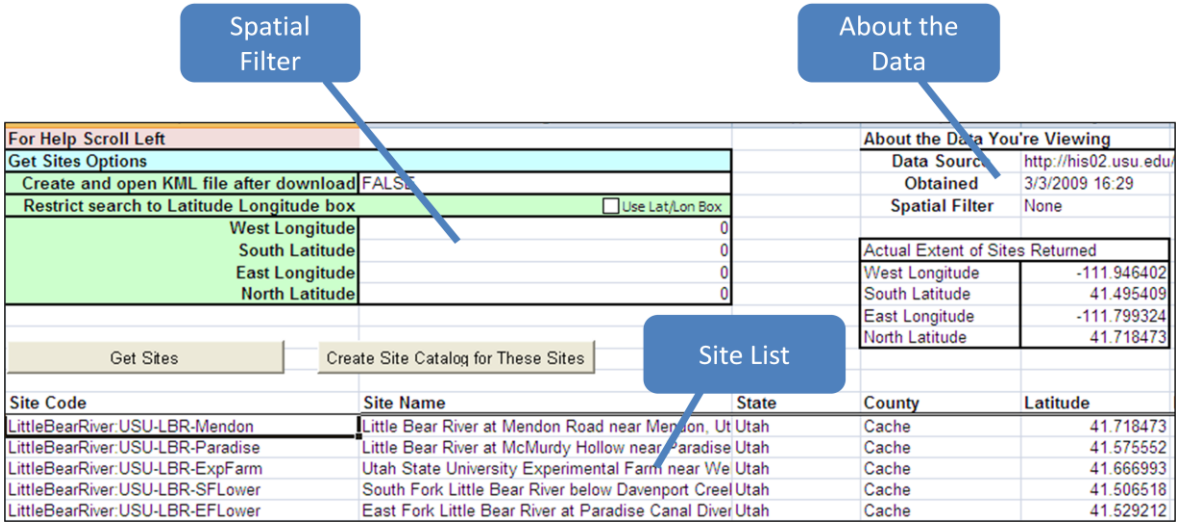


Figure 4.20 Layout of the Sites Worksheet

The Sites worksheet (Figure 4.20) has a site list, where each row in the list represents a single site. For each site, the following items are reported:

- **Site Code –** Unique identifier for each site, used by humans and programs to identify a specific site when making web service queries.
- **Site Name –** Used by humans as the more publicly recognizable name of a site.
- **State –** State that the site is in
- **County -** County that the site is in
- **Latitude** – Latitude of the site location in decimal degrees
- **Longitude -** Longitude of the site location in decimal degrees

In the top right, you will also find information about the data you are viewing. This includes the web service for which you have obtained the site list, the datetime when you downloaded the site list, and the actual spatial extent of the sites returned. When HydroExcel downloads data from a web service, it records the service location and access date in the spreadsheet to help preserve data provenance.

4.4.1 Using a KML Viewer with the Sites Worksheet

The following is an illustration of how to use a KML viewer such as Google Earth with the Sites worksheet. Notice the input that says “Create and open KML file after download.” If this item is set to TRUE, the Get Sites button will not only populate the Sites worksheet with a list of sites from the web service, but also generate a KML file that can be displayed in a KML viewer. This is a handy way of giving a spatial context to the sites from the spreadsheet. The KML file is saved on disk under a KML directory within a folder named after the web service, inside the same folder as the spreadsheet. If you have a KML viewer installed, the KML file is automatically opened with the KML viewer.

In the case of the Little Bear River network and Google Earth, Google Earth opens and zooms to sites in the Little Bear River network.

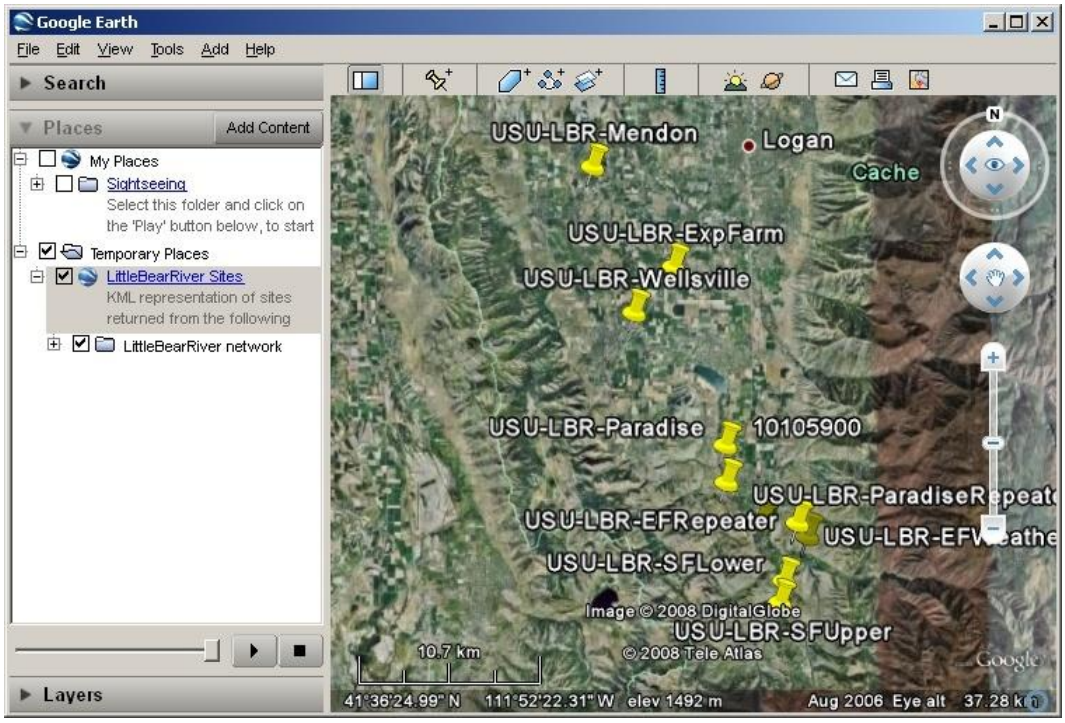


Figure 4.21 Little Bear River sites in Google Earth

In the Google Earth map window, you see placemarks for each site. The placemarks also show up under the Temporary Places folder in the Places panel on the left.

> **Note:**
> "Placemark" is a term used to describe a feature in Google Earth that has geometry.

You can click on a placemark in this folder to see more information about each placemark. You can also click on a placemark in the map to bring up the same information.

The generated KML files are saved to disk as *NetworkName*_Sites.kml, where *NetworkName* is the name of the observation network as read from the web service.

4.4.2 Using the Lat/Lon Box with Get Sites

Starting with Version 1.1.1, HydroExcel provides the option to restrict the extent of sites returned by a query to a particular box defined by latitude and longitude coordinates. To use this functionality select the checkbox labeled "Use Lat/Lon Box" and enter the latitudes and the longitudes of the bounding box.

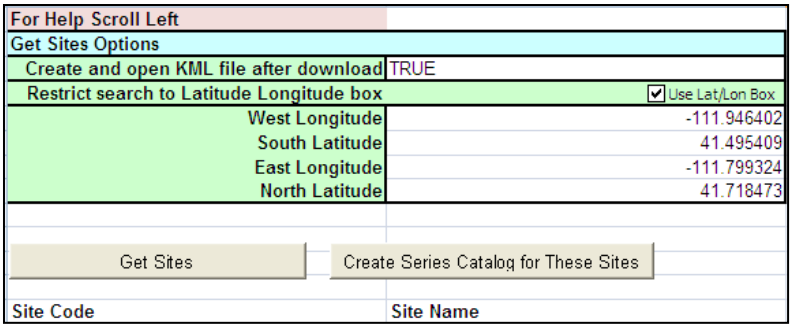


Figure 4.22 Using Spatial Filters

Not all web services support searching with spatial filters. If a particular service does not support this functionality, HydroExcel gives the user the option to retry the query without the filter as shown in Figure 4.23.

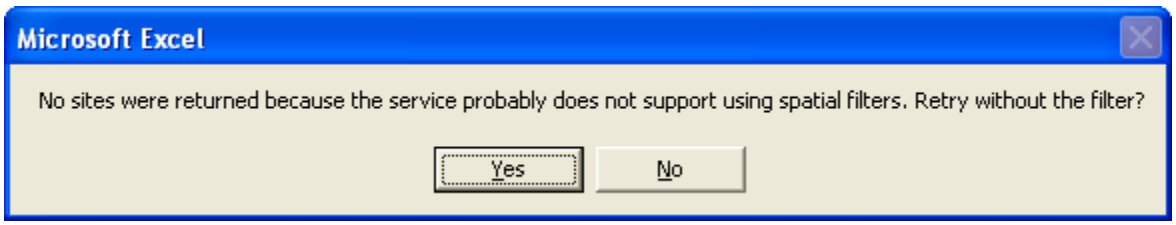


Figure 4.23 Dialog box for a site not supporting spatial filters

4.4.3 Create Series Catalog for These Sites

When the Create Series Catalog for These Sites button is clicked, HydroExcel activates the Series Catalog worksheet and triggers the Get Series Catalog button. It also sets the option to obtain the site list from the Sites worksheet (as opposed to using the web service). This gives you more control over sites that are obtained in the catalog. Rather than downloading the catalog for every site in the web service, you can filter the sites on the Sites worksheet and only retrieve the catalog for those sites.

The Series Catalog for a single site (or multiple sites) can also be obtained by right-clicking on a row containing a site (or a selected group of sites) from the table in the Sites worksheet. The menu displayed has a HydroExcel sub-menu. Clicking on the **Get Series Catalog** command from this menu creates the series catalog for selected sites.

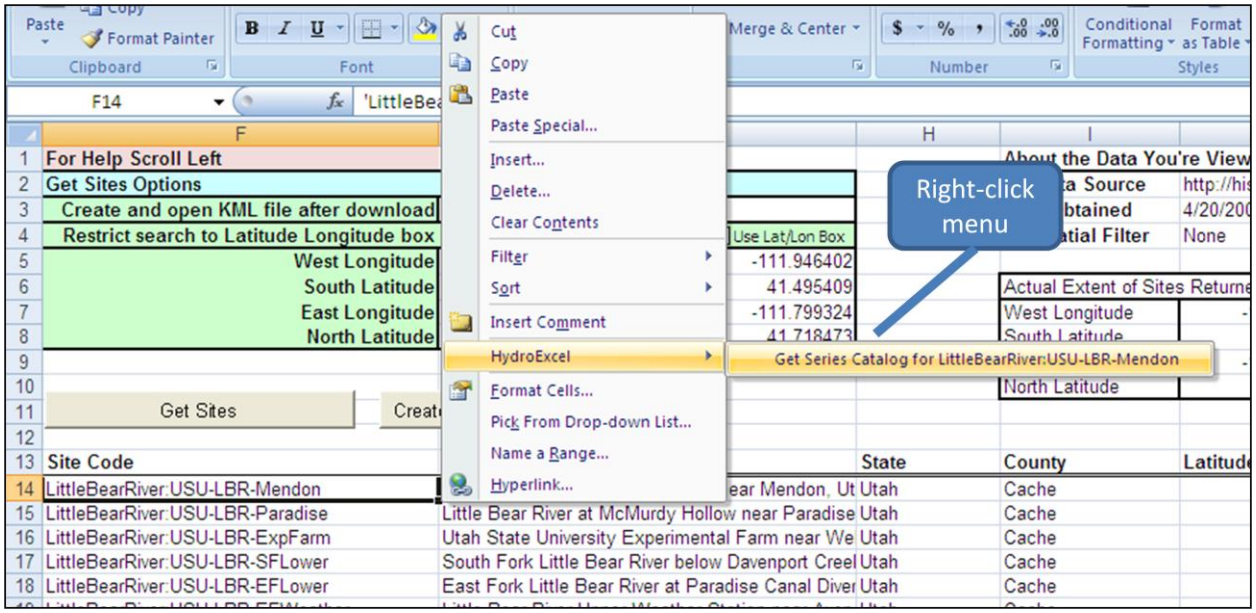
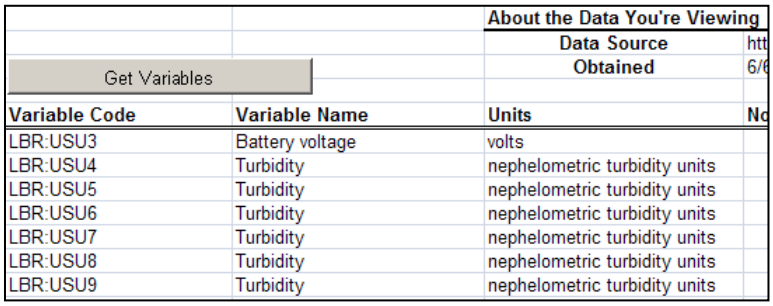


Figure 4.24 Using the right-click menu to build Series Catalog

Tip:
To filter sites, you can either delete rows for unwanted sites, or use Excel's native filtering functionality.

4.5 VARIABLES WORKSHEET

The list of all variables available through the active web service is displayed in this worksheet. Clicking the Get Variables button populates the worksheet with a list of variables and information about each variable.



Variable Code	Variable Name	Units	No
LBR:USU3	Battery voltage	volts	
LBR:USU4	Turbidity	nephelometric turbidity units	
LBR:USU5	Turbidity	nephelometric turbidity units	
LBR:USU6	Turbidity	nephelometric turbidity units	
LBR:USU7	Turbidity	nephelometric turbidity units	
LBR:USU8	Turbidity	nephelometric turbidity units	
LBR:USU9	Turbidity	nephelometric turbidity units	

Figure 4.25 Variables available from the Little Bear River sensor network

The information returned for each variable includes:

- **Variable Code –** Unique identifier for each variable in the observation network.
- **Variable Name –** Name of the phenomenon represented by this variable.
- **Units –** Units of measure for the variable.
- **Speciation –** For concentration measurements, the species in which the concentration is expressed (e.g., as N, or as NO3, or as NH4).

- **NoData Value –** Numerical value used to indicate that no data for the variable is available at a given datetime. This value shows up in a time series of values for a variable if, for example, a sensor went offline for a brief time.
- **Is Regular –** TRUE if the time series values are spaced regularly in time, such as with data measured once every 24 hours.
- **Time Units -** Units of the time support.
- **Time Support -** Numerical value that indicates the time support (or temporal footprint) of the data values. "0" is used to indicate data values that are instantaneous. Other values indicate the time over which the data values are implicitly or explicitly averaged or aggregated.
- **Value Type –** Indicates origin of the variable values, e.g., "Field Observation."
- **Data Type –** Indicates temporal qualities of the measurement, e.g., "Instantaneous."
- **General Category –** General category of the variable.
- **Sample Medium –** The medium in which the sample or observation was taken or made.

Note:
You may see a given variable name repeated several times in the variable list. In HydroExcel terms, a "variable" is actually a combination of all of the properties here, including variable name. For example, daily average turbidity and daily maximum turbidity are treated as different variables, even though the name of the variable in both cases is "Turbidity."

4.6 Site Info Worksheet

This worksheet provides information about what variables are measured at a particular site.

You can see basic site information such as site name and location as on the Sites worksheet, but now you also have the variables measured at this site. In addition to the variable descriptors included on the Variables worksheet, you also have additional descriptors that apply to the variable as measured at this site:

- **Value Count** – The number of measurements of this variable at this site.
- **Start Date –** Datetime of the first measurement for this variable.
- **End Date –** Datetime of the last measurement for this variable.
- **Method –** Method used to measure the variable.
- **Quality Control Level –** Provides some measure of data quality. Higher numbers mean higher quality assurance.
- **Organization –** The organization or entity providing the measurement.
- **Source Description –** Information on the original source of the observation (e.g. from a specific organization, agency, or investigator third party database).

It is possible to directly download the Time Series information for a particular variable from the Site Info worksheet. Right-clicking on the variable of interest brings up a menu with a HydroExcel sub-menu which offers the option of either downloading the entire Time Series for that variable or populating the parameters in the Time Series worksheet (Figure 4.26).

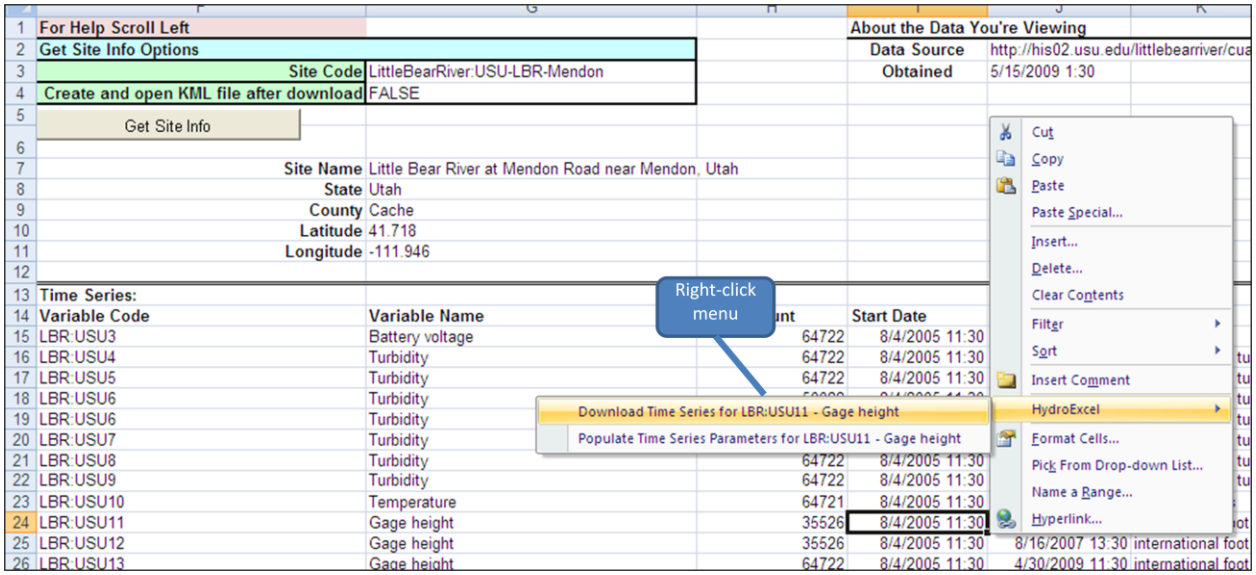


Figure 4.26 Site Info worksheet

Clicking **Download Time Series** retrieves all the available time series information for that particular variable. This can be a very time-consuming operation if tens or hundreds of thousands of values are available over the entire period of record for the variable. Selecting the **Populate Time Series** option only populates the parameters in the Time Series worksheet without actually fetching the information. This provides an option to edit the parameters such as start date and end date before proceeding to download the data.

When generating a KML file, the file is saved as *NetworkName_SiteCode*.kml, where *NetworkName* is the name of the observation network as read from the web service, and *SiteCode* is the site code for the site.

4.7 Series Catalog Worksheet

The Series Catalog worksheet has been described in detail in the walkthrough (see sections 3.3 and 3.5).

When generating a KML file for Google Earth, the file is saved as *NetworkName*_SeriesCatalog.kml, where *NetworkName* is the name of the observation network as read from the web service.

Sometimes site info cannot be read for a given site, and thus a list of variables measured at the site cannot be obtained. When this happens, a row will still be written for the site in the series catalog, but the variable code will show “Site Info Error” to indicate that site info could not be downloaded.

4.8 Site Summary Worksheet

The Site Summary worksheet has been described in some detail in the walkthrough (see section 3.4).

The pivot table on this worksheet dynamically references data in the Series Catalog worksheet. The dynamic reference reads the sites down to the first blank row in the Latitude column of the series catalog.

4.9 TIME SERIES WORKSHEET

The Time Series worksheet has been described in detail in the walkthrough (see section 3.5).

When a value cannot be recorded for a variable at a given time stamp, a “NoData value” such as -9999 is often used in place of the actual value. The Ignore NoData Value option in the Time Series worksheet is useful for filtering out data values that you may not want to include in the analysis. For example, if the NoData value for a water temperature variable is -9999, and if any NoData values are encountered in a time series for temperature, then a graph of temperature will look very strange since it will show temperature values of -9999. Sometimes it is important to know when no data are available at a given time stamp, but for other times, the Ignore NoData Value option can be used to prevent rows with NoData values from being written to the worksheet.

4.10 STATISTICS AND CHARTS WORKSHEET

The Statistics and Charts worksheet has been described in detail in the walkthrough (see section 3.6).

The pivot table on this worksheet dynamically references data in the Time Series worksheet. The dynamic reference reads the sites down to the first blank row in the DateTime column of the time series.

5 Frequently Asked Questions (FAQ)

Q. What version of Excel am I using?
A. The procedure to check the Excel version actually depends on the version, so if one of the procedures below doesn't work for you, then try the other one.

For Excel 2007:

1. Open Excel and click the **Office Button** in the upper left corner.
2. At the bottom of the menu that opens, click **Excel Options**.
3. In the Excel Options window, click the **Resources** button on the left.
4. At the right, click **About**.

For Excel 2003 and earlier:

1. Open Excel and click **Help | About Microsoft Office Excel**.

Q. Why are some cells (e.g., State or County on the Sites worksheet) blank when data come back from the web service?
A. Cells are blank when the expected information is not returned from the web service.

Q. Why does a variable name appear more than once for the list of variables for a given site?
A. A variable is defined by more than just its variable name. It takes all of the fields on the Variables worksheet to uniquely define a variable. For example, two variables could have the variable name "Temperature," but they are treated as separate variables if one variable records maximum daily temperature while the other records minimum daily temperature.

Q. Why does the site code always have a colon (":") in it?
A. When getting information about a site, WaterOneFlow web services expect a site to be provided as *NetworkName:SiteCode*, where *NetworkName* refers to the name of the observation network that a site belongs to. When referring to site codes, HydroExcel always includes the network name and colon along with the site code so that the user does not have to keep track of these two pieces of information. This "full" version of the site code can be input directly into the Site Code field on worksheets such as Time Series. In other words, the idea here is to make life easier for the user. Hopefully this has been achieved by combining the network name and site code in HydroExcel.

Q. When I show "Sites by Variable" in Google Earth, only a few sites show up. Where are the rest of my sites?
A. Sites will only show up if they measure the selected variable. Also, because a time span is associated with each site, if you are showing time in Google Earth, only sites whose period of record for the selected variable overlaps the chosen time point or time span in Google Earth will show up. To choose time options in older versions of Google Earth, click the **View** menu, and then point to **Show Time**.

6 TROUBLESHOOTING

Problem: When I open HydroExcel, I immediately get an error.

This may happen if HydroObjects is not installed. Close the spreadsheet, make sure HydroObjects is installed (under Control Panel | Add or Remove Programs, as “CUAHSI HydroObjects”), and then open the spreadsheet again.