Colorado's Decision Support System
Workshop

www.cdss.state.co.us

COLORADO DIVISION OF WATER RESOURCES

Colorado Decision Support System
Overview and Training Session

Training Material Contents:

CDSS Overview

What is CDSS?

"Colorado's Decision Support System (CDSS) is a water management system being developed by the Colorado Water conservation Board and the Colorado Division of Water Resources. The goal of this system is to assist in making informed decisions regarding historic and future use of water"

When?

1992 – Colorado State Legislature authorized CWCB to conduct a needs analysis and feasibility study for a Colorado River Decision Support System
1992 – Colorado River DSS development (HydroBase development)
1998 – Rio Grande DSS development
2001 – South Platte DSS development
2009 – Arkansas DSS Feasibility Study

Why?

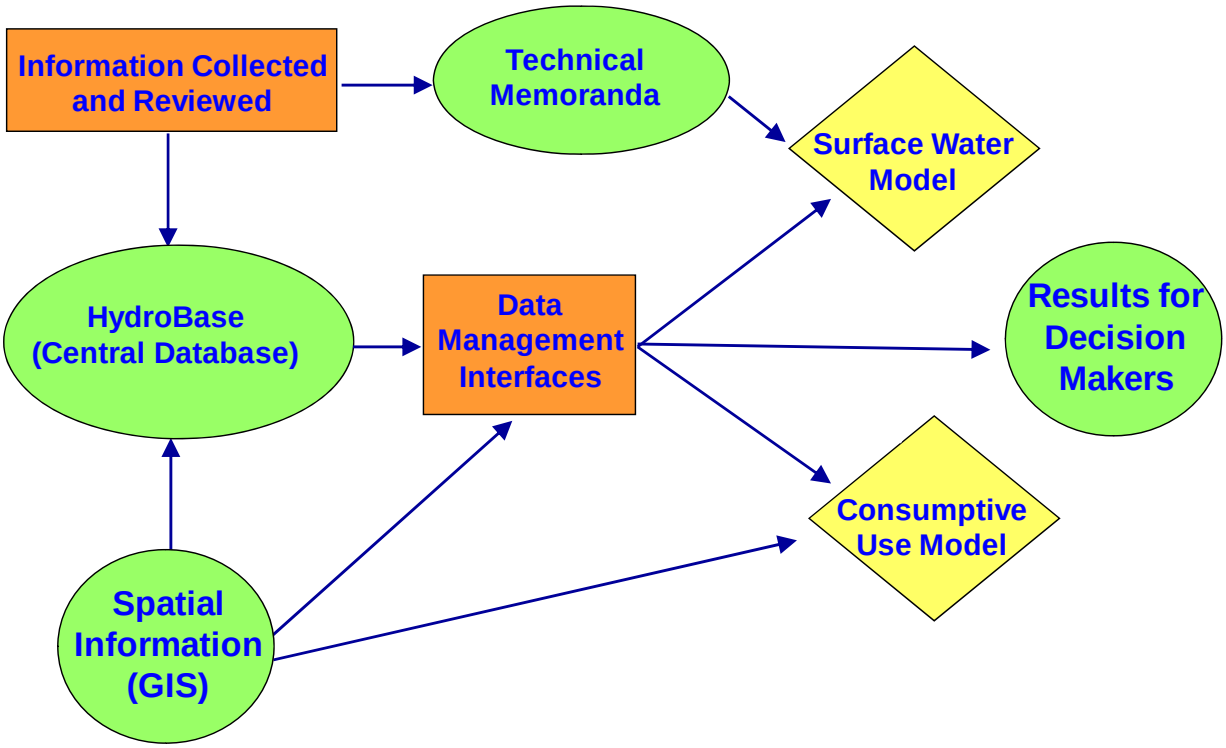
To provide the capability to develop credible information on which to base informed decisions concerning water resource management issues including:

- Interstate Compact Issues
- Resources Planning (response to population growth, drought and climate change, environmental issues, etc)
- Water Rights Administration by DWR

How?

- Provide user-friendly access to quality controlled data (data-centered around HydroBase) and GIS coverages
- Provide data and models to evaluate alternative water development and administration strategies
- Provide a functional, integrated system that can be maintained and upgraded by the State
- Have the capability to accurately represent current and potential federal and state administrative and operational policies and laws
- Promote information sharing among government agencies and water users

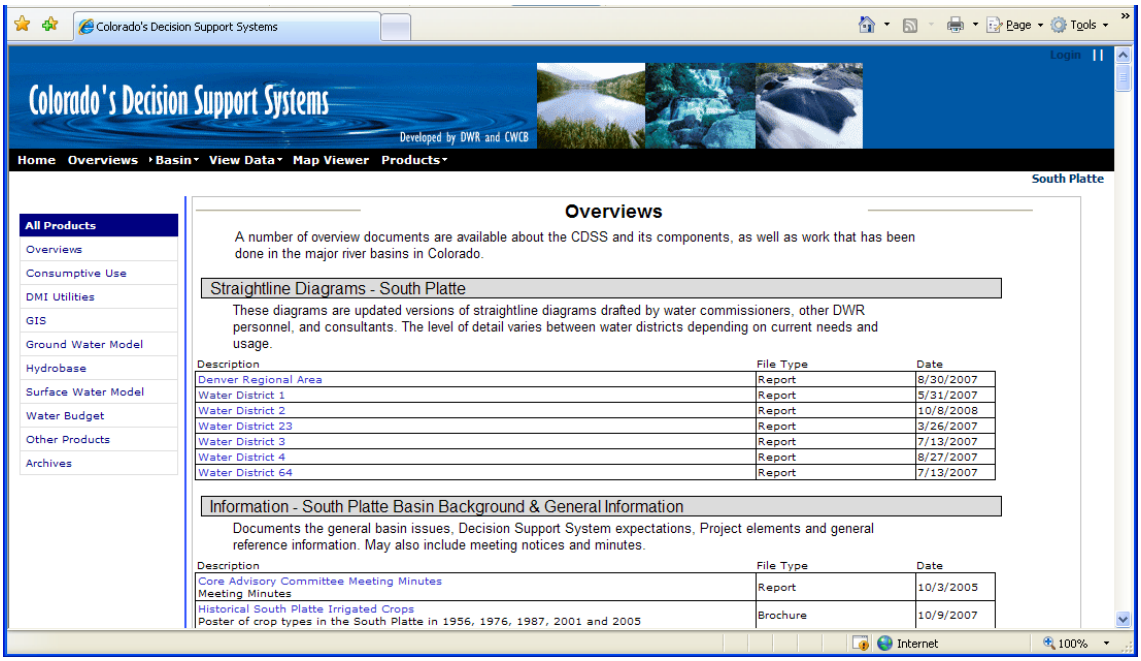
Information Management Schematic



CDSS Products

1. Basin Operation Information
    - Basin Fact Sheets
    - Straight-line Diagrams
    - Basin Information Reports
    - Water Resources Planning Model User's Manual
    - Supporting Technical Memoranda

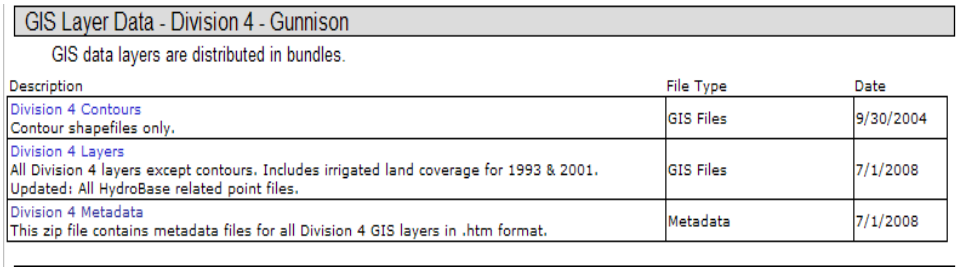
From the Colorado's Decision Support Systems home page (http://cdss.state.co.us/), select the basin of interest under the **Basin** menu. Scroll to review available information. Selecting the document will display in an internet browser, allowing the option to save in *.pdf format.



2. GIS Coverages

From the Colorado's Decision Support Systems home page (http://cdss.state.co.us/), select **GIS** under the **Products** menu. The File Download window guides you through either running the program to extract and save the layers, or saving the self-extracting zip file on your computer - allowing you to extract the layers at a later time.

Scroll down to the Division you are interested in and click on Division X Layers. (Division 4 in this example)

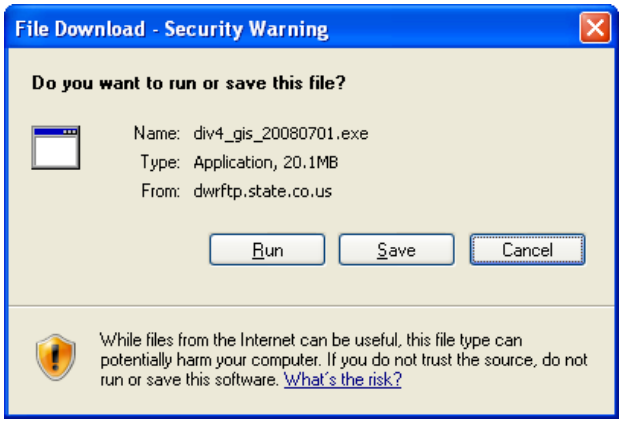


GIS Layer Data - Division 4 - Gunnison

GIS data layers are distributed in bundles.

Description	File Type	Date
Division 4 Contours Contour shapefiles only.	GIS Files	9/30/2004
Division 4 Layers All Division 4 layers except contours. Includes irrigated land coverage for 1993 & 2001. Updated: All HydroBase related point files.	GIS Files	7/1/2008
Division 4 Metadata This zip file contains metadata files for all Division 4 GIS layers in .htm format.	Metadata	7/1/2008

The File Download window guides you through either running the program to extract and save the layers, or saving the self-extracting zip file on your computer - allowing you to extract the layers at a later time. You may also want to download the associated Metadata.



Available layers for each division include:

- Water division/district boundaries
- Rivers
- Diversion structures
- Streamflow stations
- Climate stations
- Irrigated acreage (snapshot years)
- Lakes/Reservoirs
- Soil Data (AWC for CU analysis)
- Contour Lines
- Cities
- Highways
- Counties
- Hydrologic Unit Codes (HUCs)
- Land Use
- PLSS (public land survey system)
- Wells

3. General Water Resources Data

- Stored in HydroBase, more data in completed DSS basins
- Can be accessed through the CDSS Website (see Examples)
- Can be accessed through Data Management Interfaces (StateView, TSTool, StateDMI)

Available HydroBase data includes:

- Diversion records
- Streamflow measurements
- Water rights and well permits
- Climate data
- Call chronology
- Reservoir contents
- Groundwater levels
- Irrigated acreage
- Agricultural statistics
- Census data
- Owner/Operator information
- Structure physical information (headgate capacity, area/capacity curves)

4. Modeling Software and Data Sets

- StateCU – Consumptive Use Model
- StateMod – Surface Water Model
- Data Sets

Colorado Water Rights Administration - Review

Some Definitions

Prior Appropriation Doctrine "First in time, first in right". Water rights must be put to *beneficial use* – use of a reasonable amount of water to accomplish the purpose of the appropriation without waste.

Absolute water right: A water right that has been placed to beneficial use.

Conditional water right: right granted in water court that fixes the priority and provides time to complete the appropriation as long as it can be demonstrated that progress is being made toward project completion during six year "diligence" periods.

Appropriation date: date water is first put to beneficial use or steps were first taken to develop

Adjudication date: decree date

Abandonment – relinquished water right due to intentional non-use

Water rights are decreed for specific use(s). This, plus the fact that water rights can be changed, requires detailed administrative accounting to be performed by water commissioners.

In Colorado, water is a property that can be sold separately from the land; however, the public retains an interest in the water. This allows for *change of water rights*.

- Change in type of use (ex: from irrigation to municipal; from direct use to storage)
- Change in point of diversion
- Adding points of diversion

Must be approved by water court to assure no injury occurs to other water rights. Change in point of diversion or alternate points of diversion to upstream locations require an analysis to determine "exchange potential".

Filing for a new right for diversion or storage generally requires a water availability analysis.

River call: a water right holder can "place a call" to the Division Engineer indicating they are not receiving their full decreed water right and request that the Division Engineer shut down (curtail) all upstream water rights junior to the calling right.

1. CDSS has helped with the detailed administrative accounting to be performed by water commissioners.

HydroBase data-entry tools, developed through CDSS, provide drop-down menus that restrict typos and include built-in quality control checks.

Each water right location (decreed or conditional) has been assigned a 3 or 4 digit integer identifier which, when combined with the Water District, is unique and can be used to query information in HydroBase (termed WDID). In general:

- River Diversion IDs are between 100 and 1999
- Instream flow IDs are between 2000 and 2999
- Reservoir IDs are between 3000 and 3999
- Transbasin IDS are between 4000 and 4999
- Well IDs are greater than 5000

For example, the WDID for Larimer County Canal is 0300911 where 03 indicates the structure is in Water District 1, and 911 is the unique identifier for the ditch headgate location. All of Larimer County Canal's over 50 water rights are "associated" with WDID 0300911in HydroBase.

River diversions and reservoir releases are coded by source, location of source, use, and type – know as DivClass or SFUT (and now SFUTG, where G lists an augmentation plan). Structures are also assigned a Current In Use code (CUI code) that reflects current conditions. In addition, there are standard codes used in Water Commissioner comments that provide information in lieu of diversion records.

The Water Commissioner Handbook describes standard diversion and use codes and provides examples of how to code specific diversions. The following tables are directly from the Water Commissioner Handbook.

SUMMARY OF DIVERSION CODING..... SOURCES

SOURCE	CODE	COMMENTS
Natural Stream flow	1	Water available for Diversion in priority to satisfy water rights.
Reservoir Storage	2	Water that is actually stored in a Reservoir. Not flow through water.
Ground Water (Wells)	3	Both tributary and non-tributary waters. (The stream # in the structure file will identify the actual source in the diversion reports).
Transbasin	4	The same as transmountain; water imported from another basin
Non-Stream Sources	5	Springs and seepage
Combined	*6	A non-additive source code generally used when water is measured beyond the headgate where sources have been mixed. This code is used to keep from double accounting. At the intake the different sources are identified and the uses are not, while at the delivery points the source equals combined and the use is identified.
Transdistrict	7	Water imported from one sub-basin into another, both sub-basins being part of the same river basin.
Re-Used	8	Water used once and put back in stream to be re-used generally by exchange or for augmentation. Usually sewage effluent water from sources which may be fully consumed.
Multiple	9	Water with numerous sources that aren't separable. Differs from Combined in that each use is identified and Multiple source water totals in structure and district summaries. Another difference is that Multiple source water is only measured once whereas Combined water is measured twice.
Remeasured and Rediverted	R	Water that has been measured, diverted, and used later downstream.

SUMMARY OF DIVERSION CODING.....USES

USAGE	CODE	COMMENTS
Storage	0 (Zero)	An intermediate use before the final beneficial use.
Irrigation	1	Water applied to crops
Municipal	2	Urban use
Commercial	3	Ordinary non-manufacturing: retail, stockyards, campgrounds, etc.
Industrial	4	Manufacturing, mining, steam power, etc.
Recreation	5	Non-consumptive (except evaporation)
Fishery	6	Non-consumptive (except evaporation)
Fire	7	emergency and intermittent use
Domestic	8	household, lawn & garden
Stock	9	livestock watering
Augmentation	A	augmentation water, maybe used with type=6 (replacement to river)
Export from Basin	B	Water being diverted from one sub-basin to another in the same basin and or remeasured and coded as to actual use.
Evaporation	E	Non-beneficial use
Geothermal	G	Non-consumptive (except evaporation)
In House	H	Household use only
Snow making	K	Non-consumptive
Min. Stream flow	M	As defined in statute and used in decrees.
Power Generation	P	Non-consumptive
Other	Q	Used with a type code; when the use is recorded elsewhere or there is no actual beneficial use.
Recharge	R	Water used for ground water recharge
Export from State	S	Water being diverted out of state
Transmountain Export	T	Water diverted from one basin to another
Wildlife	W	Non-consumptive

SUMMARY OF DIVERSION CODING.....TYPES

TYPES	CODE	COMMENTS
		Blank is acceptable
Administrative Record Only	* 0 (Zero)	Water that is recorded for administrative purposes.
Exchange	1	Where water is diverted out-of-priority at one structure and replaced at another.
Trade	2	A particular part of an exchange where the release is not back to the stream but directly into the effected structures
Carrier	3	Water diverted into a "carrier" ditch or canal within a district and remeasured for diversion and actual use in the same district. Used to avoid duplication of "Uses"
Alternative Point of Diversion	4	Decreed water rights taken in another structure
Re-Used	5	(this code was replaced by Source equals reused and is no longer used as a type code).
Replacement to River	*6	Water replaced as exchange for upstream diversions. Water released for augmentation plans also fall in this category.
Released to River	*7	River being used as a carrier for water to be picked up downstream or water released for no beneficial use.
Released to System	*8	Water released so that it can be picked up and measured in another structure.
User-supplied Information	+9	Diversion information supplied by the user that has not been verified. After 1992, not used as a type code.
Augmented	A	Used only for augmented water. The use of augmented water would be the beneficial use it was being put to.
Geothermal	G	Geothermal
Reservoir Substitution	S	Release made by upstream reservoir in lieu of a release by a downstream reservoir when no exchange between reservoir exist

* water does not add into structure totals

+After 1992, user supplied data is notated in a special field tied to each daily amount field.

CURRENT IN USE CODES

A	Active structure with contemporary diversion records
B	Structure Abandoned by the court
C	Conditional structure
D	Duplicate, ID is no longer used
F	Structure used as FROM number-located in another District
H	Historical structure only-no longer exists or has records, but has historical data
I	Inactive structures which physically exist but no diversion records are kept
N	Non-existent structure with no contemporary or historical records
U	Active Structures but diversion records are not maintained

When a structure with a CIU of A (Active structure with contemporary Diversion Records) has no diversion records for the current year, the Not-Used-Codes (NUC) and in the case of recorded releases from Reservoirs, the Not-Released-Codes (NRC), are used:

NOT-USED AND NOT-RELEASED CODES

A	Structure is not usable
B	No water is available
C	Water available, but not taken
D	Water taken in another structure
E	Water taken but no data available
F	No information available

For example, diversion coding for Lower Platte and Beaver Ditch includes the following:

- S:1 F: U:1 T: G: (Source River for Use Irrigation)
- S:2 F:6403552 U:1 T:1 G: (Source Storage from WDID 6403552 - Prewitt Reservoir for Use Irrigation by Type Exchange)

2. CDSS has increased the efficiency and accuracy of water rights change analysis.

Analysis for water rights changes requires the information stored in HydroBase. Quality control procedures for storing data, and web-based access to data has increased efficiency of analysis and reduced water court disagreements over data sources and manipulation. StateCU has provided a tool for consultants to use to

determine historic uses, and for water administrators to use to review for consultation. For several consultants, StateMod has provided a tool to look at exchange potential under current and estimated future conditions.

3. CDSS has provided a tool to look at water available for a new diversion or reservoir.

Water availability requires defining the physical supply, legal supply, and reliable supply for a new water right. Information available in HydroBase, including historic streamflow data; diversion records; and call records; can estimate water availability based on historic water uses. StateMod can estimate water availability based on current use and future use.

Physical Supply

- Where is water available compare to demand? (spatial availability)
- Is the supply available when the demand requires it? (temporal availability)

Legal Supply

- Is the physical supply available in priority?
- Is it committed to downstream, senior uses?
- Will it be available if conditional rights are perfected, or transbasin diversions are reused?

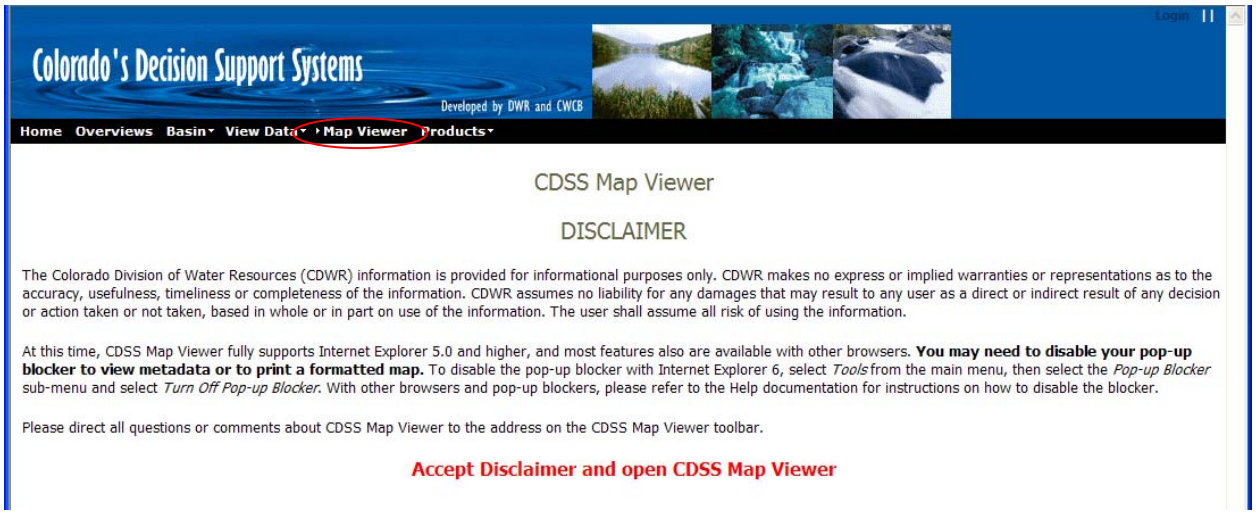
Reliable Supply

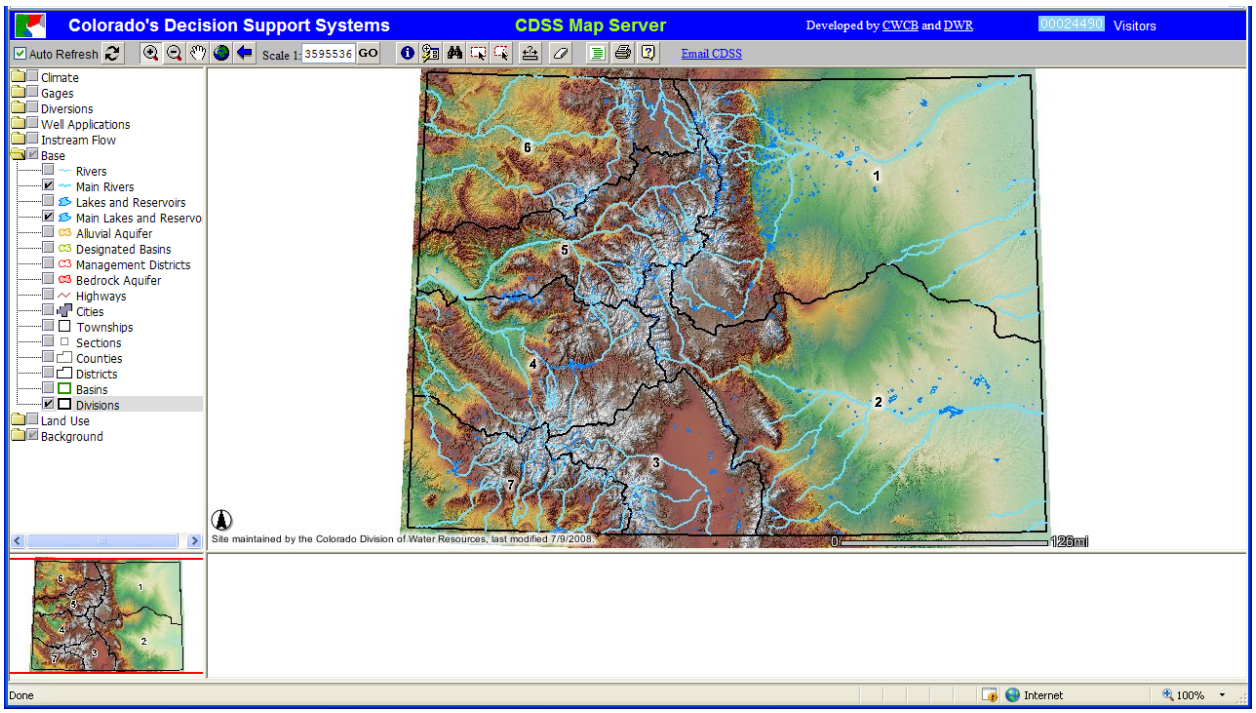
- Will the supply be there in a drought year?
- Will the supply be reliable if other conditions change?
  - Administrative changes
  - Climate change
  - Compact restrictions

Example 1: What information is available to help determine available flow for an instream flow request on Tabeguache Creek?

Step 1 – What stream gages and diversion structures can help with the analysis? Diversion records and comments can provide clues and help determine the "right questions" to ask the water commissioner.

If you are a GIS user, you can use the CDSS GIS layers to identify stream gages and diversion structures. If you are not a GIS user, or want to quickly identify nearby features, use the CDSS Map Viewer. Select the **Map Viewer** tab on the CDSS homepage and click on **Accept Disclaimer and open CDSS Map Viewer. * *You will need to turn off the Popup blocker ****



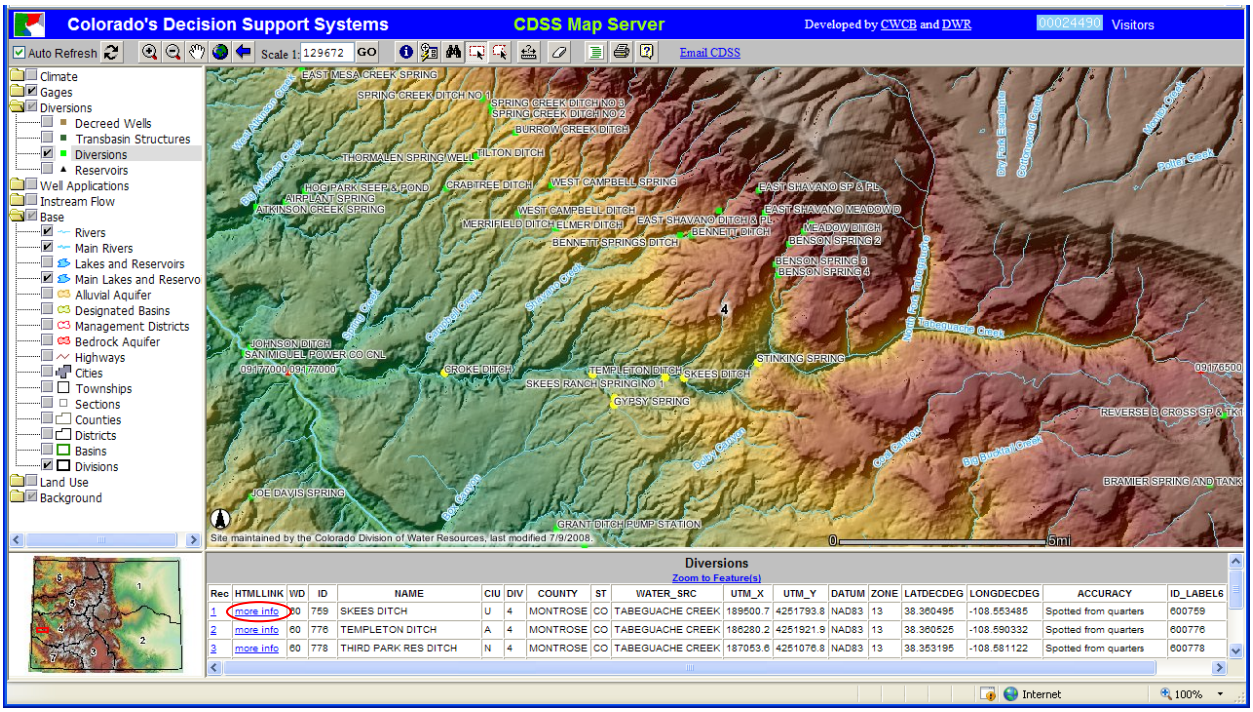


Similar to other map viewer programs, you can zoom, pan, and identify information. The StateIMS User Manual, which includes instructions to zoom, pan, display specific GIS layers, and select features, is available on-line by selecting the ? button.

Display the Diversions.. Diversions layer, the Base..Rivers layer and the Gages layer by clicking the check box next to the later name. You can also use the find button  to select a specific diversion or gage station in the area of interest.

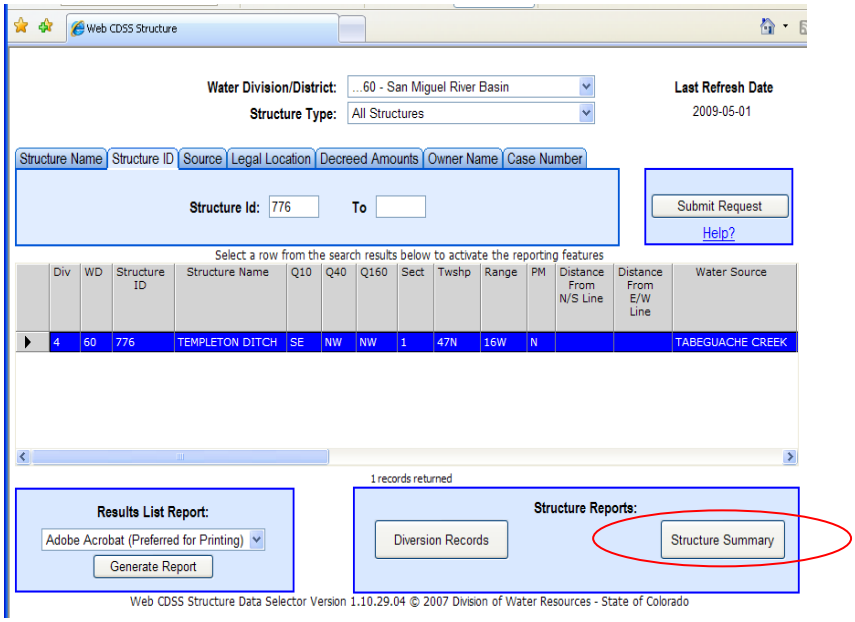
Step 2 – View diversion information available in HydroBase.

To select specific features, the layer name in the layer list must be active – click the layer name, making sure it is highlighted gray. Activate the **Diversions** layer and select diversions, using the *select by rectangle* button, graphically select diversions located in the instream flow reach.

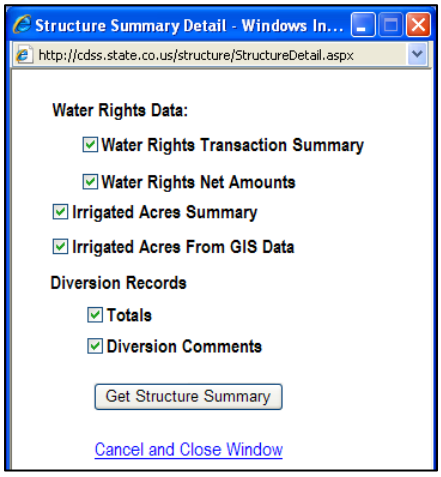


View more about a Feature by selecting more info. This takes you to the CDSS Structure Data Selector window. Highlight the structure and select the **Structure Summary** button to view all information about the structure.

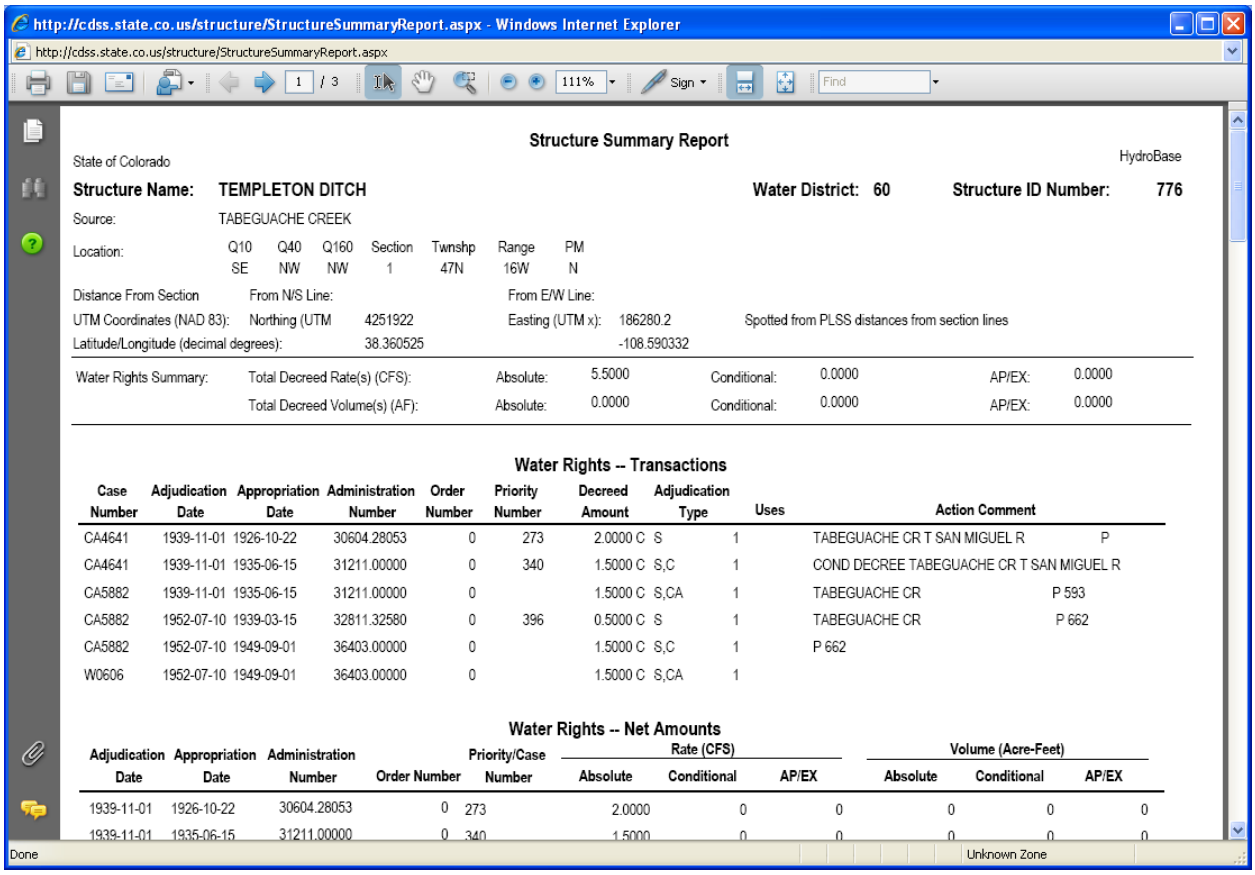
Tip: Start with the Structure Summary when investigating diversions. The summary reports all available information, including source, legal locations, water rights information, monthly diversions, and water commissioner comments.



Specify the information you want to review, and select the **Get Structure Summary** button.



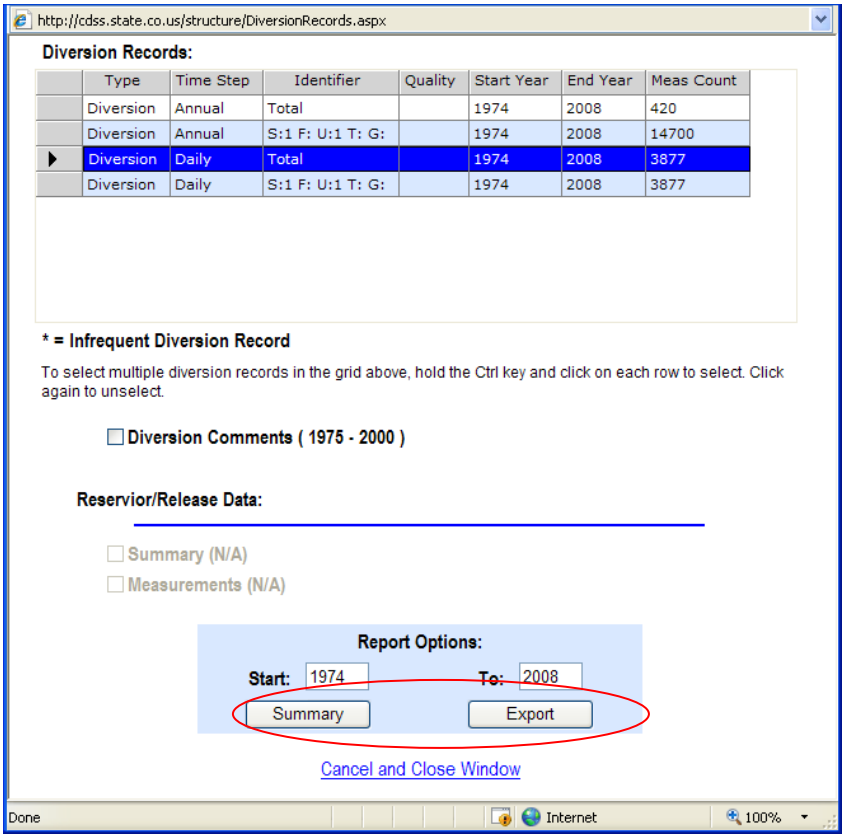
Review the **Structure Summary Report** for information regarding water available to the instream flow right. Note the relative seniority of the ditch water rights and if the water commissioner comments include “No water available”. If “No water available” for a junior ditch, may still be water in the reach. If “No water available” for a senior ditch, likely means the reach is dry.



Close the **Structure Summary Report** and choose the **Diversion Records** button. Available diversion classifications and time-steps will be presented, as outlined in the Water Commissioners Handbook.

Tip: Daily records for senior ditches can provide an indication of the minimum flow in a reach during the irrigation season on streams with no gaged data. Diversions classes can identify how much flow in the river is non-native (from reservoir releases or transbasin diversions). If senior ditches routinely divert less than decree, questions to ask the Water Commissioner include "Are they taking less than their decree because they don't have the demand for the water? Is there a physical water limitation? Is there a legal water limitation?" Infrequent diversion records often include annual totals for ditches infrequently visited by the water commissioner.

Highlight the Diversion Record of interest (in this example select Diversion Daily Total), chose the **Summary** button to review daily diversions or chose **Export** to save in text file or to open in Microsoft Excel.



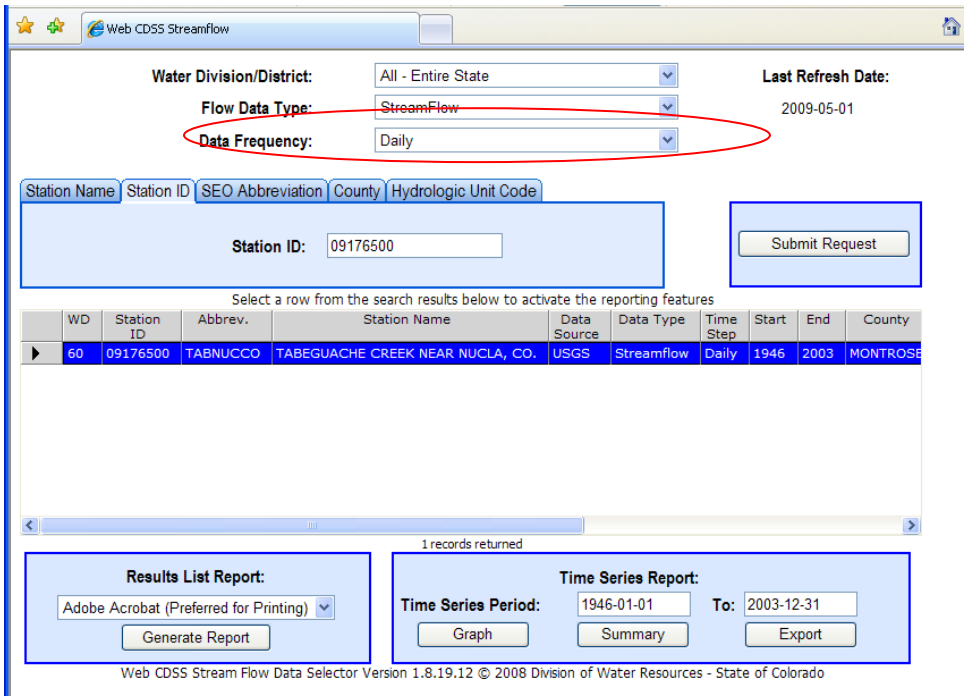
Step 3 – View stream gage information available in HydroBase.

Using the CDSS Map Server, activate the **Gage-Historic** layer and select diversions, using the *select by rectangle* button, graphically select nearby stream gages located near the instream flow reach. For this example, it may be useful to view the historic flow at the gage in the upstream reaches of Tabeguache Creek to get a sense of physical flows. Because several tributaries contribute flows before the instream flow segment, this could be considered the minimum flow likely to be seen in the reach.

View more about the Tabeguache Creek near Nucla gage Feature by selecting more info. This takes you to the CDSS Stream flow Data Selector window. Highlight the station and select the **Summary** button to view information about the structure and get a sense of data availability. In this example, data is only available from April 1946 through September 1953.

Tip: When investigating tributaries with limited historic streamflow measurements, the information is valuable especially if you understand the types of years and/or months (wet, dry, average) it represents. Use a long-term gage in the same basin to "rank" flow years and extend those categories to your limited gage. This can be done easily with TSTool and Excel – see Example 3.

To view or export daily data, change the **Data Frequency** drop-down menu to "Daily" and hit the **Submit Request** button.

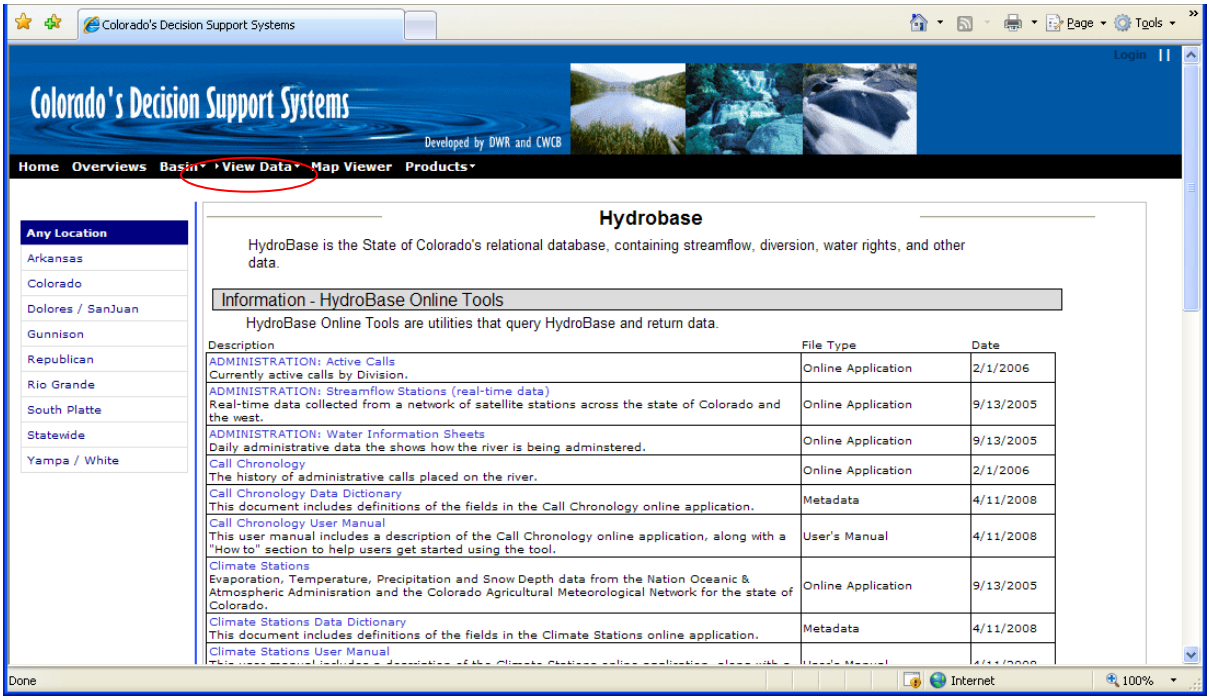


Before closing the CDSS Map Server, activate the **Climate, Temperature Station** layer and identify climate stations that are near Templeton Ditch. This information will be used in Example 5.

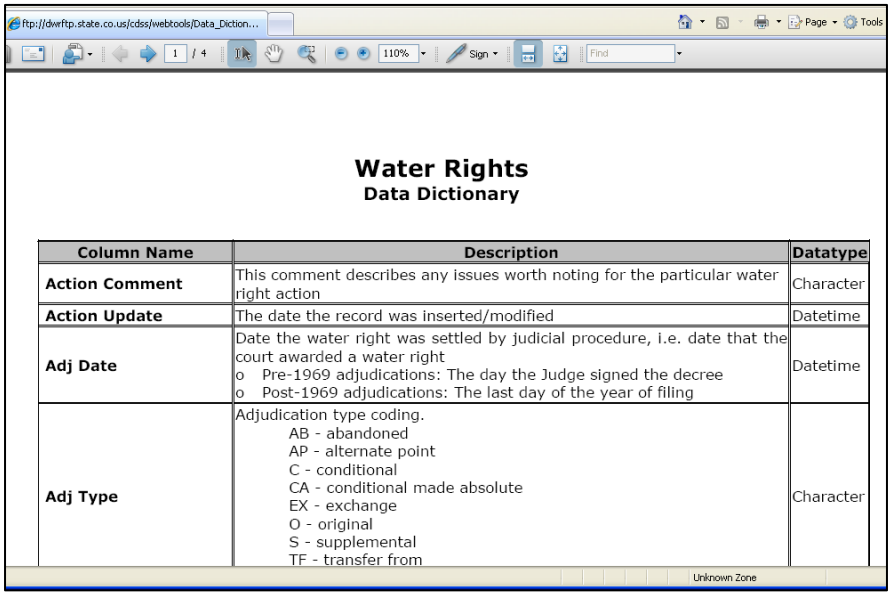
Example 2: What are the conditional direct diversion rights for energy use in the White River basin?

Step 1 – Find the water rights for a specific district with use type "Industrial". Note that "industrial" includes manufacturing, energy and mining uses.

Select **View Data** tab on the menu bar of the CDSS home page. *** *You will need to turn off the Popup blocker **** The **HydroBase** overview window will be enabled. Note that this window can also be enabled by selecting **HydroBase** under the **Products** tab. The HydroBase overview window provides the option to view Data Dictionaries to better understand the information in HydroBase and view User Manuals for instructions to query and extract data through the CDSS website.



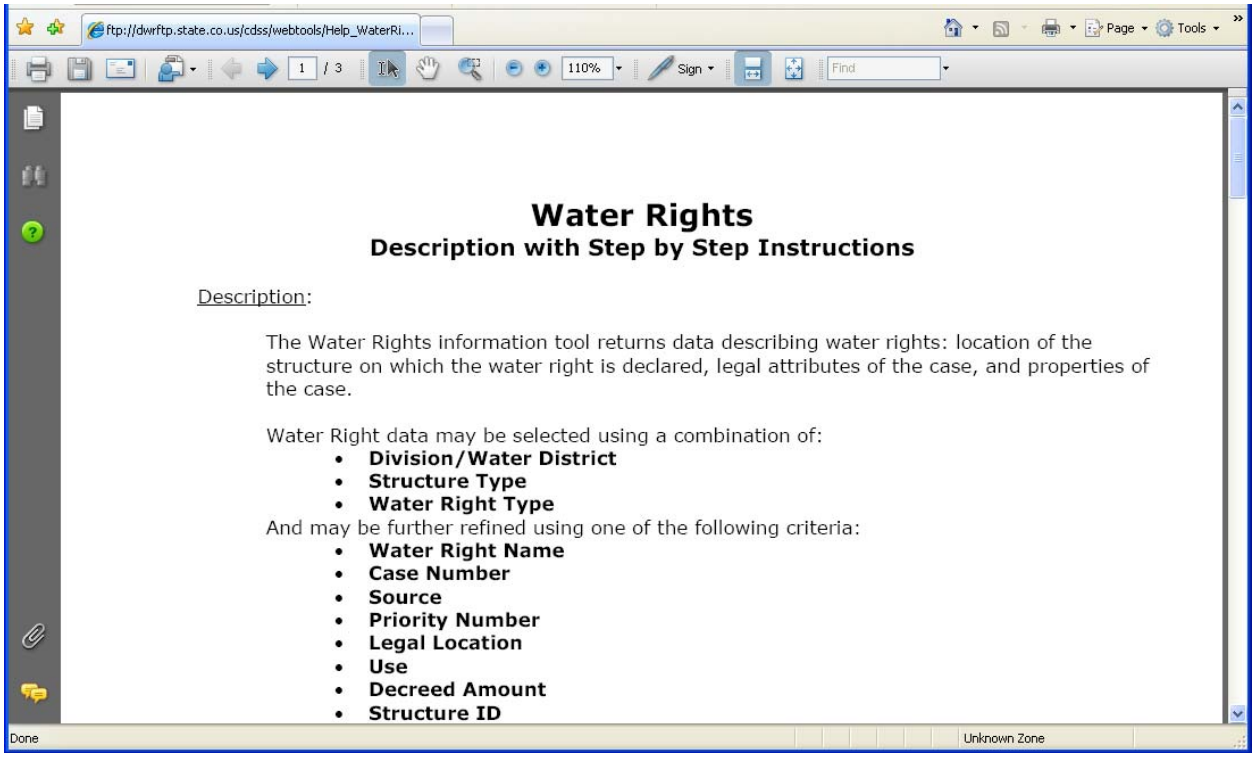
Scroll down to select and enable the **Water Rights Data Dictionary** window. Description of water rights information stored in HydroBase, including use types, is enabled to view or print.



Water Rights
Data Dictionary

Column Name	Description	Datatype
Action Comment	This comment describes any issues worth noting for the particular water right action	Character
Action Update	The date the record was inserted/modified	Datetime
Adj Date	Date the water right was settled by judicial procedure, i.e. date that the court awarded a water right o Pre-1969 adjudications: The day the Judge signed the decree o Post-1969 adjudications: The last day of the year of filing	Datetime
Adj Type	Adjudication type coding. AB - abandoned AP - alternate point C - conditional CA - conditional made absolute EX - exchange O - original S - supplemental TF - transfer from	Character

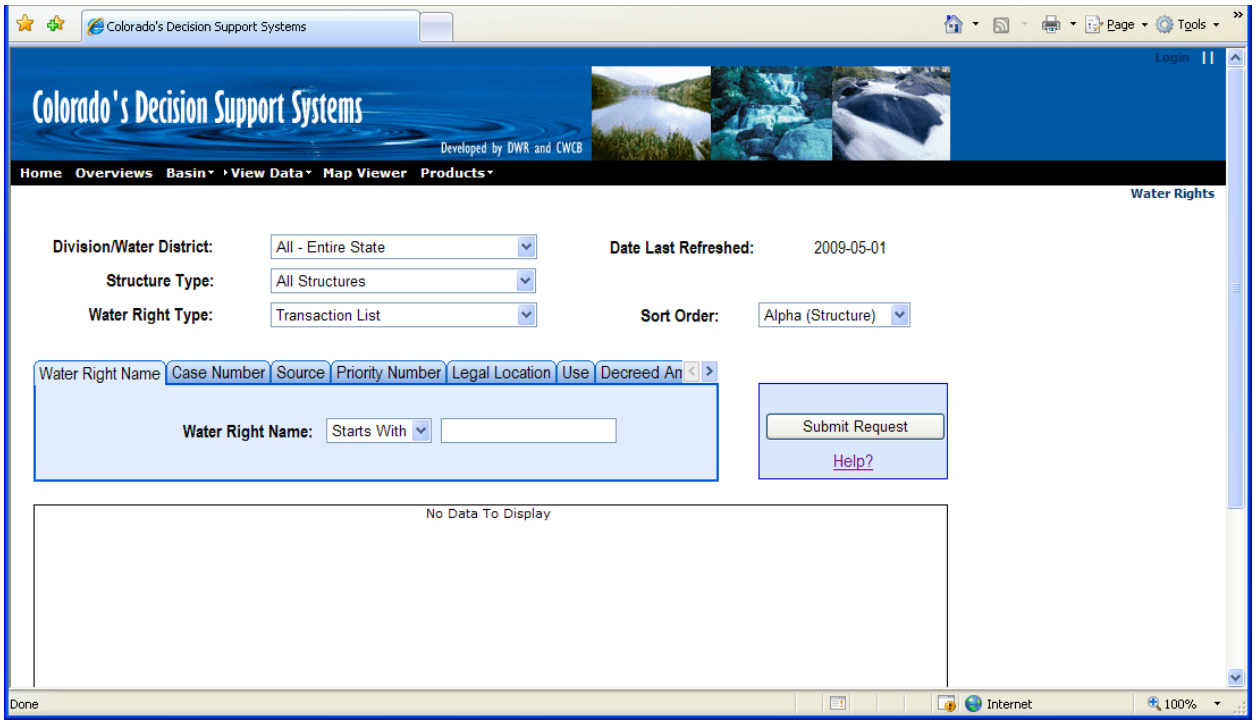
Close the **Water Rights Data Dictionary** window and select the **Water Rights User Manual** option. **Water Rights Description with Step by Step Instructions** is enabled to view or print.



You can select **Water Rights** Online Application from the **HydroBase** window, or you can mouse-over the **View Data** tab on the menu bar, then click "Water Rights". Both these options enable the **CDSS Water Rights Data Selector** screen. The following Data Selector options are available, and include Data Dictionaries and Descriptions with Step by Step Instructions to view or print as demonstrated for Water Rights:

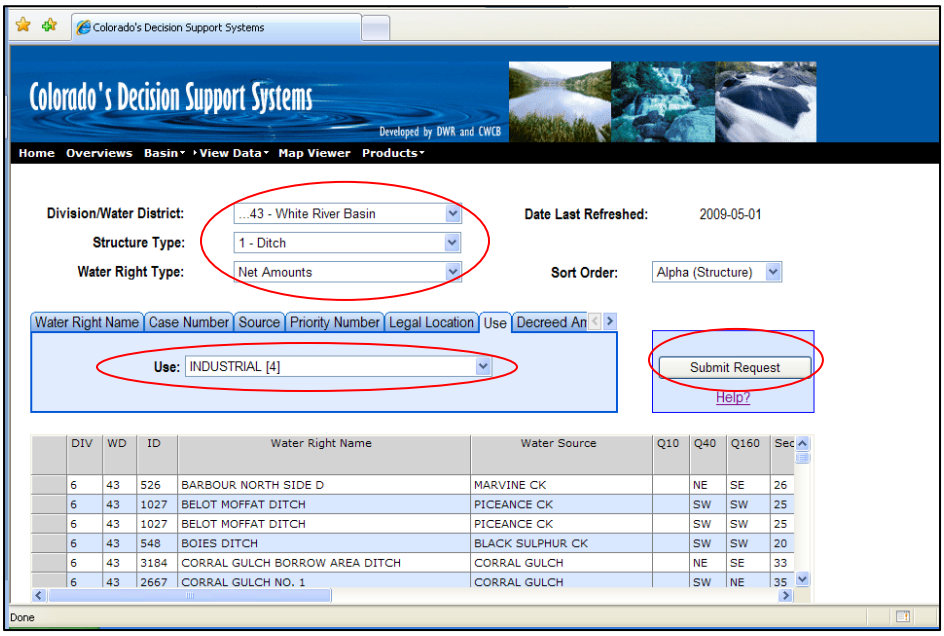
- Call Chronology
- Climate Stations
- Groundwater – Other Data
- Groundwater – Water Levels
- Streamflow Stations
- Structures

Aquifer Determination Tools option is also included under the View Data tab. This allows the user to extract aquifer characteristics consistent with the Denver Basin Rules based on a user-input location. Output also identifies whether the aquifer is tributary or non-tributary at a given location. **Other Data** option included under the View Data tab include agricultural statistics acreage and livestock census.



Select the Water District "43 - White River Basin" from the drop down list labeled **Division/Water District**. Further refine the search by selecting "Ditch" from the **Structure Type** drop down list and "Net Amounts" from the **Water Right Type** drop down list.

To define the rest of the search options, select a search tab. In this example, highlight the **Use** tab and select "Industrial" from the **Use** drop down list. Click on **Submit Request** to display the 75 records stored in HydroBase that match the search criteria. Note that the Help? Option will also display the Step by Step Instructions for using this form.

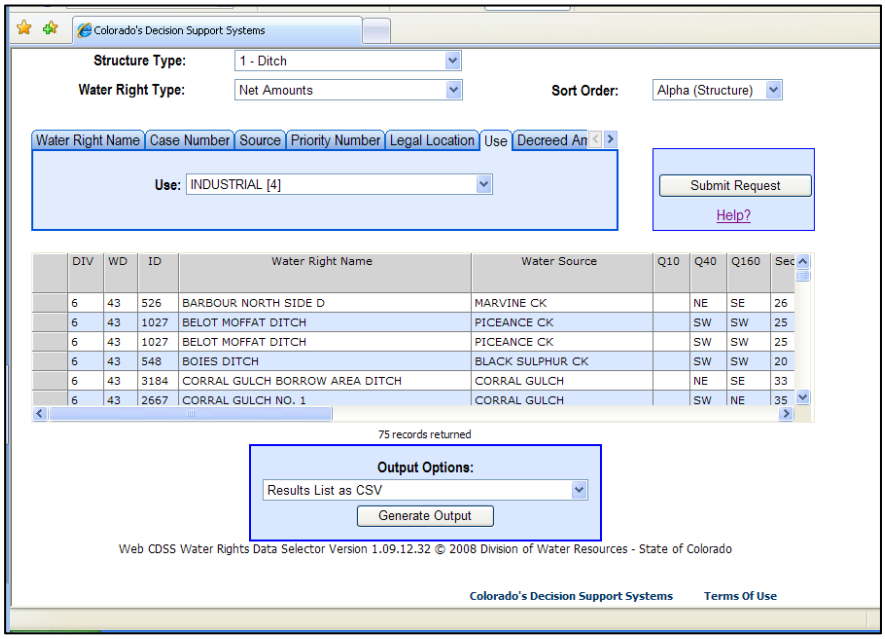


Tip: There are several options to narrow down the search of water rights in HydroBase. The tabs that refine searches cannot currently be used in conjunction, so choose a narrowing search then use Excel to sort and categorize further. For example, this search could be refined by Decreed Amount instead of Use, requesting Decree Type - Cond Rate > 0. Conditional rights for all uses would be selected (instead of the just the Industrial Use defined above), and Excel could be used to further sort and categorize by use.

Step 2 – Output the information to Excel for further analysis.

The water rights selected can be output into a standard Tabulation Report by Administration number (Adobe) or the Results List shown in the form can be output in several formats, including Adobe, HTML, Excel, CSV, or Tab Delimited.

Select "Results List as CSV" from the **Output Options** drop-down list and click **Generate Output**. A **File Download** dialogue box will allow the file to be opened in Excel or saved. Choose "Open".



Tip: Decreed and conditional water right rates are stored in HydroBase as a text field. If you choose the "Export as Excel" option when querying HydroBase, you will need to convert text columns to values to be able to use arithmetic functions, such as summing or averaging. If you save the output as a CSV file, it automatically brings rates and other numbers into Excel as a value field.

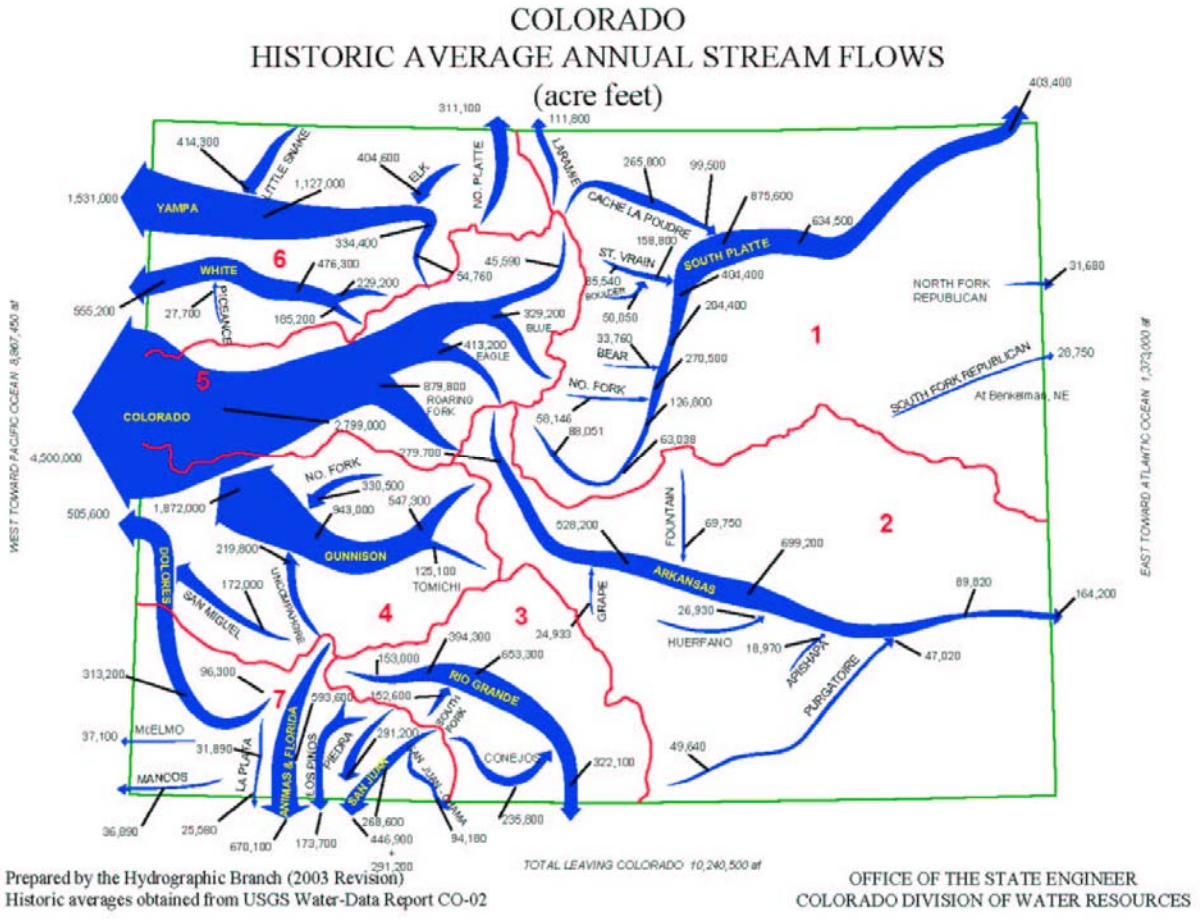
Step 3 – Sum conditional water rights in Excel.

In Excel, sum the Conditional Rates column. There are 37 conditional water rights with a use type of industrial assigned to ditches in the White River basin, for a total diversion rate of 1,432.36 cfs.

Step 4 – Check for direct conditional rights for industrial use assigned to pipelines or pumps.

Follow the same procedure selecting **Structure Type** “Pipeline” and structure type “Pump”. Note that selecting all structures with Use “Industrial” will yield an incomplete HydroBase search and the message “**Search results limited to 344 records. Please refine search for better results.**” Therefore, breaking the search into smaller queries is the best option. There are 25 conditional water rights with a use type of industrial assigned to pipelines for a sum of 3,051 cfs. There are 7 conditional water rights with a use type of industrial assigned to pumps for a sum of 251 cfs.

Example 3: Updating values presented in the Snake Diagram (with low, average and high years).



Daily and monthly streamflow measurements are stored in HydroBase. In this example, we want annual results to determine average annual of available records, the average for dry years, and the average for wet years. Monthly data can be extracted with the on-line HydroBase Viewer used in Example 1 and 2, then brought into Excel for further manipulation using Pivot Tables or other automated methods for summing monthly to annual. Another option is to extract the monthly data using the Data Management Interface **TSTool**; then use the **TSTool** option to change the interval to annual.

TSTool, and the TSTool User's Manual, can be downloaded from the CDSS website. Mouse over "Products" on the menu bar, then click DMI Utilities. TSTool can be installed directly from this screen.

Tip: State employees have direct access to HydroBase through the State's central server. Water users and consultants outside the State must purchase a "stand-alone" copy of HydroBase and have it installed on their computers to use TSTool or StateDMI. For most non-state users, the online-view data tools are sufficient, coupled with Excel for data manipulation or statistical analysis. Developers and users of StateMod require a stand-alone HydroBase installation.

Step 1 – Use TSTool to extract monthly streamflow data from HydroBase.

Determine the streamflow data of interest. In this example, we will extract the streamflow stations used in the Snake Diagram for the Rio Grande basin as follows:

- South Fork Rio Grande at South Fork (Station ID 08219500)
- Conejos River near Lasauses (Station ID 08249000)
- Rio Grande at Thirtymile Bridge, near Creede (Station ID 08213500)
- Rio Grande at Wagon Wheel Gap (Station ID 08217500)
- Rio Grande near Del Norte (Station ID 08220000)
- Rio Grande near Lobatos (Station ID 08251500)

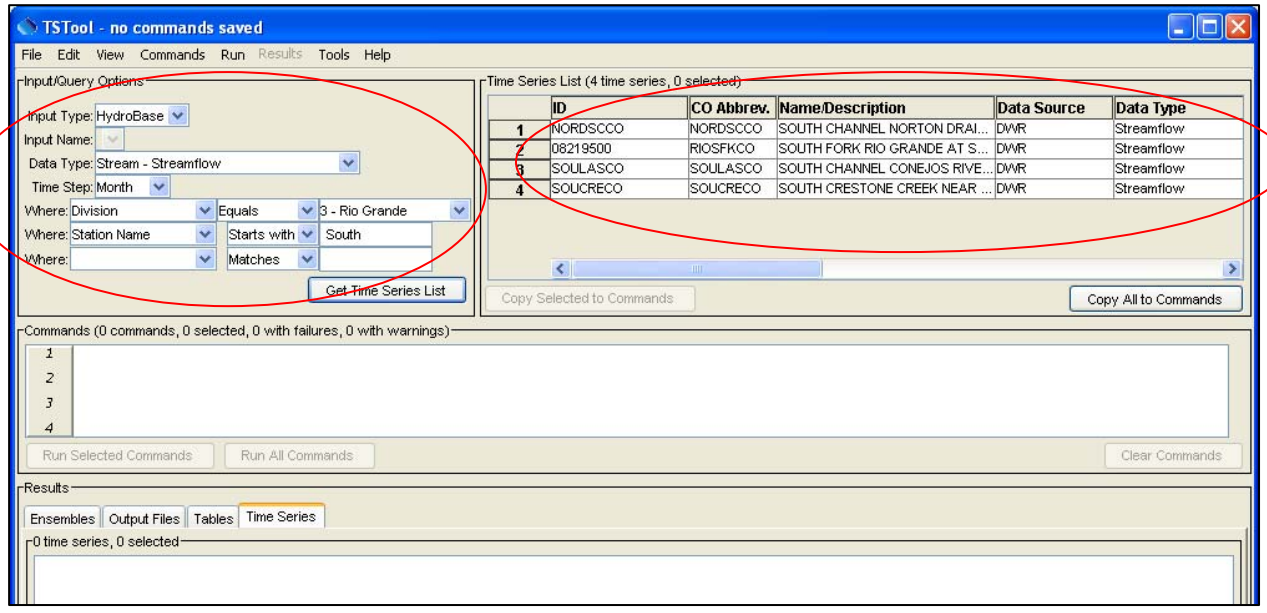
Open **TSTool** by clicking on the application on your desktop or through an explorer window. TSTool will prompt you to Select HydroBase. Use the dropdown menus to point TSTool to the appropriate connection and select okay.

Input/Query Options Window

Input Type: in the Input/Query Option box should be set to "HydroBase". Set **Data Type** to "Stream – Streamflow", and **Time Step:** to "Month". Note that data available under the View Data tab on the CDSS website, described in Example 2, are available through TSTool. Additional information not available directly from the website includes population census data and reservoir content data.

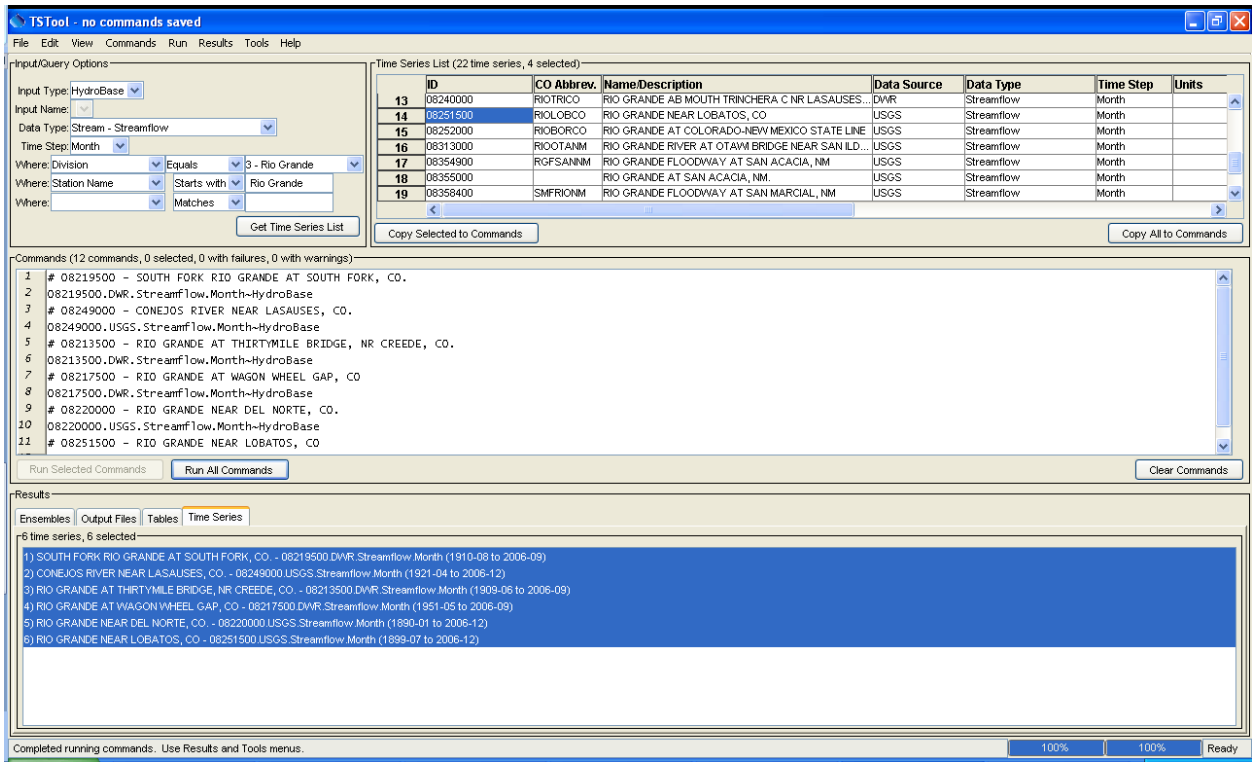
Further refine the query using the three available drop-down query boxes. Options for query refinements include County Name, District, Division, HUC, Station ID, and Station Name.

Refine the search in the first box by selecting **Where:** Division Equals 3-Rio Grande. Refine the search in the second box by selecting **Where:** Station Name Starts with South. Click on the **Get Time Series List** button. Four stations meeting these query criteria are shown in the Time Series List window. The Time Series List window provides general information about the time series, including Data Source and Start End Dates.

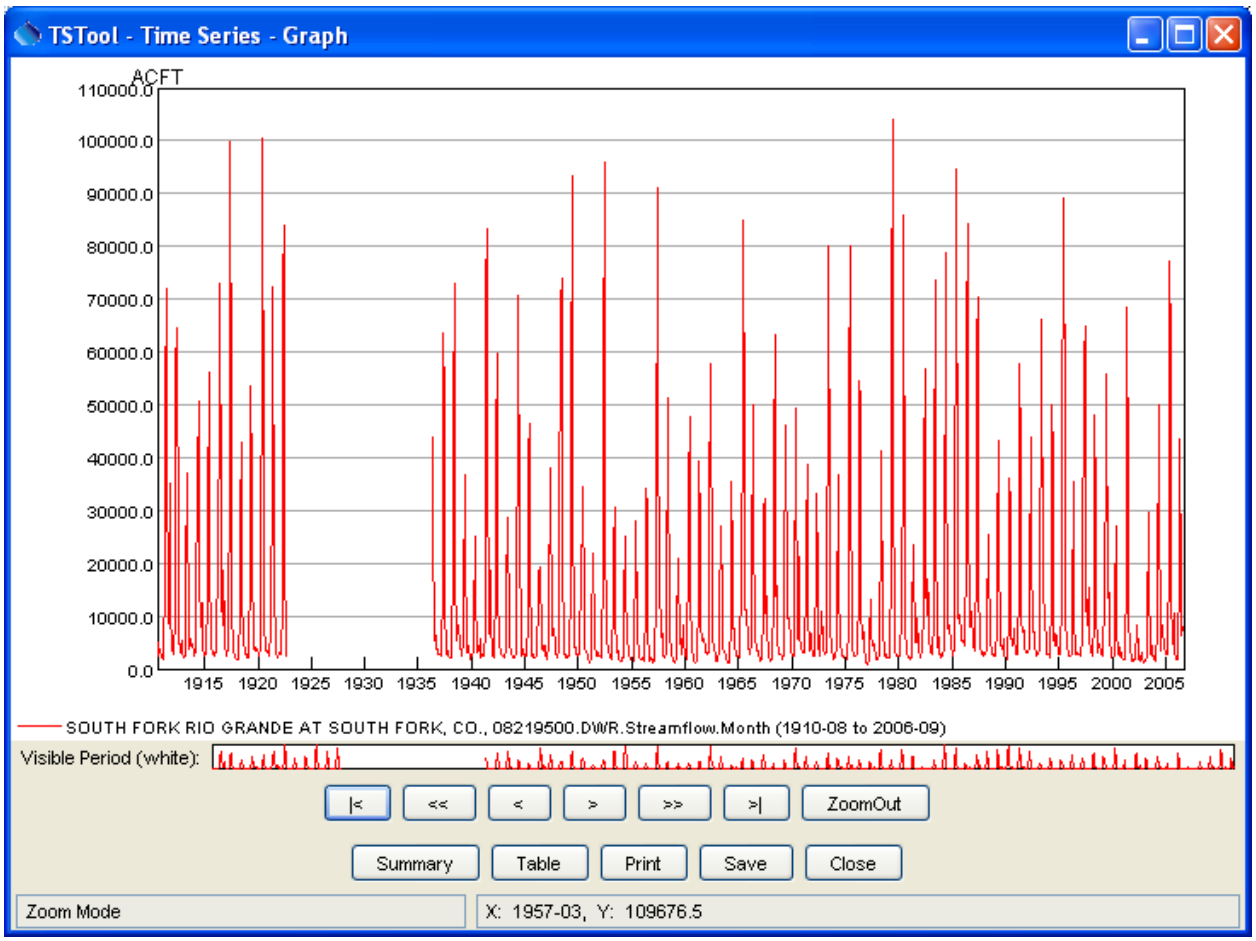


Highlight the South Fork Rio Grande at South Fork Gage in the Time Series List window and click the **Copy Selected to Commands** button. This creates a command that tells TSTool to extract monthly streamflow data for station 08219500 from HydroBase. Repeat these steps for the Conejos gage by selecting **Where:** Station Name Starts with Conejos in the Input/Query Options window and clicking on the **Get Time Series List** button. Five time series are listed in the Time Series List window. Highlight the Conejos River near Lasauses gage and click the **Copy Selected to Commands** button. Lastly repeat these steps to get the main stem Rio Grande gages by selecting **Where:** Station Name Starts with Rio Grande in the Input/Query Options window and again clicking on the **Get Time Series List** button. Highlight the four gages Rio Grande gages listed above (hold the shift key when selecting to choose more than one gage) and again click the **Copy Selected to Commands** button.

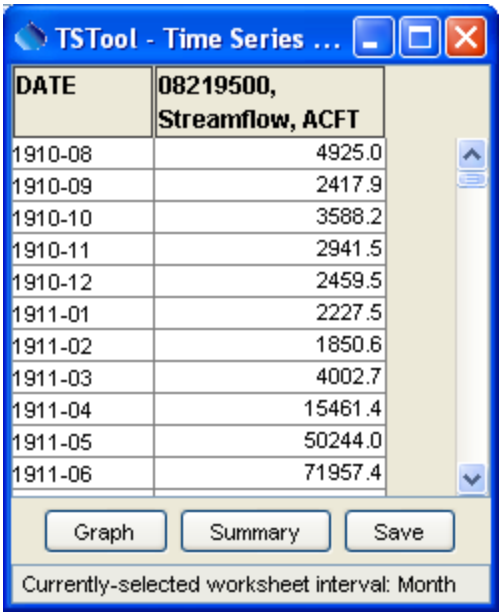
Commands to extract monthly data from HydroBase for each of the six gages of interest are now shown in the Commands window. At this time, selecting the **Run All Commands** button will extract the data from HydroBase and hold it in memory.



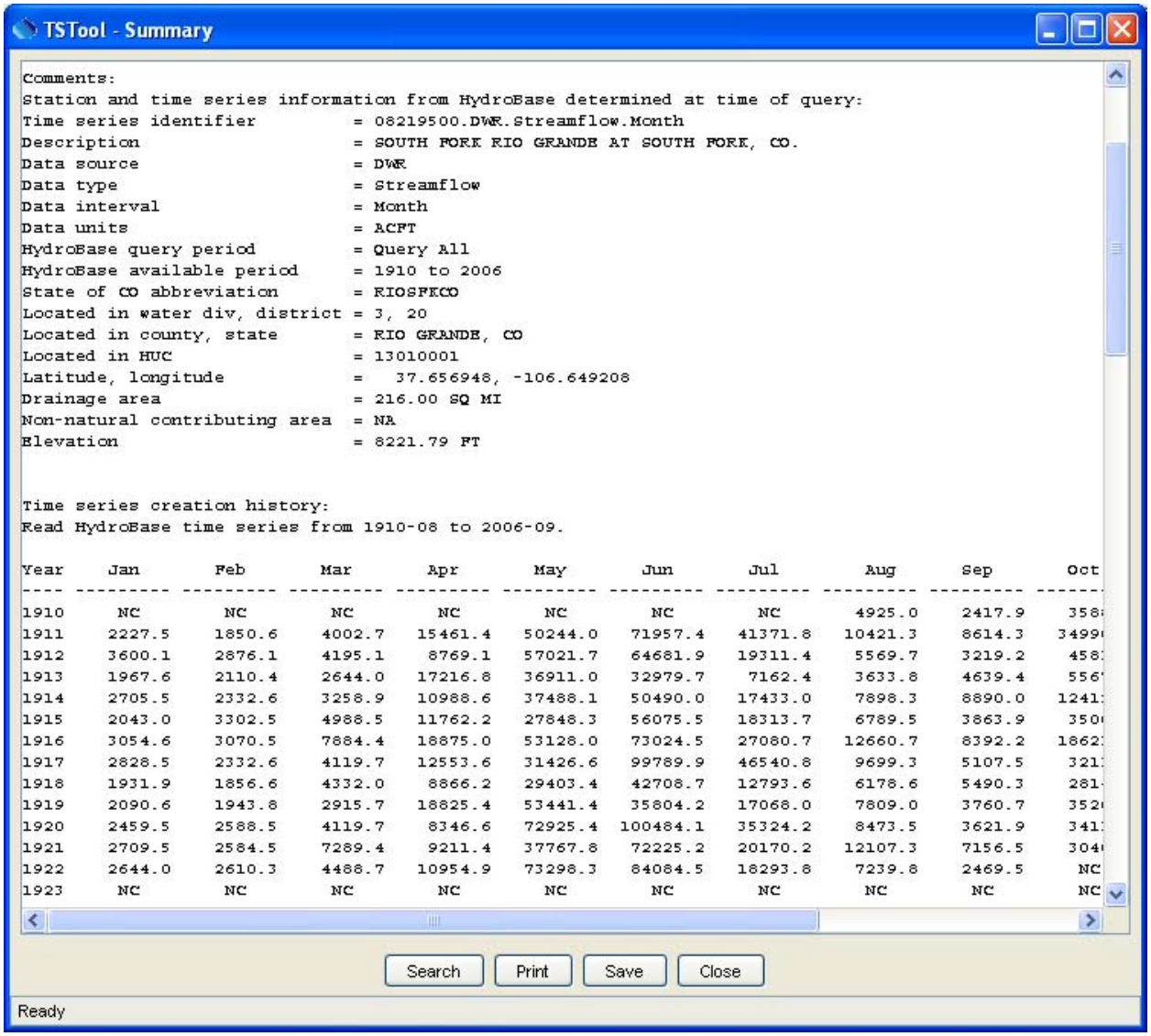
Highlighting individual time series in the Results window allows you to view, graph, and save the data extracted from HydroBase. Select South Fork Rio Grande at South Fork time series in the Results window. Right-clicking the mouse brings up the available options to look at the data. The following shows the **Graph-Line** option for viewing the data.



Selecting a **Table** provide the information in a columnar format for copying to Excel or other software.



Selecting a **Summary** provides the data in a matrix format, plus provides additional information stored in HydroBase about the time series, such as location information and drainage area.



Tip: Always view the data, graphically or in a summary form, prior to adding commands to manipulate or save the data. The period of record shown in the Time Series List window does not indicate the amount of data that may be missing in the time-series.

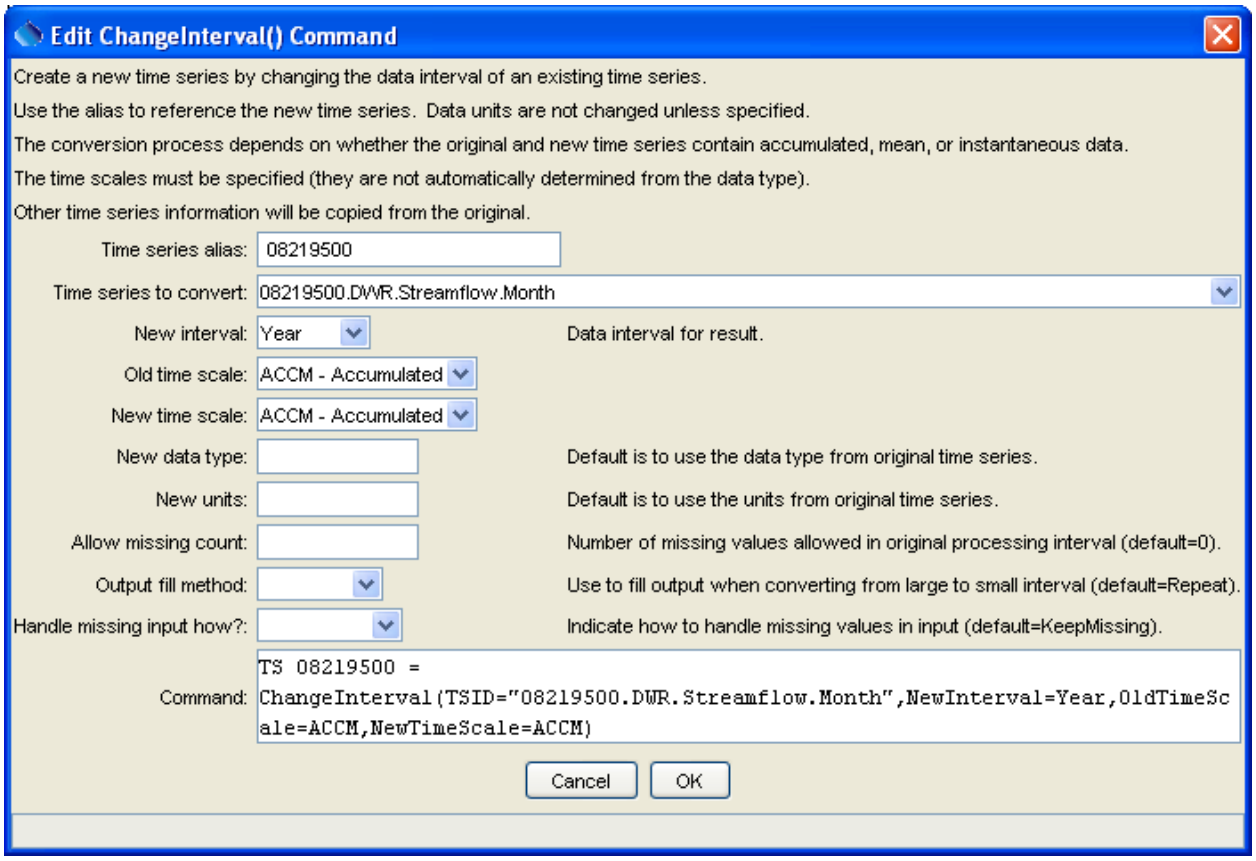
Step 2 – Use TSTool to "Change Interval" so annual streamflow totals can be extracted for use in determining wet, dry, and average year statistics.

TSTool includes commands to read time series information from sources other than HydroBase, fill missing data using statistical options, set missing data directly, and revise time series using arithmetic

functions, including add, subtract and scale. These commands are most useful for developing input files to StateCU and StateMod. The "Change Interval" command allows monthly data to be divided into daily data, daily data to be summed to monthly, monthly data to be summed to annual, etc.

Mouse-over "Commands" on the main TSTool menu bar, then mouse-over "Create Time Series" and select the **TS Alias = Change Interval()** command. This will enable the **Edit Change Interval() Command** window. The options currently filled with information are required. The remaining options will use defaults, if left blank.

1. Set an Alias identifier for the time-series to convert. It is recommended the station ID be used for the alias. For this example, type in the first gage identifier – 08219500.
2. Select the time series to convert from the drop-down menu. Only time-series identified in previous commands are available. For this example, select the corresponding first gage "08219500.DWR.Streamflow.Month".
3. Select the New Interval, "Year".
4. The Old time scale will automatically be populated with information from HydroBase. In this case, streamflow is monthly Accumulated.
5. Select the New Time Scale. In this case, we want to accumulate monthly data for an annual total so select "ACCM-Accumulated". Other options include changing interval to represent mean annual flow.
6. Click the **OK** button.



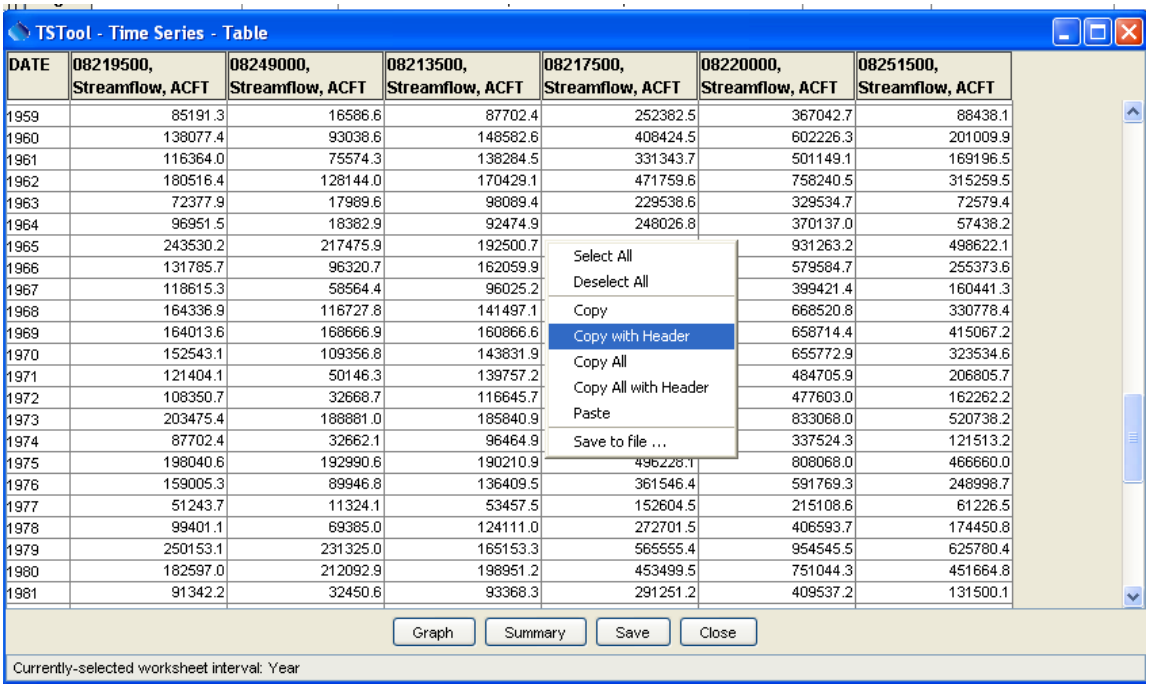
This new command will be added to previous commands in the Commands window. Repeat this step for each of the other five streamflow time series. Click the **Run All Commands** button. Now, both monthly time-series and annual time-series are shown in the Results window. Note that if you wish to edit commands, either double-click on the command, or highlight the commands and select Edit..Command from the main TSTool menu.

Step 3 – Save annual data so it can be sorted into wet, dry, and average years in Excel.

Tip: You may want to use the entire period of record for each gage, or you may want to choose the time-period of gage overlap for a more direct comparison.

Data can be saved directly from the Results window. Highlight the six annual time series (listed as ..Streamflow.Year as opposed to ..Streamflow.Month). Right click and chose Table. Click the Save button to save to DataValue Time Series file, a Tab-Deliminated Text file, or a Comma-Delimitated Text File. Each of these file types can be read directly by Excel.

Another option is to right click in the Time Series – Table window and “Copy All with Header”. This copies the time series into the clipboard where it can be “pasted” directly into Excel.



Step 4 – Save the commands to a command file so you can quickly update the information when new streamflow data becomes available.

The commands used to generate annual streamflow results can be saved into a "command file" that can then be read in and used to generate time series in the future. Select File..Save..Commands from the main TSTool menu. A standard dialogue box will allow you to provide the name and location to save the command file.

Tip: If you are extracting and manipulating data from HydroBase for an analysis that you expect to update or revise in the future, be sure to save your command files. Command files for this analysis can be saved and, at a later date, revised to include other gages represented in the Snake Diagram.

Step 5 – Copy the annual streamflow data into Excel from the clipboard or Open a saved text file in Excel. Determine the wet, dry, and average year annual flow for each gage location.

Sort the annual streamgage data for each column from smallest to largest. Determine the average of the 25 percent of available years representing the lowest flows, the 25 percent of available years representing the highest flows, and the overall average for the period of record. For example, statistical the results for the Rio Grande at Lobatos gage, representing Rio Grande flow leaving Colorado, are as follows:

1. Average annual flow = 403,000 acre-feet (for the period 1900 through current - compared to most recent Snake Diagram value of 322,100 for the period 1931 through 2002)
2. Average flow for dry years = 106,200 (for the period 1900 through current)
3. Average flow for wet years = 780,300 (for the period 1900 through current)

Example 4: Estimating missing streamflow data using a nearby station

When extracting information for the Snake Diagram we noted that five of the six gages used in the Rio Grande basin had data extending back at least to 1936. However, the Rio Grande at Wagon Wheel Gap streamflow station did not begin recording until 1951. We are interested in a comparison of all gages for the period 1936 through 2006; therefore would like to fill the gage using a nearby station with the best statistical correlation.

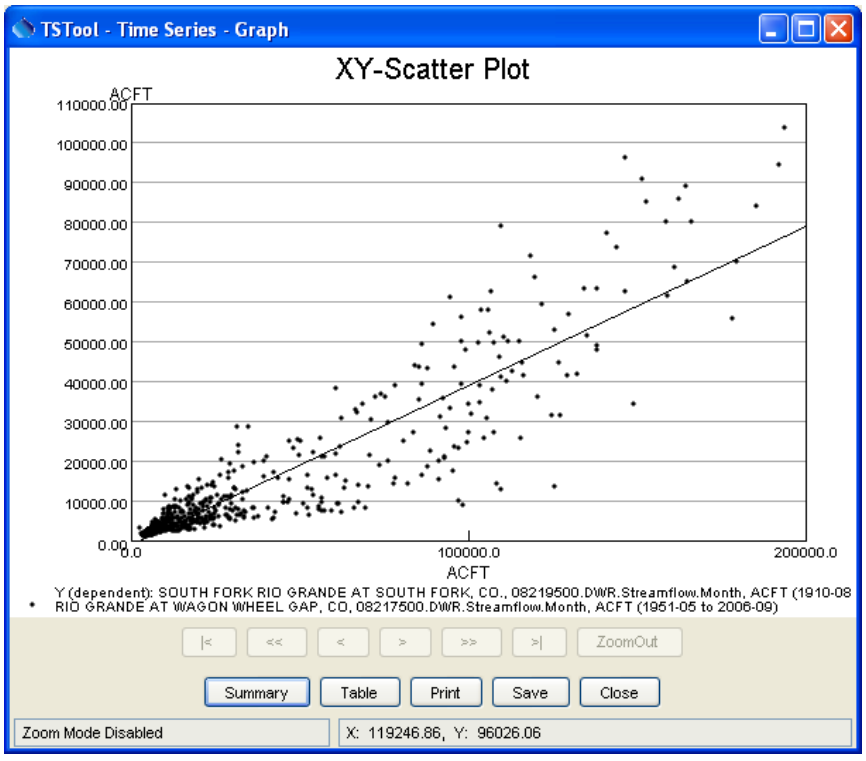
Step 1 – Use TSTool to extract monthly streamflow data from HydroBase.

Open the TSTool command file used to extract information for the Snake Diagram. Select File..Open..Command File. A standard dialogue box will allow you to enter the name and location of the saved command file.

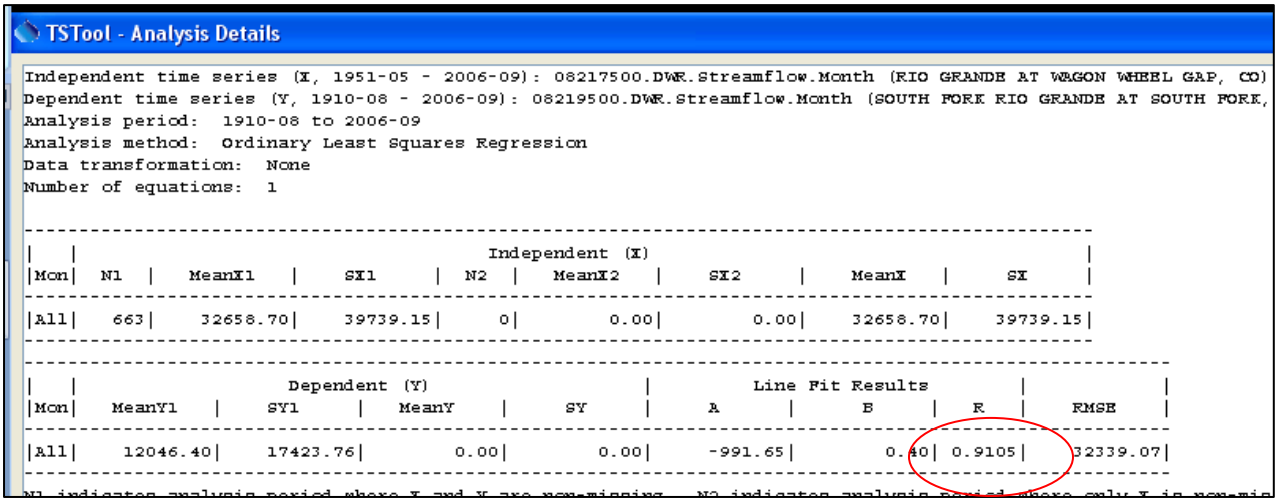
Tip: When selecting gages to use for filling, gages on the same tributary, when available, generally result in the best correlations. Next, look for gages in the same basin with the same "aspect" (flow direction) and similar drainage areas. In all cases, try to pick gages without the affects of reservoir storage and releases or without large upstream diversions.

Step 2 – Compare the relationship of the Rio Grande at Wagon Wheel Gap data with the other five streamflow gages and select the gage to use for filling.

Click the **Run All Commands** button, loading the monthly and annual streamflow data into memory. One at a time, highlight the monthly Wagon Wheel Gap gage plus one of the other gages in the Results window. Right-clicking the mouse brings up the available options to view data. Choose the **Graph-XY-Scatter** option.



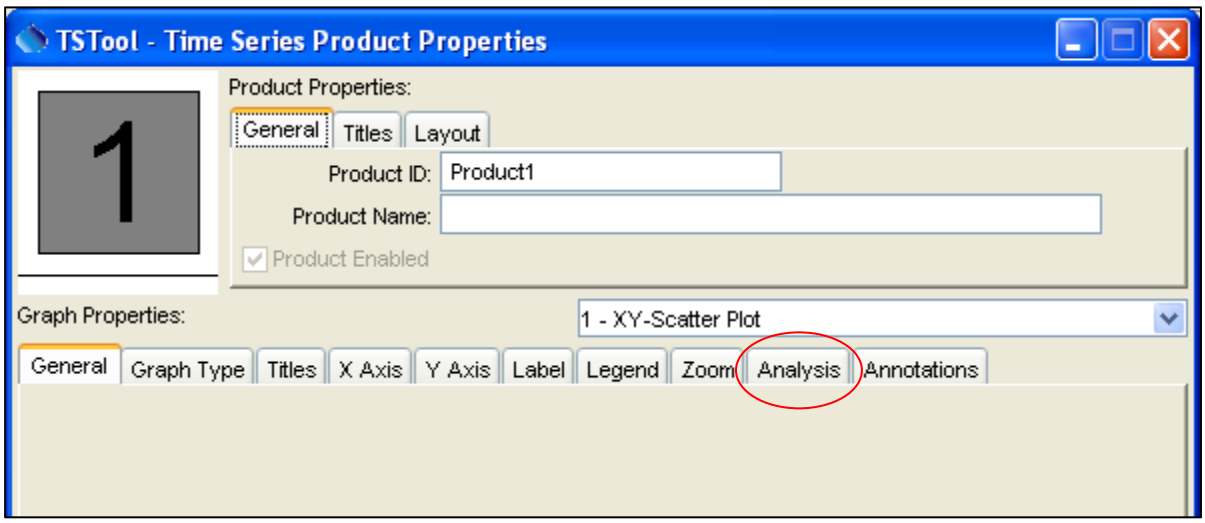
Visual inspection generally provides good information regarding the correlation between gages. Right-click in the graph for more options, including **Analysis Details**. This provides correlation details for all data (one equation) based on a linear relationship. For this example (Rio Grande at Wagon Wheel Gap as independent series and South Fork at South Fork as dependent series), the "R" value representing the correlation fit is 0.9105.



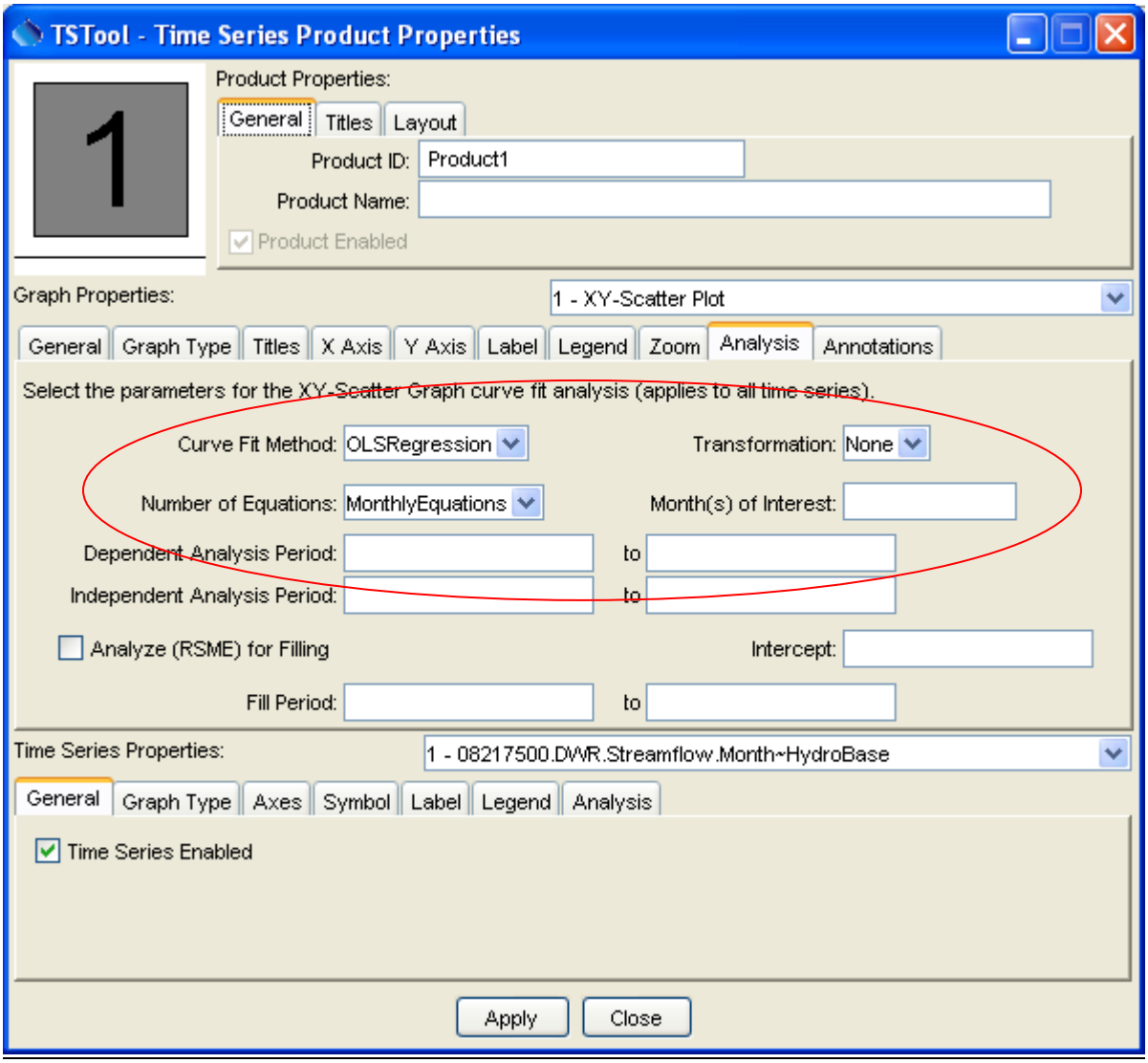
Comparing the Rio Grande at Wagon Wheel Gap and the Rio Grande at Thirtymile Bridge gage results in an R value of 0.9526; while the correlation with Del Norte results in an R value of 0.9861. Based on this quick analysis, it appears that Del Norte is the best gage to use when filling missing records for the Rio Grande at Wagon Wheel Gap gage.

TSTool allows other options for filling missing data, including using monthly linear regression equations, and annual and monthly log transformation regression equations. To determine if monthly or log transformation provides a better estimate, right click on the graph and choose **Properties**. This enables the **Time Series Product Properties** window.

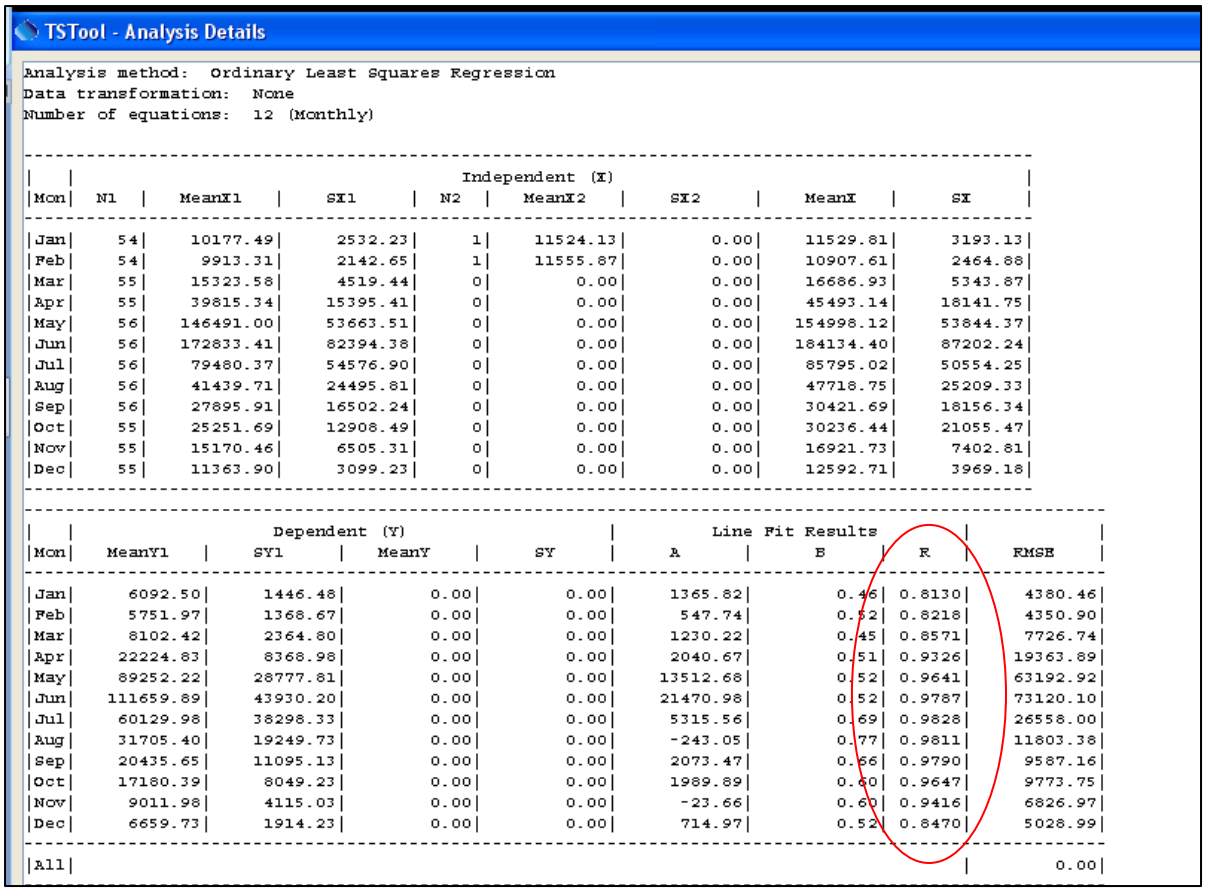
Select the **Analysis** tab in the Graph Properties: portion of the window.



Test the results if the Number of Equations is set to **MonthlyEquations**, if the Number of Equations is set to **OneEquation** and the Transformation is set to **Log,** etc. Select the options to investigate then click **Apply** button and the **Close** button.



The graph will now graphically display the relationships with the new analysis option. To again view the analysis properties, right click on the graph and select Analysis Details. Comparing the Rio Grande at Wagon Wheel Gap gage to the Rio Grande at Del Norte gage using monthly linear regression results in monthly R values ranging from a low of 0.8130 in January to a high of 0.9828 in July.



TSTool - Analysis Details

Analysis method: Ordinary Least Squares Regression
Data transformation: None
Number of equations: 12 (Monthly)

	Independent (X)							
Mon	N1	MeanX1	SX1	N2	MeanX2	SX2	MeanX	SX
Jan	54	10177.49	2532.23	1	11524.13	0.00	11529.81	3193.13
Feb	54	9913.31	2142.65	1	11555.87	0.00	10907.61	2464.88
Mar	55	15323.58	4519.44	0	0.00	0.00	16686.93	5343.87
Apr	55	39815.34	15395.41	0	0.00	0.00	45493.14	18141.75
May	56	146491.00	53663.51	0	0.00	0.00	154998.12	53844.37
Jun	56	172833.41	82394.38	0	0.00	0.00	184134.40	87202.24
Jul	56	79480.37	54576.90	0	0.00	0.00	85795.02	50554.25
Aug	56	41439.71	24495.81	0	0.00	0.00	47718.75	25209.33
Sep	56	27895.91	16502.24	0	0.00	0.00	30421.69	18156.34
Oct	55	25251.69	12908.49	0	0.00	0.00	30236.44	21055.47
Nov	55	15170.46	6505.31	0	0.00	0.00	16921.73	7402.81
Dec	55	11363.90	3099.23	0	0.00	0.00	12592.71	3969.18

	Dependent (Y)				Line Fit Results			
Mon	MeanY1	SY1	MeanY	SY	A	B	R	RMSE
Jan	6092.50	1446.48	0.00	0.00	1365.82	0.46	0.8130	4380.46
Feb	5751.97	1368.67	0.00	0.00	547.74	0.52	0.8218	4350.90
Mar	8102.42	2364.80	0.00	0.00	1230.22	0.45	0.8571	7726.74
Apr	22224.83	8368.98	0.00	0.00	2040.67	0.51	0.9326	19363.89
May	89252.22	28777.81	0.00	0.00	13512.68	0.52	0.9641	63192.92
Jun	111659.89	43930.20	0.00	0.00	21470.98	0.52	0.9787	73120.10
Jul	60129.98	38298.33	0.00	0.00	5315.56	0.69	0.9828	26558.00
Aug	31705.40	19249.73	0.00	0.00	-243.05	0.77	0.9811	11803.38
Sep	20435.65	11095.13	0.00	0.00	2073.47	0.66	0.9790	9587.16
Oct	17180.39	8049.23	0.00	0.00	1989.89	0.60	0.9647	9773.75
Nov	9011.98	4115.03	0.00	0.00	-23.66	0.60	0.9416	6826.97
Dec	6659.73	1914.23	0.00	0.00	714.97	0.52	0.8470	5028.99
All								0.00

Step 3 – Fill the Rio Grande at Wagon Wheel Gap gage based on regression with the Rio Grande at Del North gage.

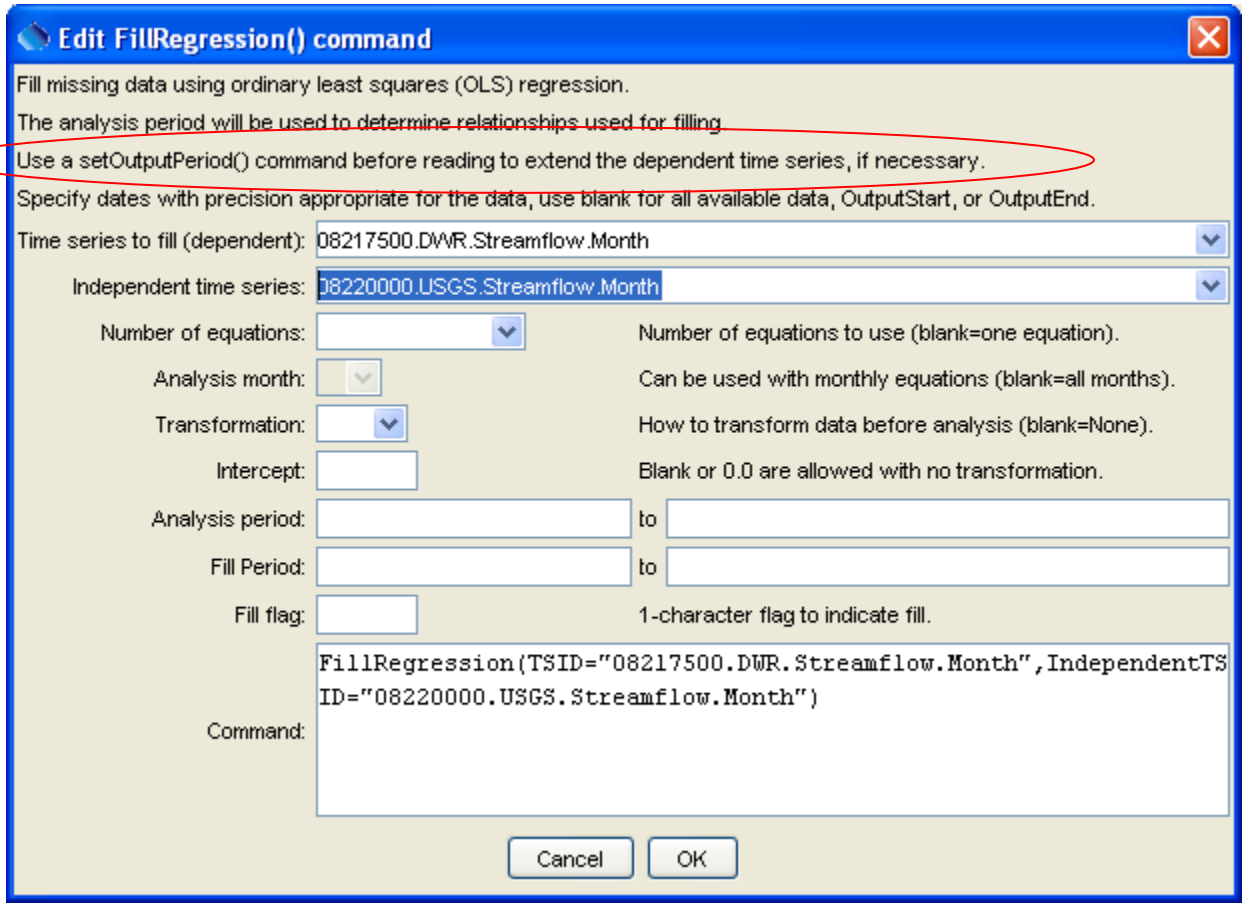
Fill the Rio Grande at Wagon Wheel Gap gage on a monthly basis – prior to changing the interval to annual.

Tip: When adding new commands to TSTool, the new command will be entered ABOVE the command highlighted in the Commands window. Time series to be used in new commands must have been "read in" from HydroBase above the new command.

Highlight the first Change Interval command in the Commands window. This will ensure that the fill command is run in sequence *after* we've read the data from HydroBase, and before we change to an annual interval. Mouse-over "Commands" on the main TSTool menu bar, then mouse-over "Fill Time Series Missing Data" and select the **FillRegression()** command. This will enable the **Edit FillRegression() command** window. The options currently filled with information are required. The remaining options will use defaults, if left blank.

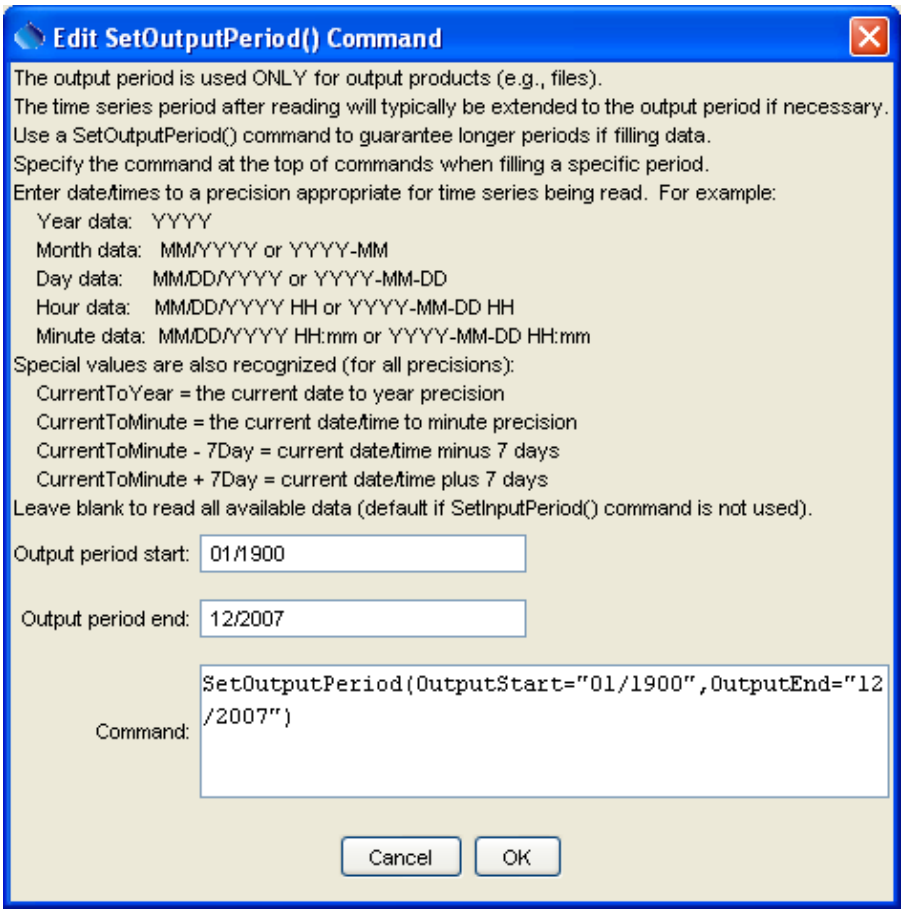
Using the drop-down list, choose 08217500.DWR.Streamflow.Month (Wagon Wheel Gap) time series as the Time series to fill (dependent). Select 08220000.USGS.Streamflow.Month (Del Norte) time series as the Independent time series. Fill in other options as necessary. For this example, leave other options

blank as we are using one equation without a log-transformation to fill the missing data. (See the TSTool Documentation for more details regarding filling options.) Click the OK button to include the command.

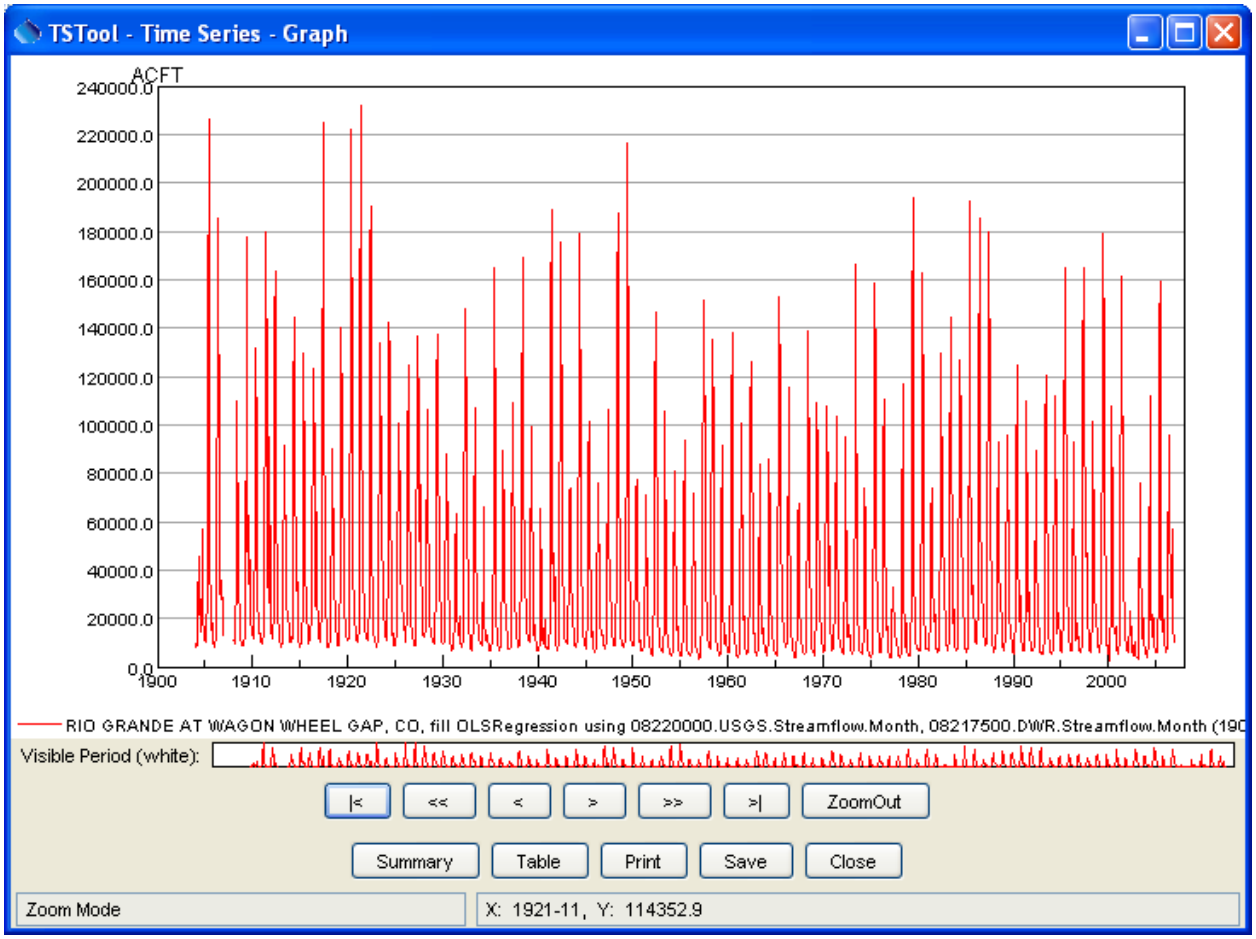


Note the highlighted comment above "Use a setOutputPeriod() command before reading to extend the depended time series, if necessary." This is CRITICAL if you want to fill data prior to the beginning date in a time-series. Otherwise, only missing data within the original period of the time-series will be filled. As noted, this command needs to be included before the data is read from HydroBase.

Highlight the first command in the Commands window. This will ensure that output period is set prior to reading data from HydroBase. Mouse-over "Commands" on the main TSTool menu bar, then mouse-over "Output Time Series" and select the **SetOutputPeriod()** command. This will enable the **Edit SetOutputPeriod() Command** window. Use the format for month data, since we are reading monthly streamflow from HydroBase. Note that the comments in this window also provide a reminder to "Use a SetOutputPeriod() command to guarantee longer periods if filling data." Set the output period and press the **OK** button.



Click the Run All Commands option and review the results. The Rio Grande at Wagon Wheel gage now extends back to 1904, when measurements began at the Del Norte gage. As with Example 3, the results can be viewed, graphed, exported, and copied/pasted to another software program.

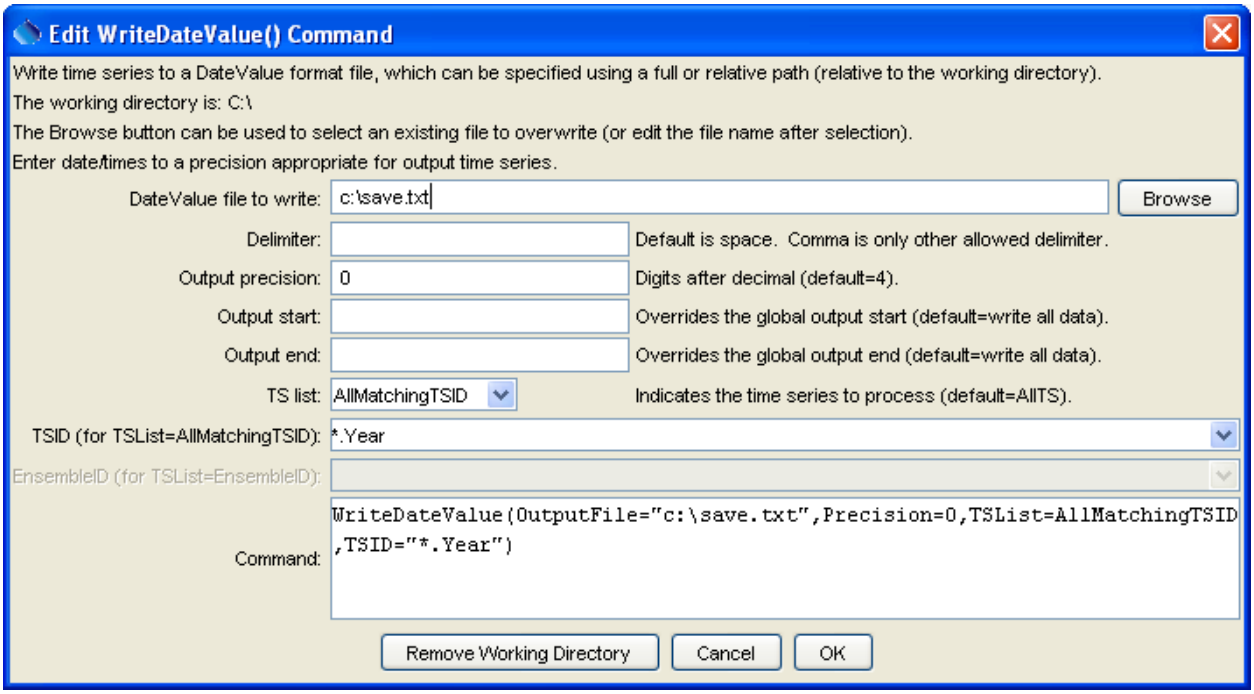


Step 4 – Include a command to save the results to file within the command file.

The benefit of writing results to an output file using a Write command (in lieu of copy/paste or saving from a viewing results) is that all commands used to create the file are "stamped" in the output so at a later date, it is clear how the data was filled or otherwise manipulated. In addition, the date, time, and HydroBase version used to extract data are stamped in the output file. Make sure none of the commands in the Command window are highlighted, so the output file is written after all other commands have been executed. As noted, additional commands are added above the highlighted command. To "deselect" any highlighted commands, right click and choose **Deselect All Commands**.

Mouse-over "Commands" on the main TSTool menu bar, then mouse-over "Output Time Series" and select the **WriteDateValue()** command. This will enable the **Edit WriteDateValue() command** window. The only required input is the name of the Date Value file to write and TS List to output.

Selecting the **Browse** button will bring up a dialogue box allowing you to navigate to a specific directory and provide a file name. Because the command includes both monthly data, and annual data, indicate the data to save is the annual data using a wild card *.Year.


Edit WriteDateValue() Command
Write time series to a DateValue format file, which can be specified using a full or relative path (relative to the working directory).
The working directory is: C:\
The Browse button can be used to select an existing file to overwrite (or edit the file name after selection).
Enter date/times to a precision appropriate for output time series.
DateValue file to write:
c:\save.txt
Browse
Delimiter:
Default is space. Comma is only other allowed delimiter.
Output precision:
0
Digits after decimal (default=4).
Output start:
Overrides the global output start (default=write all data).
Output end:
Overrides the global output end (default=write all data).
TS list:
AllMatchingTSID
Indicates the time series to process (default=AllTS).
TSID (for TSList=AllMatchingTSID):
*.Year
EnsembleID (for TSList=EnsembleID):
Command:
WriteDateValue(OutputFile="c:\save.txt",Precision=0,TSList=AllMatchingTSID
,TSID="*.Year")
Remove Working Directory
Cancel
OK

Historical Crop Consumptive Use Analysis - Review

Definitions

1. Monthly **P**otential **C**onsumptive **U**se (**PCU**) = *crop evapotranspiration*

- **Modified Blaney-Criddle** – outlined in SCS Technical Release 21
  (*most common*)

$$\mathbf{PCU = k * f}$$

$f = t * p/100$
$k = k_t * k_c$

where:
t = mean monthly air temperature
p = mean monthly percentage of annual daylight hours
k_t = temperature coefficient
k_c = crop coefficient

- **Original Blaney-Criddle** – outlined in FAO-24
  (*typically used w/ calibrated coefficients developed from lysimeter data*)

- **Pochop Method** – outlined in Elevation – A Bias Error in SCS Blaney-Criddle ET Estimates
  (*for bluegrass*)

Input Data:

- **Climate** – monthly temperature and frost dates
- **Latitude** – used to calculate daylight hours
- **Crop Type**
- **Crop Coefficients/Growing Season Triggers**

2. Monthly Effective Precipitation (Re) = *amount of monthly precipitation effective at serving crop needs*

Methods:

- **SCS** – outlined in SCS Technical Release 21
  (*dependent on net depth of application and average monthly PCU*)

- **USBR**
  (*linearly related to the monthly precipitation*)

Input Data:

- **Climate** – monthly total precipitation

- **Net Application Depth**

Adjustments to Climate Data:

- **Orographic Adjustment**– outlined in ASCE Manual 70

  User Supplied adjustments, typical values:

  Temperature – Adjust the climate station temperature down by 3.6 degrees per 1,000 feet rise in elevation between the irrigated acreage and the climate station location (based on the standard meteorological Environmental Lapse Rate)

  Precipitation – Compute the ratio of the annual precipitation at the location of the irrigated acreage (using average annual Isohyetal maps) divided by the average annual precipitation at the climate station. Monthly values at the climate station are then multiplied by the ratio to estimate monthly values at the irrigated lands.

  - Adjusts climate station data to location of irrigated lands

  - Used when representative climate station data not available (e.g. high altitude irrigated areas)

  - General "weight" climate station data if irrigated lands are located between multiple climate stations, in lieu of adjusting raw data

Adjustments to PCU:

- **Use Crop Coefficients Representing Local Conditions**
- **Elevation Adjustment** – outlined in ASCE Manual 70

  10% upward for each 1,000 meters increase in elevation above MSL

  - Corrects for lower mean temp at higher elevations that do not reflect crops' reaction to warm daytime temp and cool nights
  - Applies to Modified B-C and Original B-C method (Pochop has separate built-in altitude adjustment)
  - Applies to any crop type

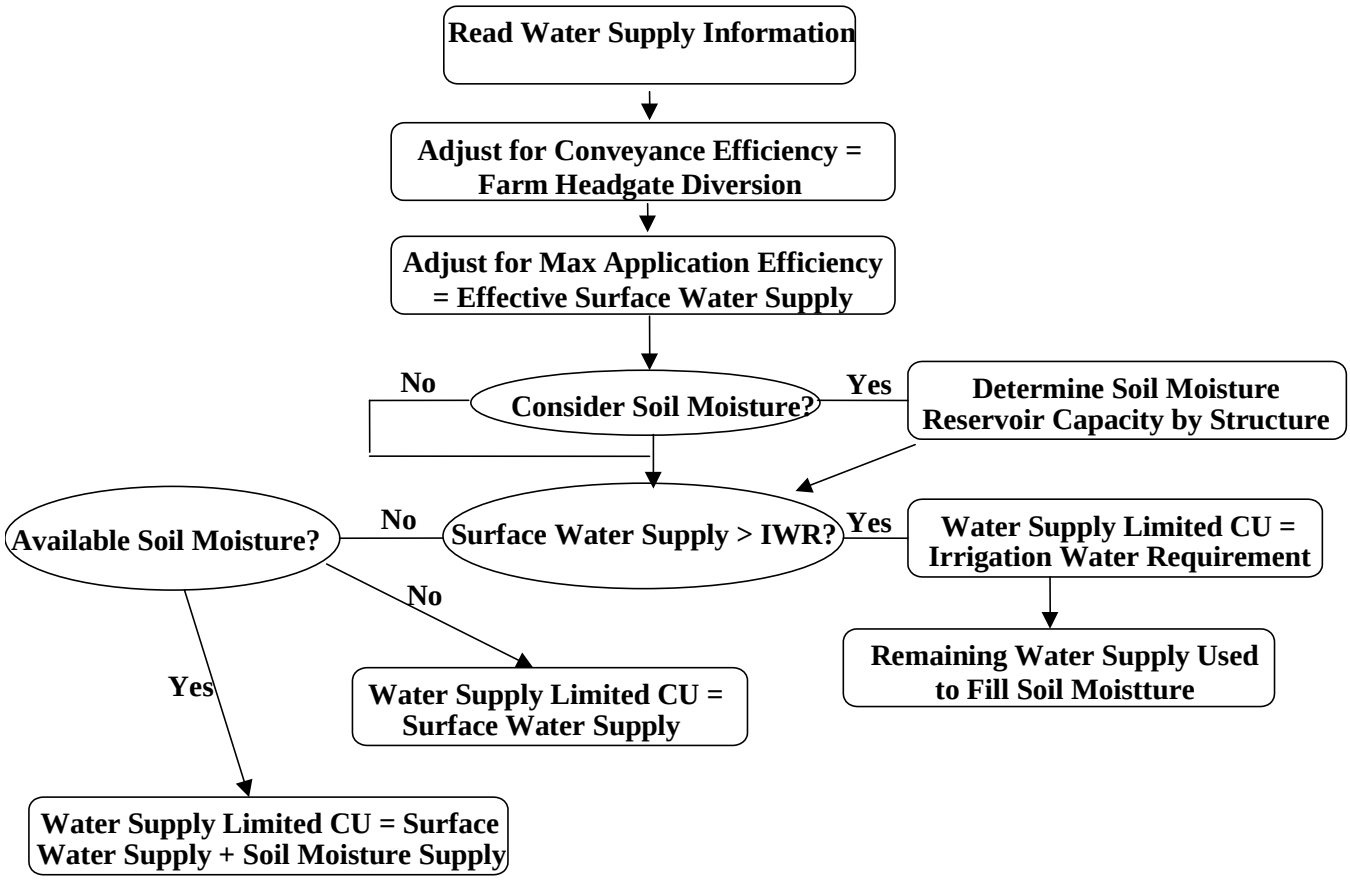
3. Monthly Crop Irrigation Requirement = the amount of water the crops could use from a full irrigation supply

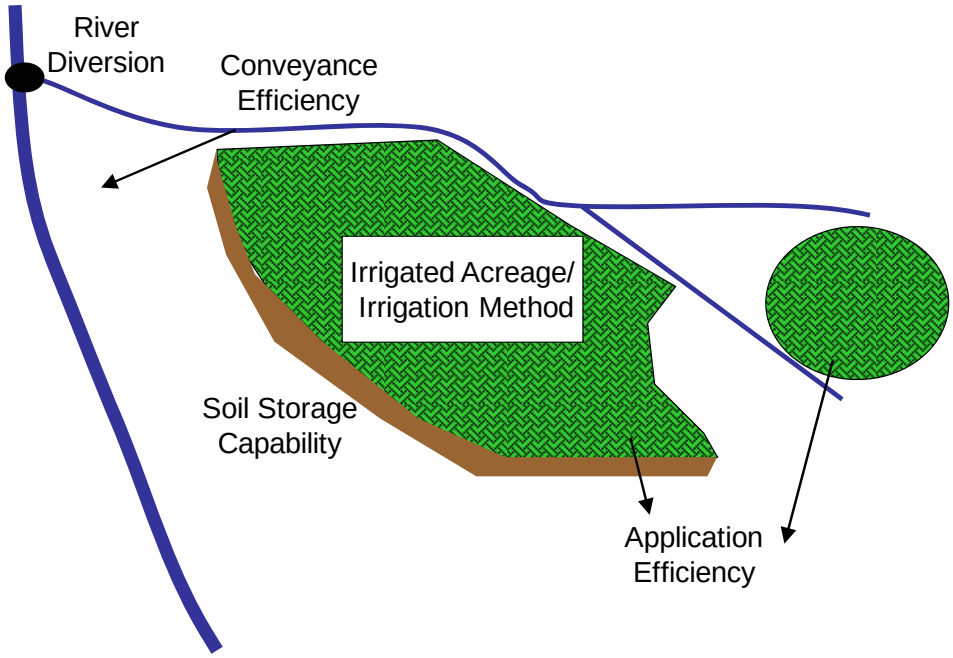
CIR = PCU – Re

4. Supply-Limited Crop CU = Actual Crop Consumptive Use = Historical Crop Consumptive Use = Total Crop CU

The actual amount of water the crops consumed from irrigation supplies. This is the amount that can be transferred to another use or another location. The amount of water historical diverted (surface or ground water) but not-consumed by the crop due to conveyance and application losses is the *unlagged or total return flow obligation*. As a "Term and Condition" of the water right change or transfer, this amount must continue to be available to the river based on historical lagged patterns to assure junior uses are not injured.

Monthly Supply to the crop is compared to monthly CIR estimates based on a ditch-level water balance approach as follows:


Read Water Supply Information
Adjust for Conveyance Efficiency = Farm Headgate Diversion
Adjust for Max Application Efficiency = Effective Surface Water Supply
No
Consider Soil Moisture?
Yes
Determine Soil Moisture Reservoir Capacity by Structure
Available Soil Moisture?
No
Surface Water Supply > IWR?
Yes
Water Supply Limited CU = Irrigation Water Requirement
No
Remaining Water Supply Used to Fill Soil Moistture
Yes
Water Supply Limited CU = Surface Water Supply
Water Supply Limited CU = Surface Water Supply + Soil Moisture Supply

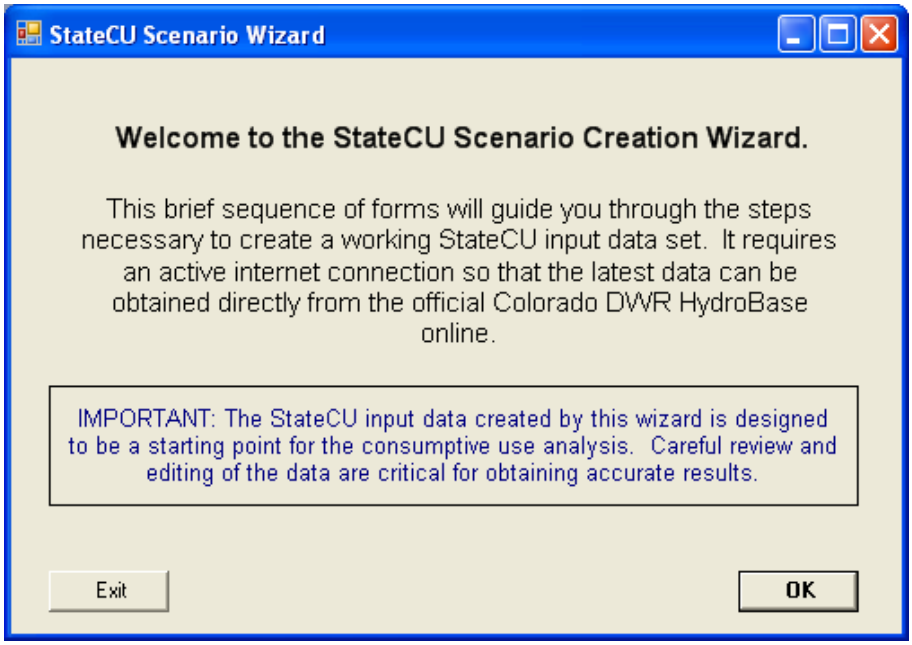

River Diversion
Conveyance Efficiency
Irrigated Acreage/ Irrigation Method
Soil Storage Capability
Application Efficiency

Example 5: Estimating crop CU for a specific ditch using the StateCU Wizard

Estimate the crop consumptive use for the Templeton Ditch considered as part of the Instream Flow review in Example 1 using the CDSS StateCU model. The StateCU model, and associated Documentation, is available on the CDSS website under the **Products** menu. Open **StateCU** by clicking on the application on your desktop or through an explorer window by clicking on the **StateCUI.exe** executable installed in the \cdss\statecu\bin\ subdirectory.

The HydroBase Wizard is an interactive tool that guides the user step-by-step through the development of a new monthly scenario and pulls required input data directly from HydroBase through an internet connection. The HydroBase Wizard can be used to create a new monthly *Climate Station Scenario* or a *Structure Scenario*. Required data (e.g. climate data, diversion records, crop characteristics) is pulled directly from HydroBase via an active internet connection and formatted into the correct input files. *Note that the purpose of the Wizard is to create a complete and operational scenario based on HydroBase data; it is the user's responsibility to review and edit specific data in the input files through the GUI to obtain accurate results.*

Activate the Wizard by selecting the **Create new StateCU scenario using HydroBase Wizard** command through the **File** menu. **Figure 5** displays the introductory screen to the Wizard. All screens in the Wizard have an **Exit** button. Select the **OK** button to proceed to Step 1.

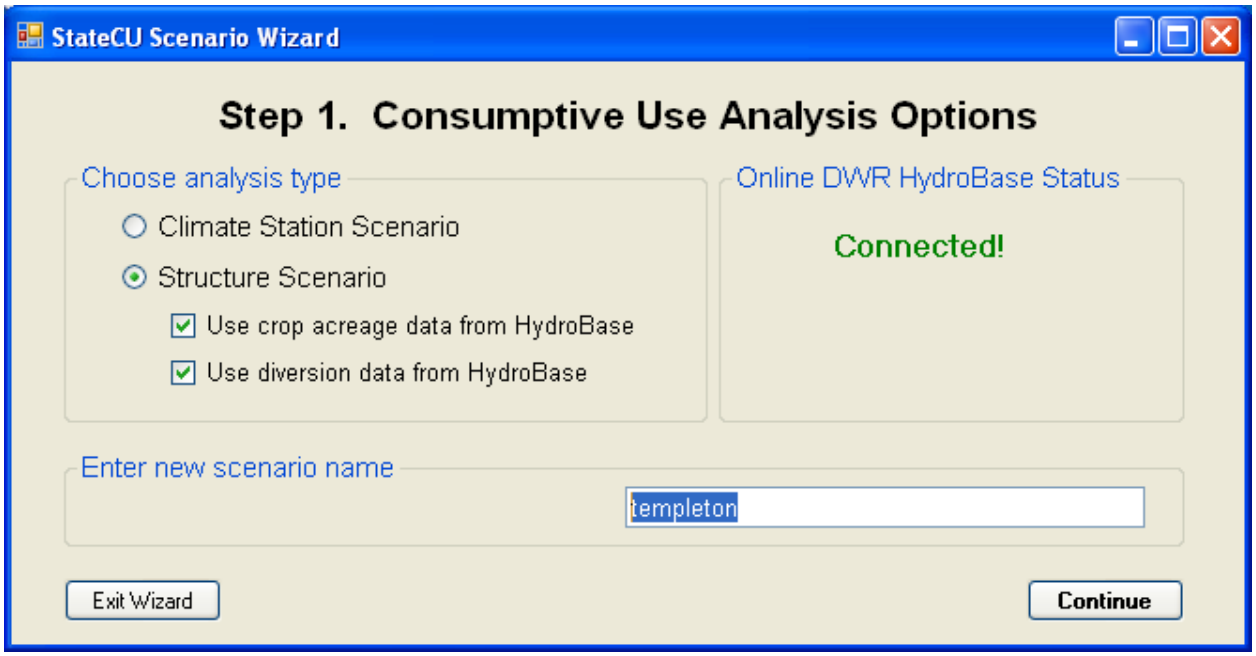


Step 1 – Select Consumptive Use Options

Step 1 of the Wizard identifies the analysis as a *Climate Station Scenario* or a *Structure Scenario.* Using the radio controls, select the **Structure Scenario**. Select the option to use crop and acreage data from the data source and to use diversion data from the data source. The crop, acreage and diversion data loaded in HydroBase for the specific structure will be used when creating the input files. If either of these options is unchecked, the Wizard will ask for crop and acreage data to be manually entered in Step 3 and diversion data to be manually entered by the user in the GUI.

Note that the message of 'Connected' in green text will appear if there is an active internet connection. If an internet connection is not available, the message will state 'Not Connected!' in red text.

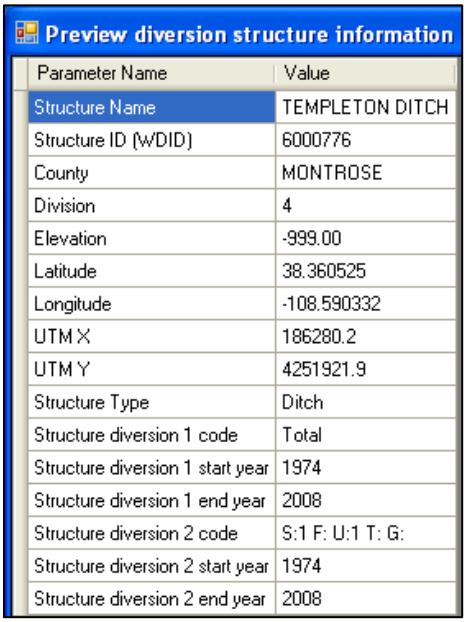
Enter a new scenario name avoiding special characters, spaces or periods in the file name. All input files will receive the same scenario 'base' name. The Wizard saves all new scenarios to the C:\CDSS\Data\StateCUWizard directory. Name this scenario "Templeton". Click on the **Continue** button to move to the next step.



Step 2 – Select the structure for the analysis

A *Structure Scenario* created in the Wizard will determine the potential crop consumptive use, irrigation water requirement and water supply limited consumptive use for one or more crops at a specific diversion structure. Step 2 of the Wizard determines the consumptive use location (ditch) that will be used in the analysis. Select the radial button to Search by Name, and enter Templeton in the Search by window. The search can be narrowed, if desired. Narrow the search by Division, and select Division 4 for the Gunnison Basin. Select the green Refresh List button.

Highlight the Templeton Ditch in Water District 60 – San Miguel River basin. Click on the **View structure info** to view structure and diversion class information. Templeton Ditch has only one diversion class, S:1 F: U1 T: G:, indicating the structure only diverts Source 1 (river) for Use 1 (irrigation). Therefore, when performing the historical crop consumptive use analysis for Templeton Ditch, it is appropriate to use DivTotal through the headgate.

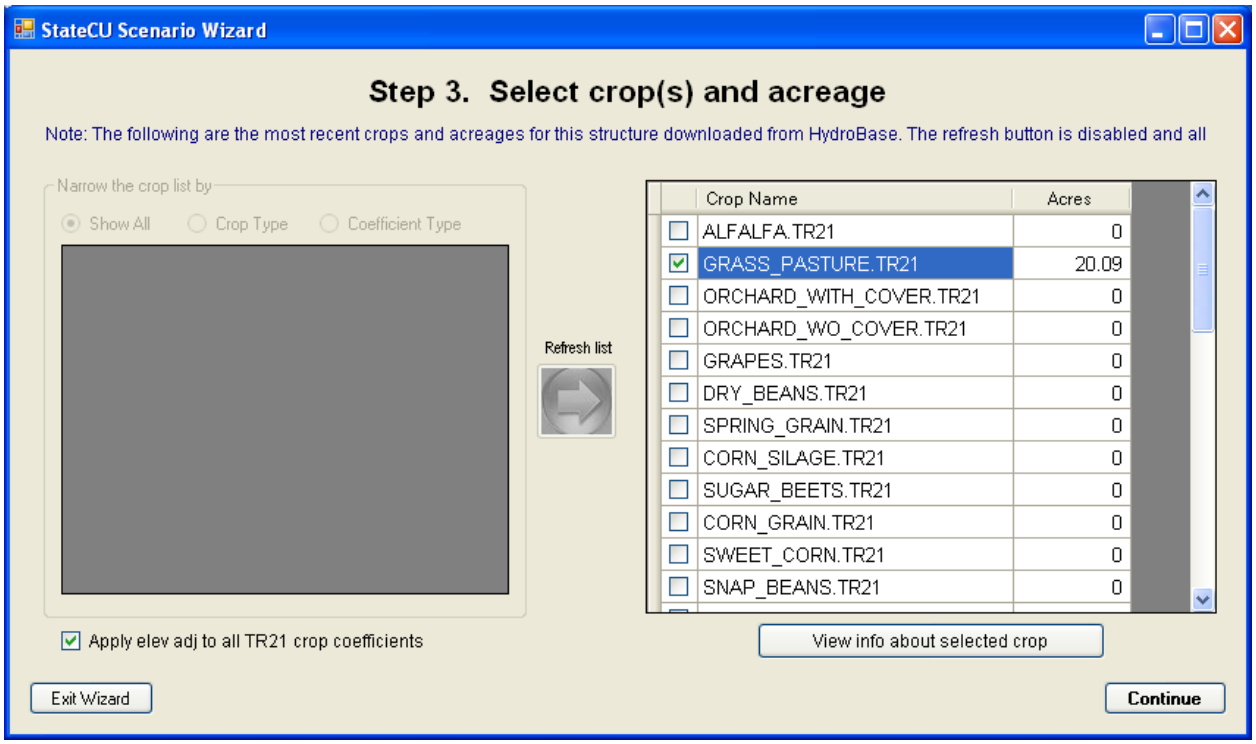


Parameter Name	Value
Structure Name	TEMPLETON DITCH
Structure ID (WDID)	6000776
County	MONTROSE
Division	4
Elevation	-999.00
Latitude	38.360525
Longitude	-108.590332
UTM X	186280.2
UTM Y	4251921.9
Structure Type	Ditch
Structure diversion 1 code	Total
Structure diversion 1 start year	1974
Structure diversion 1 end year	2008
Structure diversion 2 code	S:1 F: U:1 T: G:
Structure diversion 2 start year	1974
Structure diversion 2 end year	2008

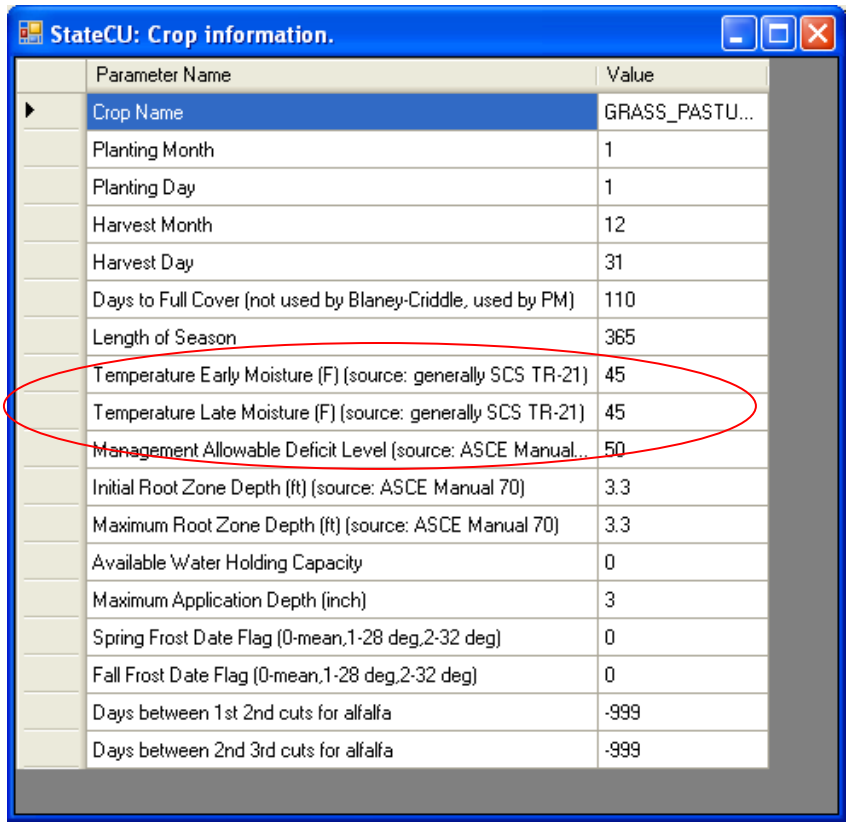
The diversion data can be previewed by clicking on the **View DivTotal.** Select the radial button for "Use structure DivTotal" and click the **Continue** button.

Step 3 – Select crop(s) and acreage

Step 3 of the Wizard determines which crop(s) will be used in the analysis. Note that although acreage and crops can vary over time, the Wizard uses the single 'snapshot' of the most current CDSS acreage assessment data in this step and applies them to all years in the scenario. This data can be edited in the GUI to represent changes in cropping practices.



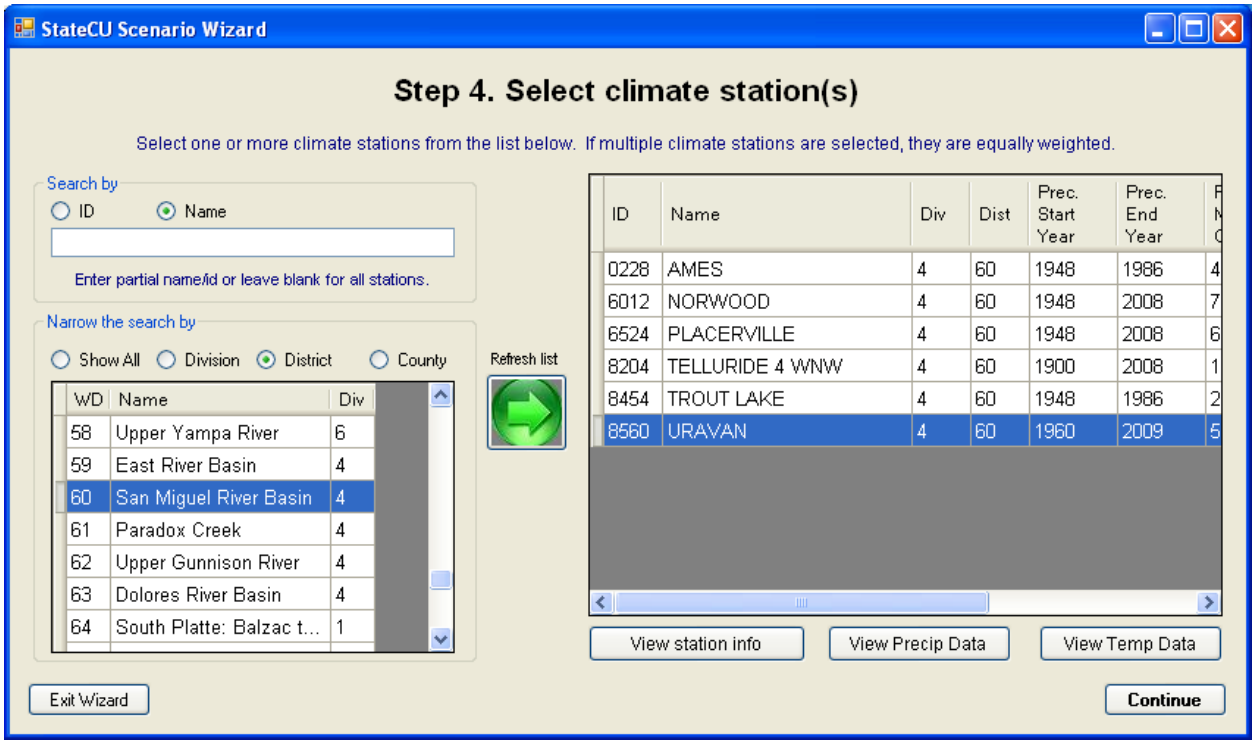
Based on the most recent CDSS Irrigated Acreage Assessment representing the year 2000, Templeton Ditch irrigates 20.09 acres of Grass Pasture. The Grass_Pasture.TR21 designation indicates that standard TR-21 coefficients will be used to estimate potential crop consumptive use. Highlight Grass_Pasture.TR21 and click the **View info about selected crop** button to see the parameters used to estimate growing season. The "Temperature Early Moisture" and "Temperature Late Moisture" indicates that the growing season will start when the mean monthly temperature reaches 45 deg F and end when it drops below 45 deg F. Note that these defaults are recommended in SCS TR-21, and can be revised by the user to reflect known irrigation practices.



The user can also revise the acreage and crop type, based on additional information by checking the boxes to select additional crops and entering or revising the associated acreage. The user can also choose to apply an elevation adjustment to all TR21 Crop Coefficients, using the check box in the lower left corner of the window. For this analysis, check the **Apply elev adj to all TR21 crop coefficients** and click on the **Continue** button to move to the next step.

Step 4 – Select climate station(s)

Step 4 of the Wizard determines which climate station(s) will be used in the analysis. The *Structure Scenario* will only include one consumptive use location, however data from multiple climate stations can be used to determine the consumptive use. If multiple climate stations are selected, the Wizard equally weights the climate data from the multiple climate stations for the analysis. Select the **District** radial button in the "Narrow the search" by window and select Water District 50 – San Miguel River Basin. Six climate stations are available. Based on the location of Templeton Ditch with respect to climate stations reviewed in Example 1, select Uravan to represent the climate.

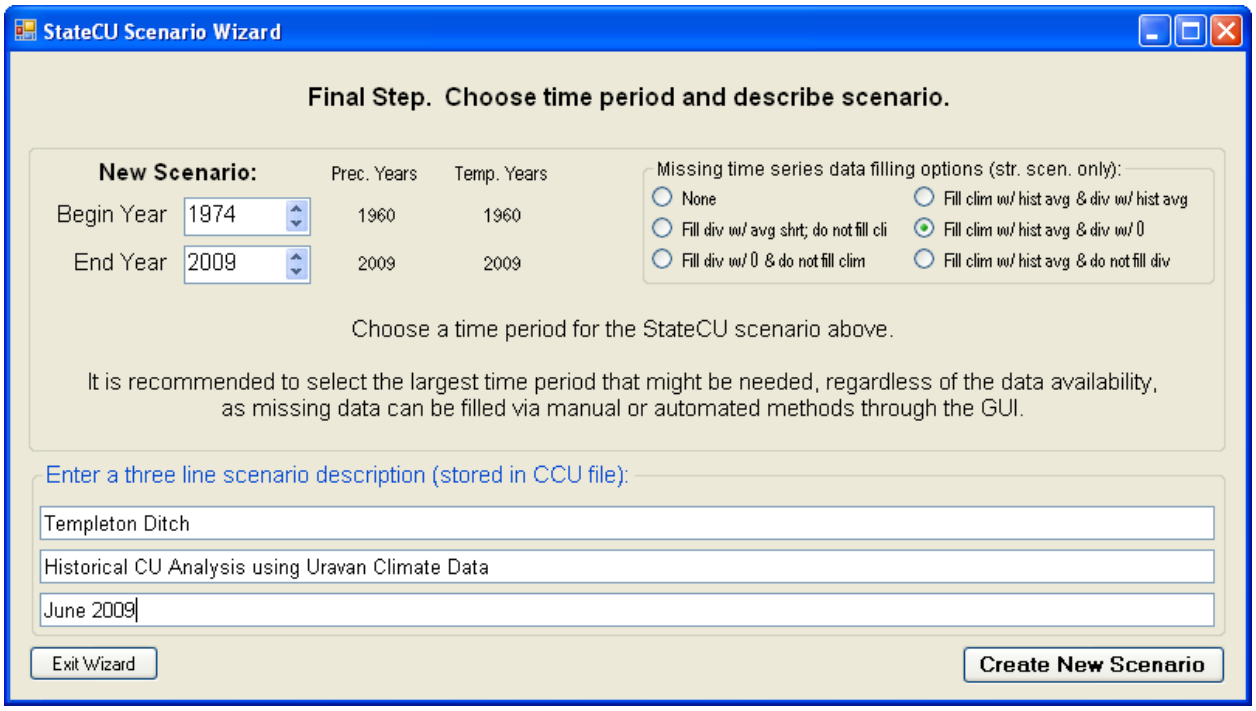


The **View station info** button displays physical information about the climate stations, including elevation and latitude. The **View Precip Data** and **View Temp Data** buttons provide monthly climate data and shows when/if data is missing. Review of the climate data indicates there is sufficient data for the analysis. Click on the **Continue** button to move to the next step.

Step 5 – Choose the time period and describe the scenario

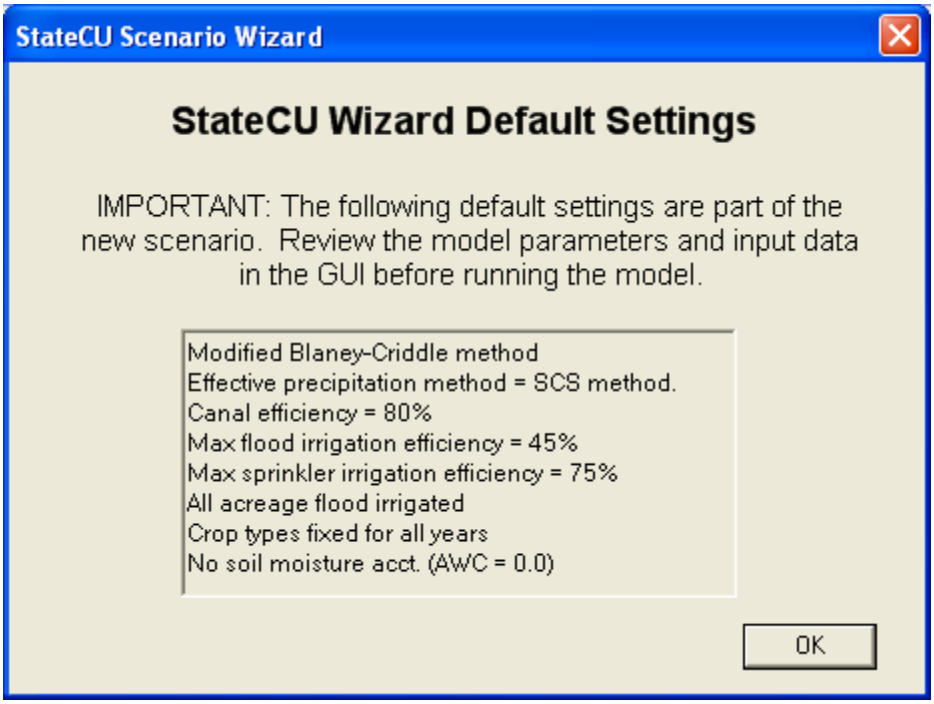
After completing the climate station selection in Step 4 of the Wizard, the user has determined all of the input parameters necessary to create a *Structure Scenario.* The Final Step of the Wizard is to set the beginning and ending year of the analysis and enter a description of the scenario. Note that all time series data files will be created using these time period parameters. Through the GUI, an analysis can be adjusted to a smaller time period, but not a larger period, therefore it is recommended to define this period as large as available data can support.

Missing data in the input files is indicated by -999. The user can choose to have StateCU fill missing data 'on-the-fly' with month averages or zeros through selecting **Missing time series data fill options** in the Final Step. Note that 'on-the-fly' filling will fill the missing data for the consumptive use calculations only; the original input file data will remain unchanged. Consumptive use calculations cannot be performed for years with any missing data. Edit the years by typing over the default or using the up and down arrows. When we reviewed available diversion records in Step 2 above, we noted that diversion records are available beginning in 1974. Set the **Begin Year** to 1974. In addition, we noted that there were a few months of missing climate data. Select the **Fill clim w/hist avg & div w/0** radial button. Enter a description of the scenario in the three allotted lines - this information is stored in the header of the model control options file and is included in certain output reports. Select the **Create New Scenario** to complete the creation of the scenario.



Several parameters and modeling options are not specifically input by the user into the Wizard, rather it is the responsibility of the user to review and edit these parameters through the GUI. The Wizard sets these parameters to defaults when creating the scenario. The default settings are listed in a window that is activated once the scenario is created. The following is a list of these defaults settings:

- The Modified Blaney-Criddle consumptive use analysis method is set
- The effective precipitation method is set to the SCS method.
- Crop types and crop acreages is fixed for all years
- Canal efficiencies are set to 80%
- Acreage is all set to be flood irrigated and crop types are fixed for all years (non-variable)
    - The maximum flood irrigation efficiency is set to 45%
    - The maximum sprinkler irrigation efficiency is set to 75%
- No soil moisture accounting and structure available water capacity is set to zero



Input data generated through the StateCU Wizard can be viewed and edited through the StateCU **Edit** menu. For more information and easy to follow instructions, including screen shots, see the StateCU Documentation.

Step 6 – Run the simulation

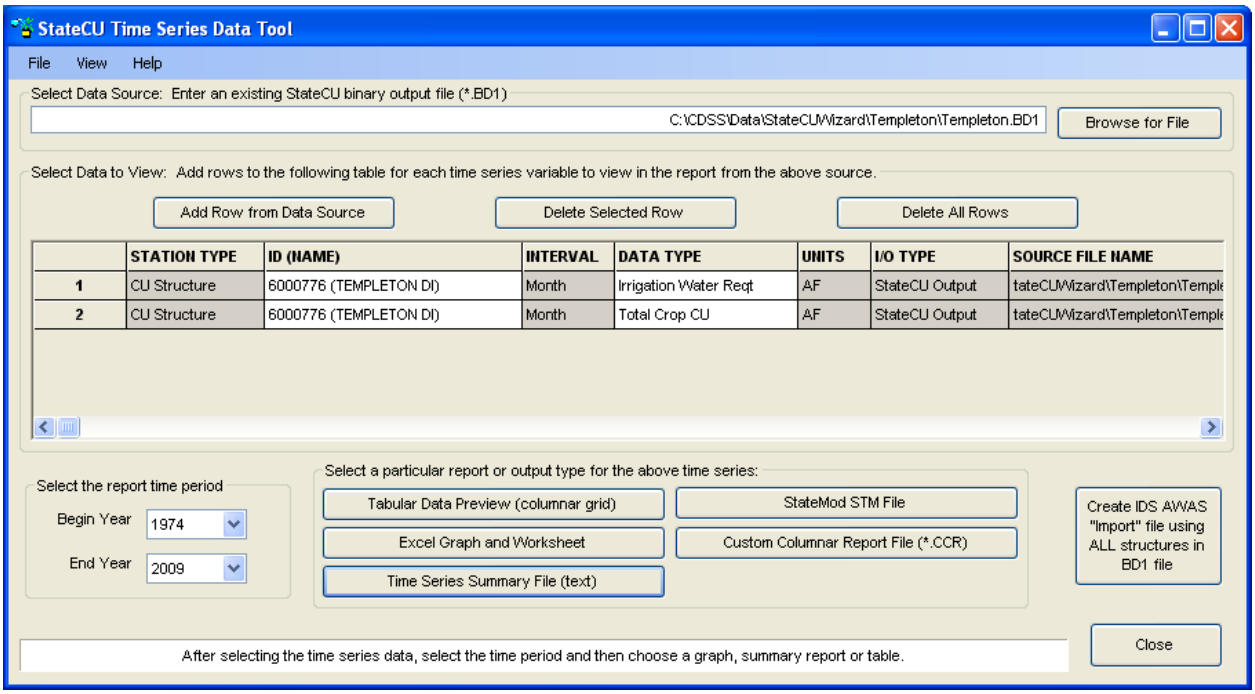
Select the Run.. **Run Simulation** command under the main menu. When a run is initiated, the StateCU GUI shells out to a DOS window to execute the StateCU program. The process status and any warning or error messages are displayed in the DOS window during StateCU execution. If the execution is successful, the DOS window will either close automatically or prompt the user to press the Enter key, and the user will be returned to the GUI to view output. If the execution is unsuccessful, the StateCU generated log file will be displayed on the screen with a description of the error that caused the program to terminate.

Tip: The user should view the **StateCU Fortran Program Log File** located in the **Results** menu or through a text editor even with a successful execution, as it may contain warnings or other pertinent information. In addition, the log file summarizes much of the data input.

Step 7 – View the results

StateCU generates standard output reports that can be viewed through the GUI. Select the Results..**Detailed Water Budget Output (*.dwb)** to view annual, average monthly, and monthly results for the analysis. As shown, on average the annual Irrigation Water Requirement for the Templeton Ditch, based on the acreage assigned in HydroBase, is 54 acre-feet. The average Total Estimated Crop CU is 36 acre-feet, indicating the ditch does not receive a full supply.

Select the **Results..Time Series Data Report Generator (*.bd1)** to select specific water budget components to view, graph, and save. Click twice on the **Add Row from Data Source** button. Double click on the **ID (Name)** and select "6000776 (TempletonDI)" from the drop-down list in both rows. Double click on the Data Type in row 1 and select "Irrigation Water Reqt" from the drop-down list. Double click on Data Type in row 2 and select "Total Crop CU" from the drop-down list.



The results can be viewed in several formats, described in the StateCU Documentation. Select the **Excel Graph and Worksheet** button. The data is loaded into a Data worksheet in Excel and a corresponding Graph worksheet is created. The Excel spreadsheet can be saved and the graphical presentation revised.