STREAMFLOW DATA ANALYSIS PROTOCOL

Protocol Narrative

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Inventory and Monitoring Program
National Park Service
U.S. Department of the Interior

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Version 1.0

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Add rows as needed for each change or set of changes tied to an updated version number				

1.0 BACKGROUND AND INTRODUCTION

1.1 RESOURCE ISSUE BEING ADDRESSED

The most fundamental hydrological measurement that characterizes all stream ecosystems is streamflow or discharge, the volume of water flowing through a cross section of a stream channel per unit time. An analysis of a hydrograph showing the manner in which streamflow varies over time provides insight into the characteristics of the watershed that influence such conditions as runoff and storage (Gore 1996). The intensity of the exposure to potential stressors for stream organisms depends on how fast water is traveling past the organisms, and on the dilution factor, which depends on how much water is in the stream. Streamflow provides key support data for other ecosystem indicators including freshwater quality, groundwater dynamics, species of management concern, aquatic assemblages (fish, amphibians and reptiles), erosion and deposition, wetlands, and riparian habitat.

1.2 RATIONALE FOR SELECTING THIS RESOURCE TO MONITOR

In general, changes in streamflow have the potential to alter both aquatic (instream) and riparian (streamside) ecosystems (Rood et al. 2005). Changes in streamflow also influence patterns of erosion, transport and deposition of alluvial sediments and thus can alter channel and floodplain characteristics, including fish and vegetation habitat. Ecoregion transitions reflect moisture availability that enables particular plant communities. Spatial shifts in ecological communities could result from changes in the timing and quantity of streamflow.

The hydrology of rivers in the Greater Yellowstone Network (GRYN) can change from direct human modification (e.g., impoundments, water abstraction) or via changes in climate (Meyer et al. 1999). Rivers can be altered hydrologically from dam operations (e.g., Snake River), which can in turn alter biotic assemblages (Stanford and Ward 1989). Measurements of continuous discharge can help determine how water withdrawals and impoundments are influencing river and streamflow dynamics. Water removal for irrigation can reduce instream flows and flood peaks in the summer, (e.g., Gros Ventre River, Bighorn River, Shoshone River, Spread Creek, Reese Creek) and may negatively impact fish populations (Mahoney 1987).

Climate change may alter stream hydrology (Poff 2002) which will affect all aspects of river ecosystem function (Meyer et al. 1999, Firth and Fisher 1992) ranging from food web interactions (Power et al. 1995) to nutrient cycling. Changes in baseflow characteristics (generally expressed as an index - the ratio of baseflow to total flow) may affect the following: balance of competitive and stress-tolerant organisms; creation of sites for plant colonization; structuring of aquatic ecosystems by abiotic vs. biotic factors; structuring of river channel morphology and physical habitat conditions; soil moisture stress in plants; dehydration in animals; anaerobic stress in plants; volume of nutrient exchanges between rivers and floodplains; duration of stressful conditions such as low oxygen and concentrated chemicals in aquatic environments; distribution of plant communities in lakes, ponds, floodplains; duration of high flows for waste disposal; and aeration of spawning beds in channel sediments. The timing of annual extreme water conditions (such as the date of maximum flow) may affect the following:

compatibility with life cycles of organisms; predictability/avoidability of stress for organisms; access to special habitats during reproduction or to avoid predation; spawning cues for migratory fish; and evolution of life history strategies; and behavioral mechanisms (The Nature Conservancy 2005).

Changes in land use (agricultural to residential) outside park boundaries and modifications or additions to park developed areas can result in an increase in impervious surfaces. As impervious surfaces increase across the landscape, less water percolates into the soil thus reducing groundwater recharge and baseflow into streams, and increasing the velocity and amount of runoff into lakes, rivers, and streams through overland flow. Runoff may also be increased through deforestation (which can occur through natural events such as forest fires, or through changes in administrative policies in adjacent forest service lands), as trees are no longer using large amounts of water through evapotranspiration. Climate change may increase the amount of precipitation in an area. Increased flow regimes can result in sedimentation, altered stream morphology, scouring, bank instability and mass wasting, decreased buffer/filter capacity for groundwater, increased water quantity, and dilution of solutes and particulates.

Reduced flows could cause increases in stream water temperature that impose stress on coldwater species such as native cutthroat trout. Low flow regimes can result in changes in the number, timing, and presence of pools; increase in disease; fish kills; concentration of solutes and particulates; decreased dissolved oxygen; increased surface water temperature; and decreased water quantity.

Streamflow is altered (could be unnaturally high or low) as a result of water impoundments and diversions. Water withdrawals lower the groundwater table. Dams may raise the local water table level, alter seasonal water table fluctuation, and flood or saturate normally mesic or xeric soils. Roads may also act as dams and influence the level and fluctuation of the water table in nearby ecosystems (Norris 2005).

The GRYN will utilize selected gages from the existing network of permanent streamflow (continuous discharge) gaging stations that are being monitored by the United States Geological Survey (USGS) National Stream Gaging Program. The data collected at these stations are collected and quality assurance and quality control checked by the USGS, and are easily available on the National Water Information System (NWIS) website (http://waterdata.usgs.gov/wy/nwis/current/?type=flow). Currently streamflow is being monitored continuously by the USGS at the locations described in Table 1.

Table 1. Station names, ID#s and period of record for USGS gaging stations in the GRYN

Station_Name	USGS Station_ID	Period_of_Record
Madison River near West Yellowstone MT	06037500	1913-present
Yellowstone River at Yellowstone Lk Outlet YNP	06186500	1926-present
Lamar River nr Tower Falls Ranger Station YNP	06188000	1923-present
Yellowstone River at Corwin Springs MT	06190500	1889-1893; 1910-present

Gardner River near Mammoth YNP	06191000	1938-present
Firehole River near West Yellowstone MT	06036905	1983-1996 (discharge); 2002-present
Firehole River at Old Faithful	06036805	2006 - present
Gibbon River at Madison Jct, YNP	06037100	2000-present
Boiling River at Mammoth, YNP	06190540	1988-1995; 2002-present
Soda Butte Cr at Park Bndry at Silver Gate	06187915	1999-present
Soda Butte Cr nr Lamar Ranger Station YNP	06187950	1988 – present
Tantalus Creek at Norris junction, YNP	06039640	2004-present
Bighorn River at Kane, WY	06279500	1928-present
Bighorn River near St. Xavier, MT	06287000	1934-present
Shoshone River near Lovell, WY	06285100	1966-present
Snake River AB Jackson Lake at Flagg Ranch WY	13010065	1983 to present; prior to 1988 pub as 13010200
Snake River NR Moran WY	13011000	1903 to present
Pacific Creek at Moran WY	13011500	1906 to 1917; 1944 to 1975; 1978 to present
Buffalo Fork AAB Lava Creek NR Moran WY	13011900	1965 to present
Gros Ventre River at Kelly WY	13014500	April 2008 to present
Gros Ventre River at Zenith WY	13015000	July-Sept. 1917 and 1918; October 1987 to present
Granite C AB Granite C Supplemental, NR Moose, WY	13016305	1995 to present
Snake River AT Moose, WY	13013650	1995 to present

While it is recognized that some of these stations may be abandoned in the future by the USGS, they still represent an easily accessed, easily analyzed vital sign for the GRYN.

1.3 PURPOSE OF PROTOCOL

The purpose of this protocol is to document standards, policies, and procedures for activities related to the processing and analysis of streamflow data collected by the U.S. Geological Survey in the Greater Yellowstone Network. The primary goal of this protocol is to connect park managers with available data by providing annual and synthesis reports on streamflow using an analysis program – Indicators of Hydrologic Alteration (IHA) – that was developed by the Nature Conservancy.

2.0 MONITORING OBJECTIVES

2.1 MONITORING QUESTION TO BE ADDRESSED BY THIS PROTOCOL

Specific monitoring objectives were developed for each park to answer the following broad question:
Are hydrologic regimes, as characterized by streamflow, changing in the GRYN?

2.2 MEASURABLE OBJECTIVES

2.2.1 Bighorn Canyon National Recreation Area (NRA)

The gaged rivers in Bighorn Canyon NRA are all considered regulated, in the sense that flows are controlled by dams and diversions. Resource managers in Bighorn Canyon NRA are interested in periodically reviewing the height and date of both high and low flows from each of the gaged rivers in or near the park.

Bighorn Canyon NRA Objective 1. Compare annual hydrographs and Environmental Flow Components (EFCs) for the five most recent years of record at the USGS gaging stations #06279500 (Bighorn River at Kane, WY); #06285100 (Shoshone River near Lovell, WY); and #06287000 (Bighorn River near St. Xavier, MT).

2.2.2 Grand Teton National Park (NP)

Resource managers in Grand Teton NP are interested in looking at streamflow trends on the unregulated portion of the Snake River that might be affected by climate change. This would include the IHA analysis of baseflow characteristics and the date of maximum flow. An annual review of the ten most recent annual hydrographs will allow park managers to determine whether park surface waters are experiencing a drought or other weather related cycle. In addition, Grand Teton NP is concerned about the effects of dewatering on the resources of the Gros Ventre River, and so would like to review annual hydrographs at the two continuously gaged sites on that river.

Grand Teton NP Objective 1. Estimate trends in the baseflow index (7-day minimum flow/mean flow for the year) at the USGS gaging station # 13011000 (Snake River AB Jackson Lake at Flagg Ranch, WY).

Grand Teton NP Objective 2. Estimate trends in the date of maximum flows at the USGS gaging station # 13011000 (Snake River AB Jackson Lake at Flagg Ranch, WY).

Grand Teton NP Objective 3. Compare annual hydrographs for the ten most recent years of record at the USGS gaging stations # 13011000 (Snake River AB Jackson Lake at Flagg Ranch, WY); #13015000 (Gros Ventre River at Zenith WY); and #13014500 (Gros Ventre River at Kelly WY).

2.2.3 Yellowstone NP

Resource managers in Yellowstone NP are interested in looking at streamflow trends (baseflow index, date of maximum flows and recent stream hydrographs) on the Yellowstone, Madison and Lamar Rivers. The Yellowstone and Lamar are considered to be important due to their highly productive riparian zones and for providing critical habitat for fish and other native aquatic species. The Madison River, although not as pristine as the Yellowstone and Lamar Rivers, also provides fish habitat. All of these rivers are potentially threatened by invasive exotics and high public recreational use. The gage at the Yellowstone River at Corwin Springs MT is located in Park County, Montana, hydrologic unit (HUC) 10070002, and has a contributing drainage area of 2,619 square miles. The gage on the Madison River near West Yellowstone MT is located in Gallatin County, Montana, HUC 10020007, and has a contributing drainage area of 420 square miles. The gage at the Lamar River near Tower Falls Ranger Station is located in Park County, Wyoming, HUC 10070001, and has a contributing drainage area of 660 square miles.

Yellowstone NP Objective 1. Estimate trends in the baseflow index (7-day minimum flow/mean flow for the year) at the USGS gaging station #s 06037500 (Madison River near West Yellowstone MT), 06188000 (Lamar River nr Tower Falls Ranger Station YNP), and 06190500 (Yellowstone River at Corwin Springs MT).

Yellowstone NP Objective 2. Estimate trends in the date of maximum flows at the USGS gaging station #s 06037500 (Madison River near West Yellowstone MT), 06188000 (Lamar River nr Tower Falls Ranger Station YNP), and 06190500 (Yellowstone River at Corwin Springs MT).

Yellowstone NP Objective 3. Compare annual hydrographs for the ten most recent years of record at the USGS gaging stations #s 06037500 (Madison River near West Yellowstone MT), 06188000 (Lamar River nr Tower Falls Ranger Station YNP), and 06190500 (Yellowstone River at Corwin Springs MT).

3.0 SAMPLING DESIGN

This protocol uses a targeted sampling design, based on individual park needs. The rational for selecting the gaging stations to be analyzed by this protocol is detailed in Sections 2.2.1 through 2.2.3, above. These analyses will be performed as frequently as annually, depending on park needs. This protocol will use existing data that is collected, verified and validated by the USGS. In order to capture an entire water year (October through September), the analysis will take place after the data have been quality checked by the USGS (usually a minimum of 6 months after the end of the water year).

Stream gaging by the USGS involves (1) obtaining a continuous record of stage—the height of the water surface at a location along a stream or river, (2) obtaining periodic measurements of discharge (the quantity of water passing a location along a stream), (3) defining the natural but often changing relation between the stage and discharge, and (4) using the stage-discharge relation developed in step 3 to convert the continuously measured stage into estimates of streamflow or discharge (Olson and Norris 2005). The USGS has quality control processes in

place to ensure the streamflow information being reported is obtained and analyzed using consistent methods.

4.0 METHODS

4.1 USING THE IHA

Streamflow data will be analyzed and interpreted through the use of the analysis program "Indicators of Hydrologic Alteration" or IHA. IHA is a software program that provides useful information for those trying to understand the hydrologic impacts of human activities. Over 1,000 water resource managers, hydrologists, ecologists, researchers and policy makers from around the world have used this program to assess how rivers, lakes and groundwater basins have been affected by human activities over time or to evaluate future water management scenarios. This program was developed by scientists at The Nature Conservancy to facilitate hydrologic analysis in an ecologically meaningful manner. This software program assesses 67 ecologically relevant statistics derived from daily hydrologic data. For instance, the IHA software can calculate the timing and maximum flow of each year's largest flood or lowest flows, then calculates the mean and variance of these values over some period of time. Comparative analysis can then help statistically describe how these patterns have changed for a particular river or lake due to abrupt impacts such as dam construction or more gradual trends associated with land, water use, and climate changes.

The stations selected for long-term trend analysis (base flow index and date of maximum flow) will have hydrologic datasets which contain at least 20 years of data. Stations selected for annual hydrograph and EFC comparisons may have fewer years of data. All downloaded datasets will be reviewed for outliers, gaps, incorrect data entries and other anomalies, per IHA manual instructions.

4.2 DOWNLOADING DATA

Data can be imported into the IHA program from three different file formats from the USGS NWIS website, and then saved as an internal Hydrologic Data file. The assumption is that the USGS NWIS site can be revisited in perpetuity to regenerate a given data set for analysis. Projects are then created such that each project is linked to a single Hydrologic Data file, and can be used to create and run multiple analyses. Each analysis stores a series of user-settable parameters that define how the hydrologic data will be analyzed. Multiple analyses can be saved in a single project. Results will be displayed in graphical outputs, which are customized for each park. The IHA contains a self-explanatory Wizard to guide users through all steps, but specific instructions can be found in Standard operating procedure (SOP) #1 – Preparation of graphical outputs and analyses.

First, download the IHA program from the site: http://www.nature.org/initiatives/freshwater/conservationtools/art17004.html and install on the main drive on your computer. To download data from the USGS NWIS site, navigate to the site: http://waterdata.usgs.gov/wy/nwis/current/?type=flow and click on the station of interest (they are sorted by basin).

- **YELLOWSTONE RIVER BASIN**

06186500	Yellowstone River at Yellowstone Lk Outlet YNP
06187950	Soda Butte Cr nr Lamar Ranger Station YNP
06188000	Lamar River nr Tower Ranger Station YNP
06190540	Boiling River at Mammoth, YNP
06191000	Gardner River near Mammoth YNP
06191500	Yellowstone River at Corwin Springs MT
06207500	Clarks Fork Yellowstone River nr Belfry MT

This will pull up the station and its available information. Select "Time series – daily data" from the drop-down menu. Select "Discharge" from the available parameters. The output format should be "tab separated data". Enter the Begin and End dates to match the entire period of record for the discharge data set. Save the resulting screen as a text file, to the IHA7\IHAWorkingDir\HydroData folder, using the USGS station number and the date the data are downloaded as the file name (13001650_6-9-2008). Open the text file and delete all of the provisional data. The provisional data appear towards the bottom of the file, and are identified by a "P" in the last column. Save the file again. Note the begin and end dates of the resulting file, as these will be used to name the Hydrologic Data File in the IHA program.

4.3 DATA MANAGEMENT

Hydrologic data files downloaded from the USGS NWIS will be named (saved) in the IHA program using the following protocol: USGS_NWIS_13001650from10-1-1907thru12-31-2007, where **13001650** is the USGS Station Number; and where **from10-1-1907thru12-31-2007** is the range of dates of the downloaded data (refer to SOP#1). This naming convention will allow the particular analysis to be repeated, if desired. Once the data are imported into the IHA, the original downloaded text file can be deleted.

5.0 DATA ANALYSIS AND REPORTING

Once a project has been created, the analysis (along with a standard set of graphical outputs) can be run. SOP #1 – Preparation of graphical outputs and analyses, provides details for customizing the tutorial for use by the GRYN. The graphical outputs should be reviewed by a hydrologist to provide interpretation and analysis, relevant to park managers. Trends in baseflow indices, dates of maximum streamflow and annual hydrographs will be routinely reported upon in a one- to two-page resource summary document. These summaries may be updated as frequently as annually, depending upon individual park needs.

6.0 ADMINISTRATION/IMPLEMENTATION OF THE PROTOCOL

6.1 CORE DUTIES

The core duties for implementing this protocol include the following:

- Downloading data into the IHA program from The Nature Conservancy website
- Downloading data from the USGS NWIS site
- Performing the required IHA analysis for each park
- Providing interpretation and written analyses to compliment graphical outputs

- Preparing annual summary reports, including Resource Briefs
- Consulting with park managers to maintain applicability and relevance of monitoring objectives
- Revising the protocol as needed

6.2 ROLES AND RESPONSIBILITIES

This protocol will be implemented by the GRYN water resource specialist, or park affiliated personnel with hydrologic expertise. Because the program uses existing data which are easily imported into the IHA analysis program, this protocol could potentially be implemented by almost anyone, concurrent with other activities, with little extra time. However, review of graphical outputs and providing the interpretation and analysis could require additional time from someone with hydrologic expertise.

6.3 PERIODIC REVIEWS

This protocol will be reviewed and revised at least once every 3 years to insure that responsibilities and methodologies are kept current and to insure that the outputs continue to relevant to park managers. After the first year of implementation, a critical review will be conducted by the Network water resource specialist. Outputs will be reviewed in order to determine whether additional calibration is needed to tailor them to park specific locations. This is done by displaying the graph of daily flow data coded by EFC type, and then bringing up the Analysis Properties window by clicking on the button on the graph window. The EFC daily graph can be evaluated to see if the IHA is providing the proper distinction between high flows and lows flows, the desired return interval for floods, or other desired flow characteristics, and the EFC parameters adjusting accordingly.

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PREPARATION of GRAPHICAL OUTPUTS and ANALYSIS for Streamflow Data Analysis

VERSION 1.0

September 30, 2008

STANDARD OPERATING PROCEDURE #1

Suggested citation: O'Ney SE. 2008. Standard operating procedure #1: Preparation of graphical outputs and analysis, Version 1.0. In: Streamflow data analysis protocol, Version 1.0. Bozeman (MT): National Park Service, Greater Yellowstone Network.

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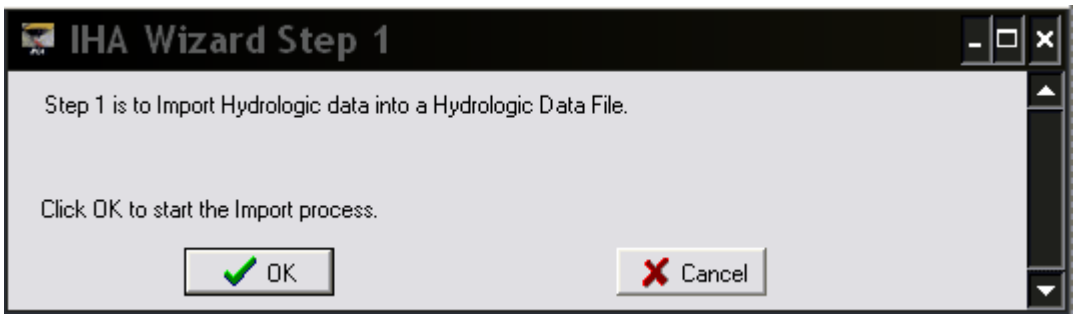
Original Publication Name, Version and Date: SOP #1 – Preparation of Graphical Outputs and Analysis, Version 1.0, September 30, 2008				
Date and number of Previous Version	Date of Revision	Author(s) of Revision (with title and affiliation)	Location in Document and Concise Description of Revision	Reason for Change
Add rows as needed for each change or set of changes tied to an updated version number				

1.0 USING THE INDICATORS OF HYDROLOGIC ALTERATION TO CREATE PROJECTS, PERFORM ANALYSES, GENERATE AND SAVE GRAPHS

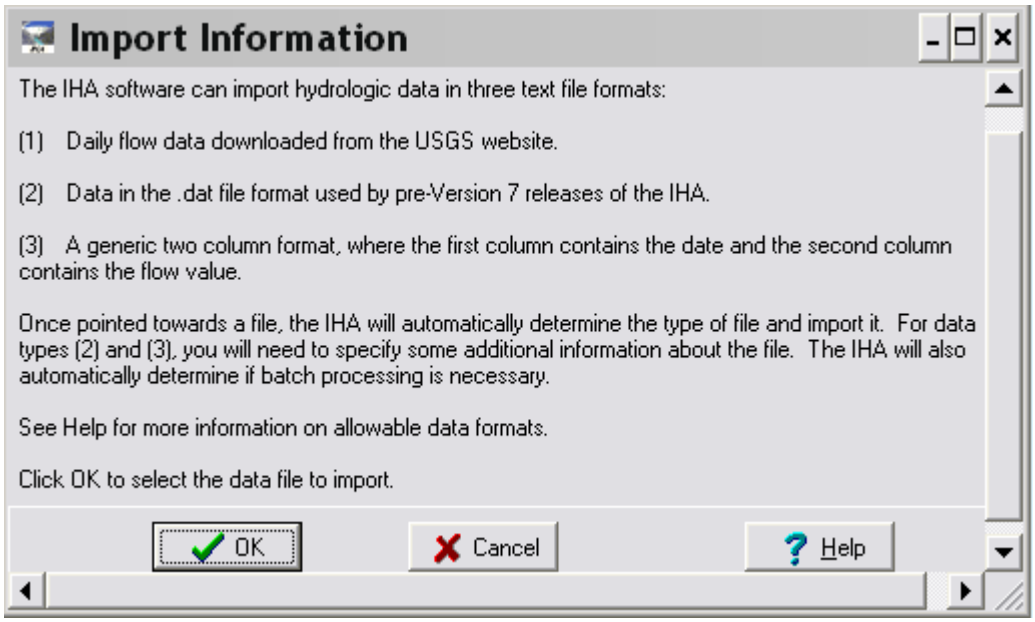
The primary goal of this protocol is to connect park managers with available data by providing annual and synthesis reports on streamflow using an analysis program – Indicators of Hydrologic Alteration (IHA) – that was developed by The Nature Conservancy. This SOP assumes that the IHA program has already been downloaded from The Nature Conservancy website and that the appropriate data files have been downloaded from the USGS National Water Information System (NWIS) website (refer to the protocol narrative, O'Ney 2008).

To start the IHA Wizard, click OK on the welcome screen that appears when you first start the software, or select menu option IHA | Wizard.

1.1 Import Hydrologic Data.



Click OK on this window to bring up the following window:

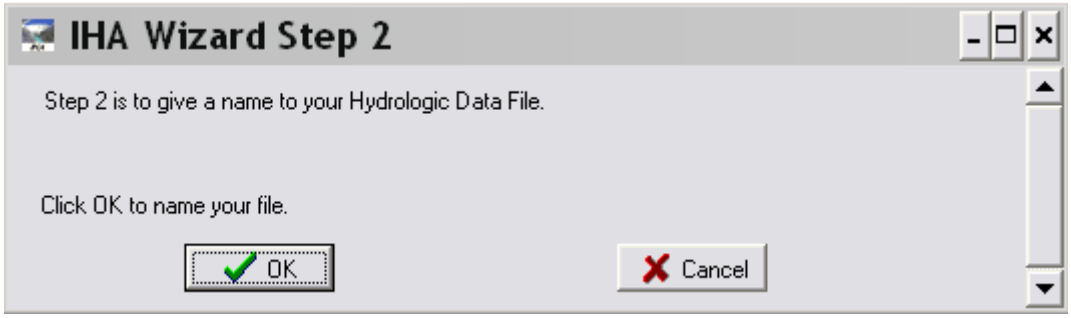


Clicking OK will allow you to select a text file to import.

The text files that were downloaded from the USGS NWIS site should have been saved in the IHA7\IHAWorkingDir\HydroData folder. The following stations should be included in the analyses:

06037500	Madison River near West Yellowstone MT
06188000	Lamar River nr Tower Ranger Station YNP
06191500	Yellowstone River at Corwin Springs MT
06279500	Bighorn River at Kane-, WY
06285100	Shoshone River near Lovell, WY
06287000	Bighorn River near St. Xavier, MT
13010065	Snake River above Jackson Lake at Flagg Ranch, WY
13014500	Gros River at Kelly, WY
13015000	Gros Ventre River at Zenith, WY

1.2 Name your hydrologic data file

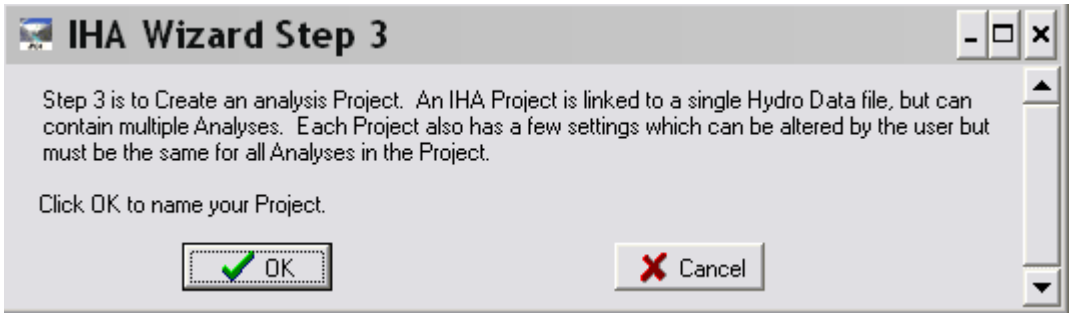


Click OK in this window to enter a name for your imported file. Hydrologic data files downloaded from the USGS NWIS should be named (saved) in the IHA program using the following protocol: USGS_NWIS-06285100from10-1-1966thru09-30-2007, where **06285100** is the USGS Station Number; and where **from10-1-1966thru09-30-2007** is the range of dates of the downloaded data. This naming convention will allow the particular analysis to be repeated, if desired.

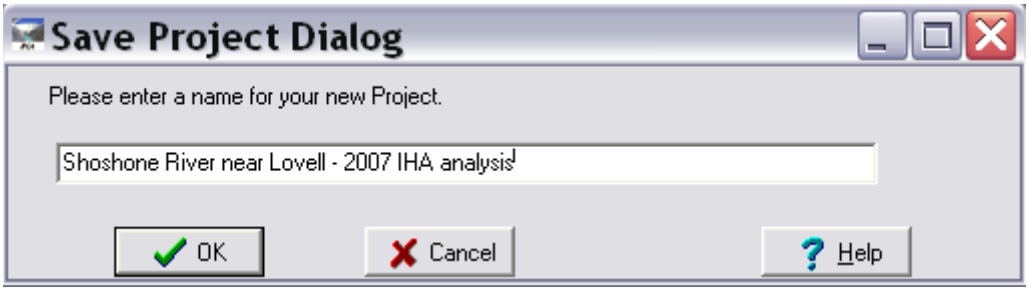
It is recommended, at this time, to view the flow data and inspect it for outliers, gaps, incorrect data entries and other anomalies. The IHA User Guide states, "When viewing your flow data in the Hydrologic Data file editor, selecting **Hydro Data | Review Recorded and Missing Date Ranges** will bring up a summary of the dates of both missing and recorded data. Long periods of interpolated data can also usually be easily discerned in the daily data graph, since they will be straight lines.

1.3 Create an analysis project.

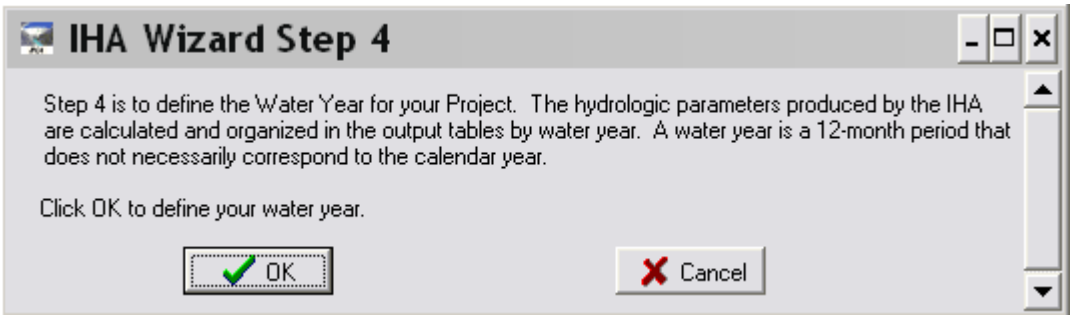
Analyses in IHA are organized in separate projects. Click OK to name your new project.



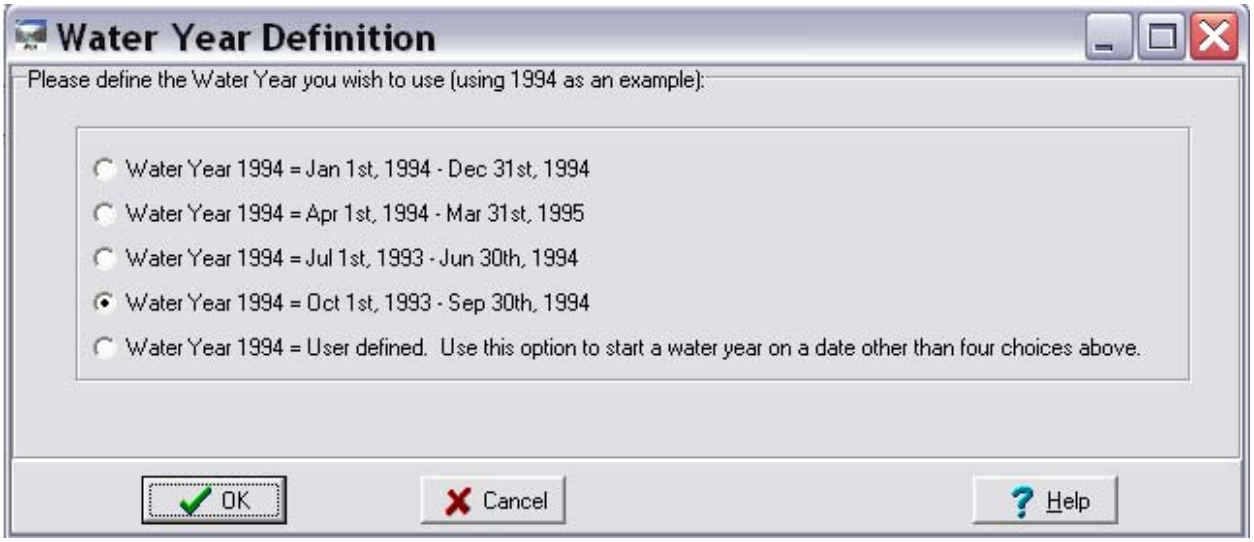
This will bring up the following screen. Enter a name for your project, using the following convention:



where "Shoshone River near Lovell" is the station name and "2007" is the year that the analysis is being performed. Then click OK to bring up

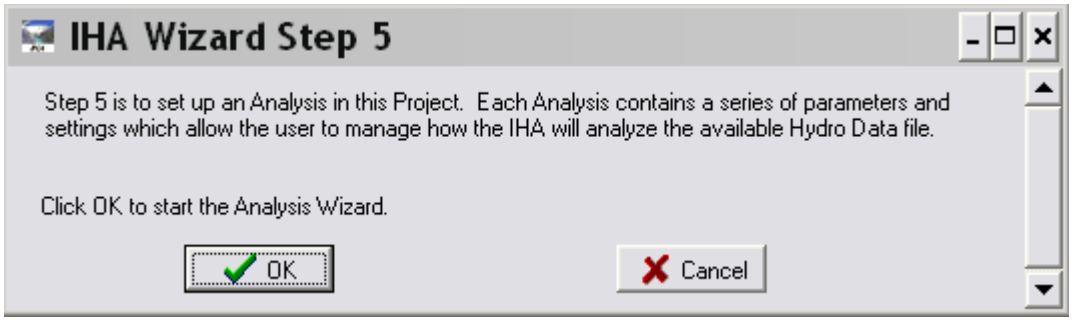


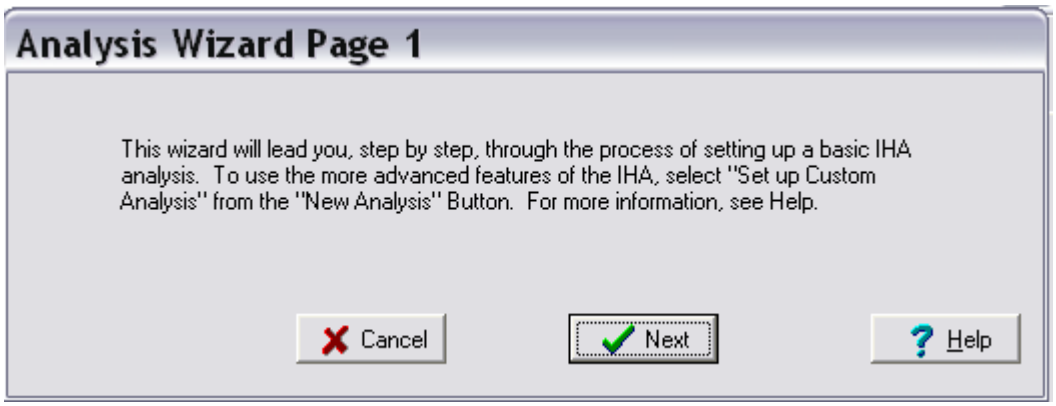
Click OK again. Then select the 4th option for the standard water year, and click OK.



Click OK, then Next to start the Analysis Wizard:

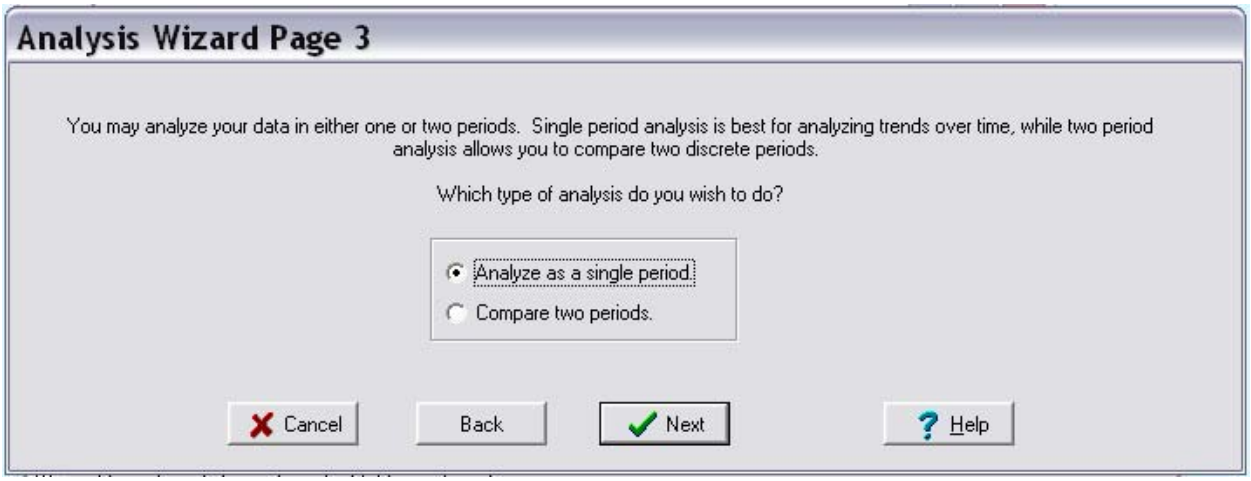
1.4 Performing an analysis and generating graphs



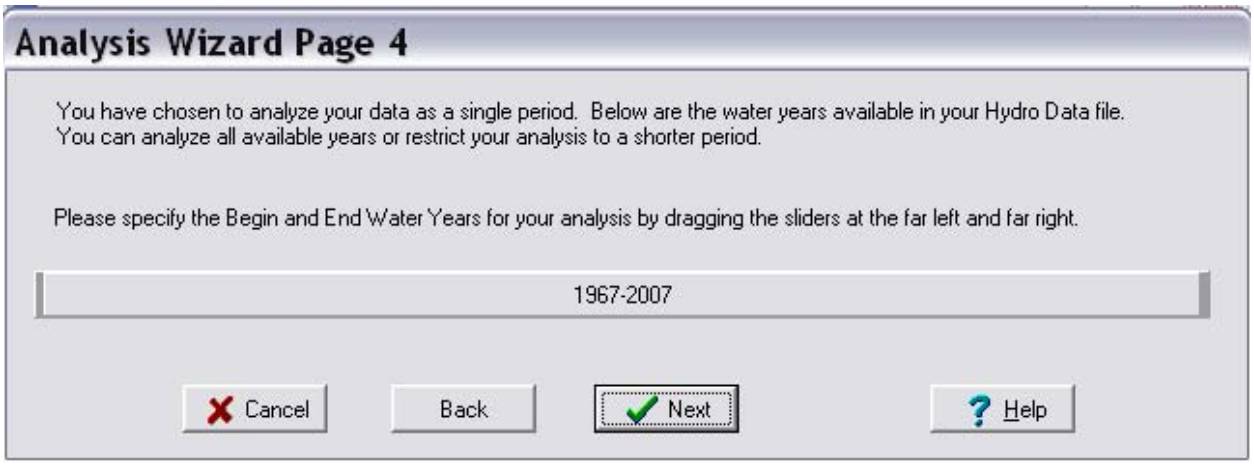


Name the analysis as follows:
GRYN, Station Name, year of analysis

Next, select single period analysis:

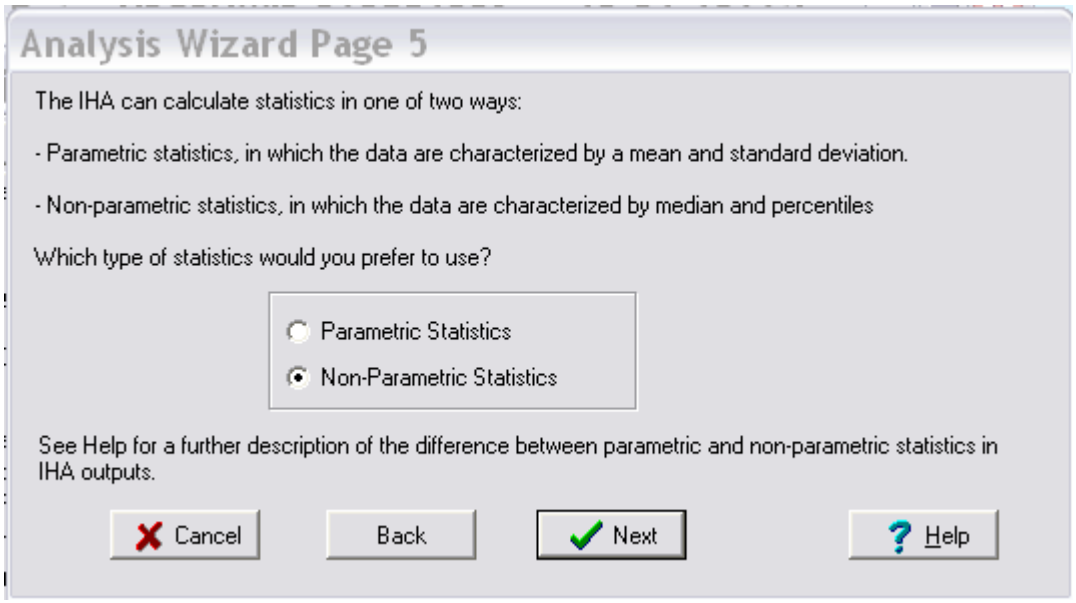


Click Next. This will bring up the screen that allows you to adjust the years to analyze. Default to the entire period of record. This can be adjusted to meet specific park objectives, further on in the analysis process.

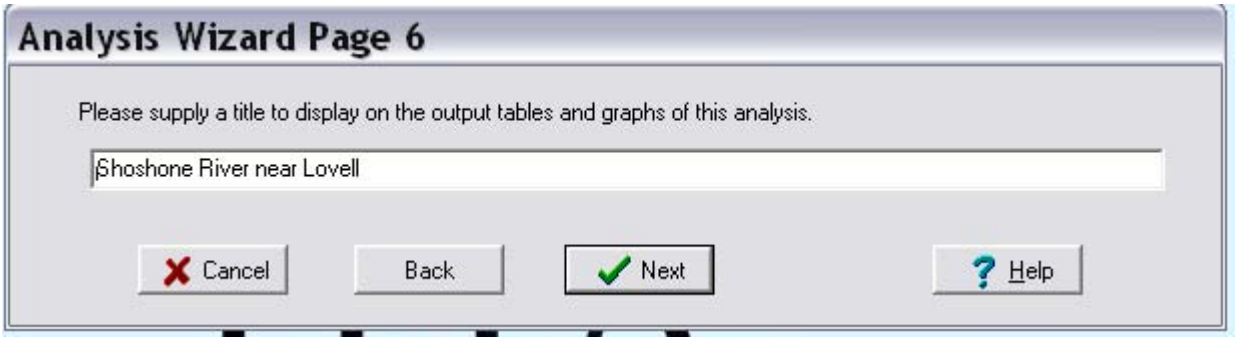


Click Next (above), which brings up the Analysis Wizard Page 5, and then select Non-Parametric Statistics, and click Next again

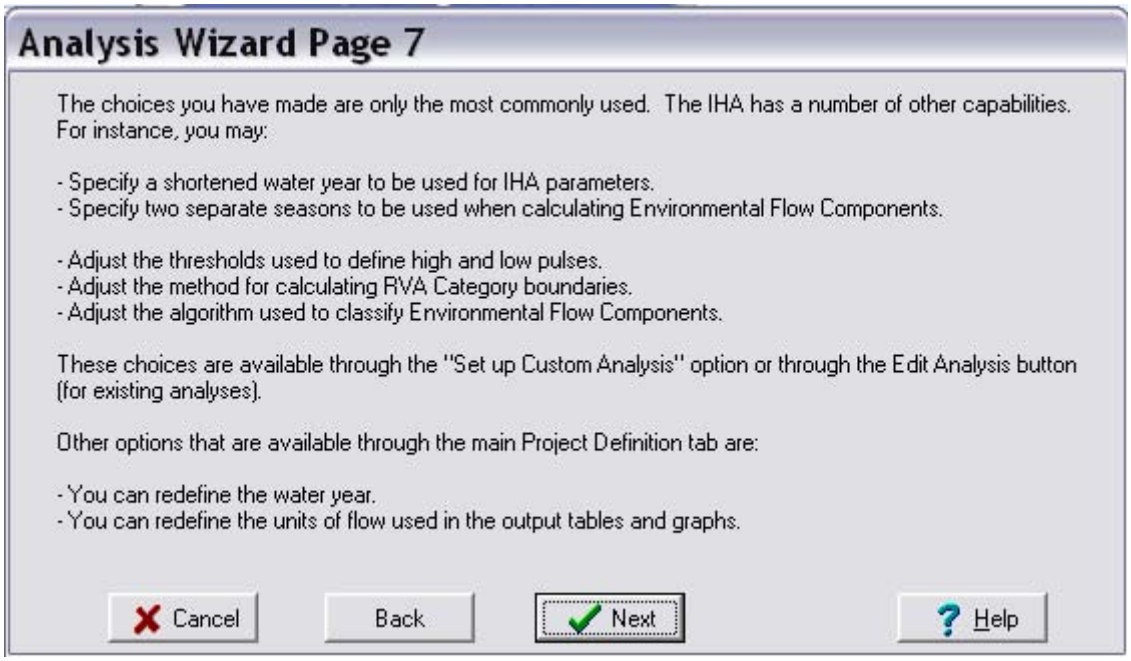
.



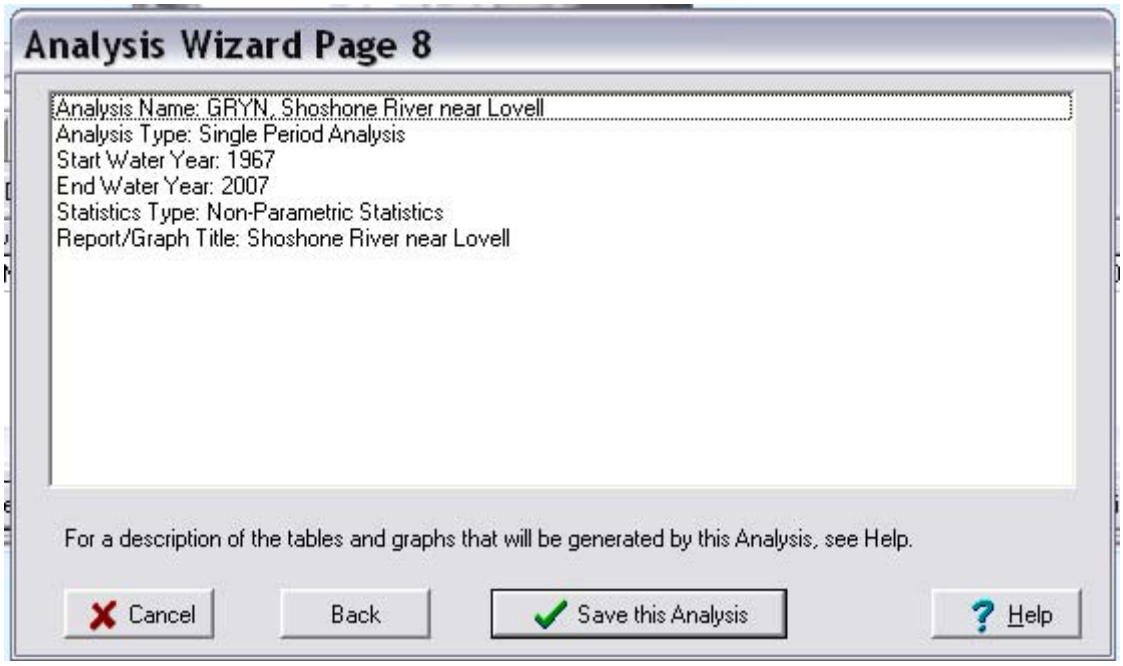
You will be asked to provide a title to display on tables and graphs. The title should be the station name. Enter the station name, and click Next:



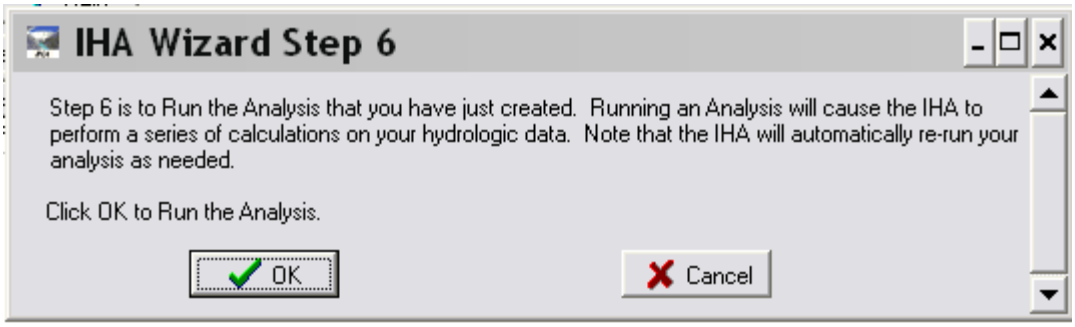
Accept the most commonly used choices by clicking Next:



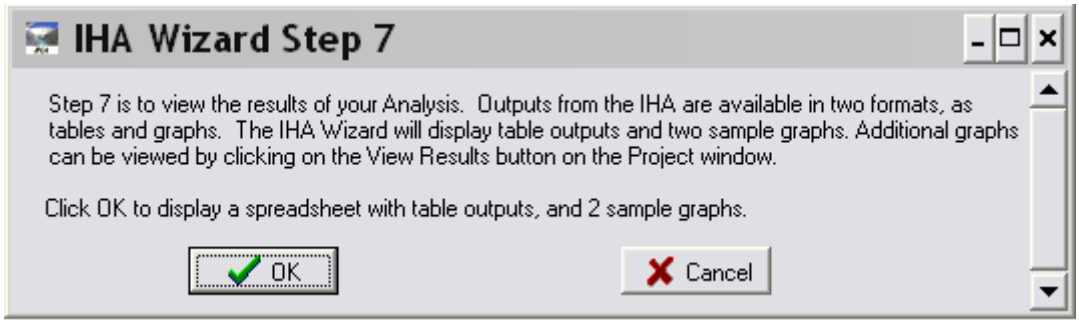
Review the information for accuracy, then click to Save this Analysis:



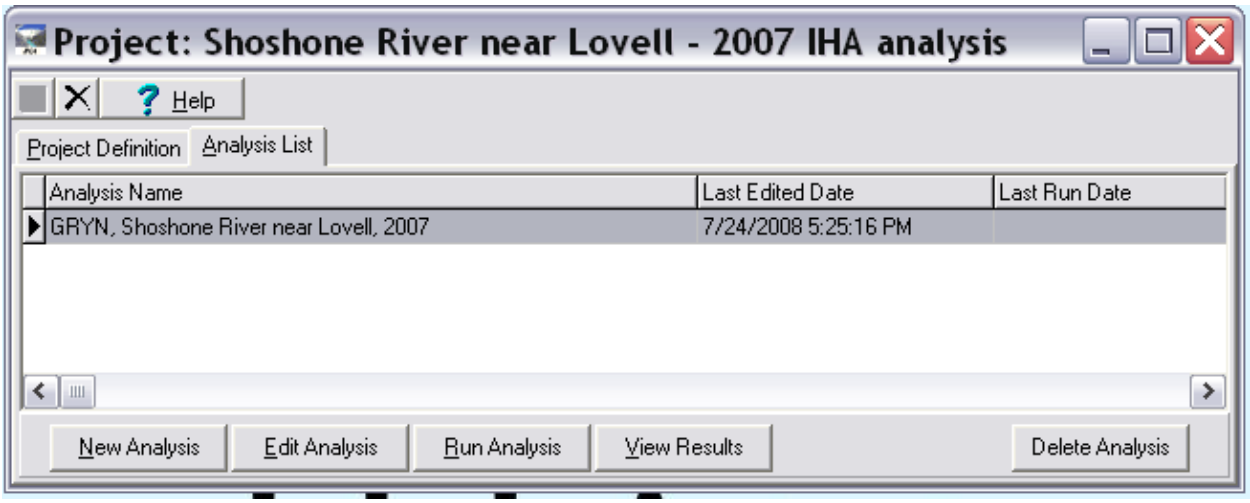
Then Click OK to run the analysis:



and OK again to view the results:



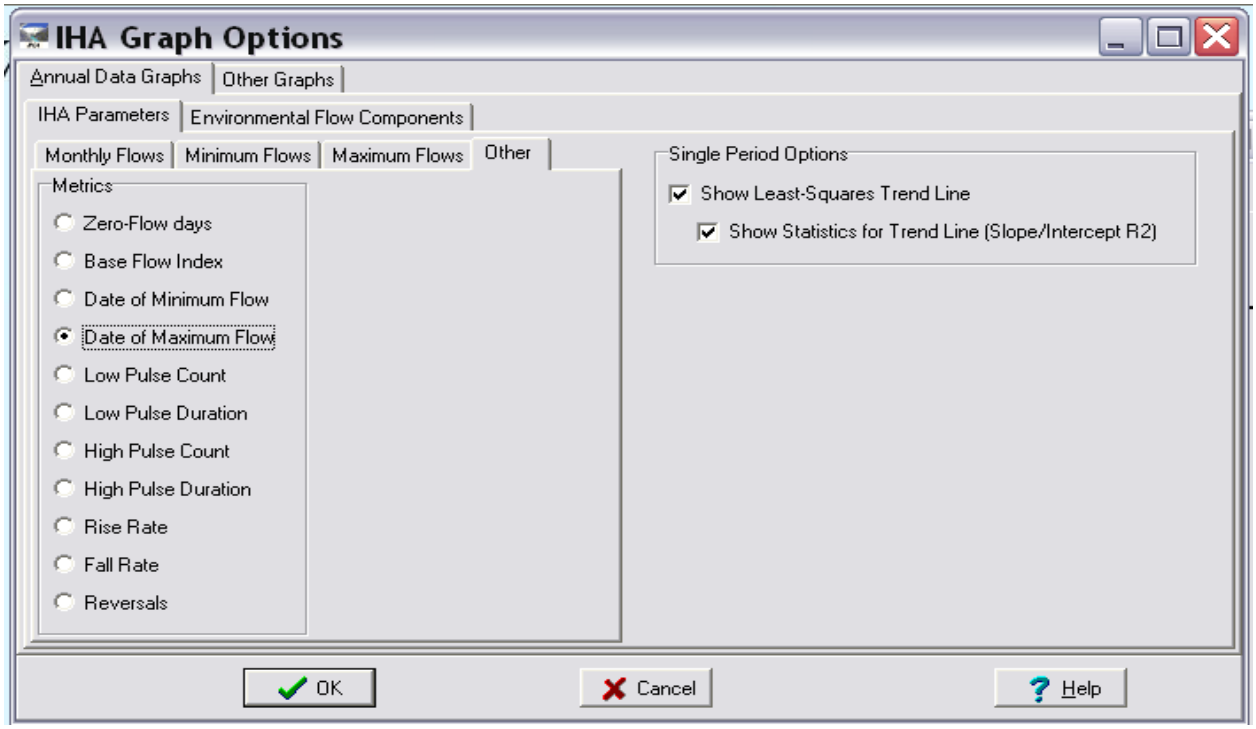
Close all the open windows, EXCEPT for this one:



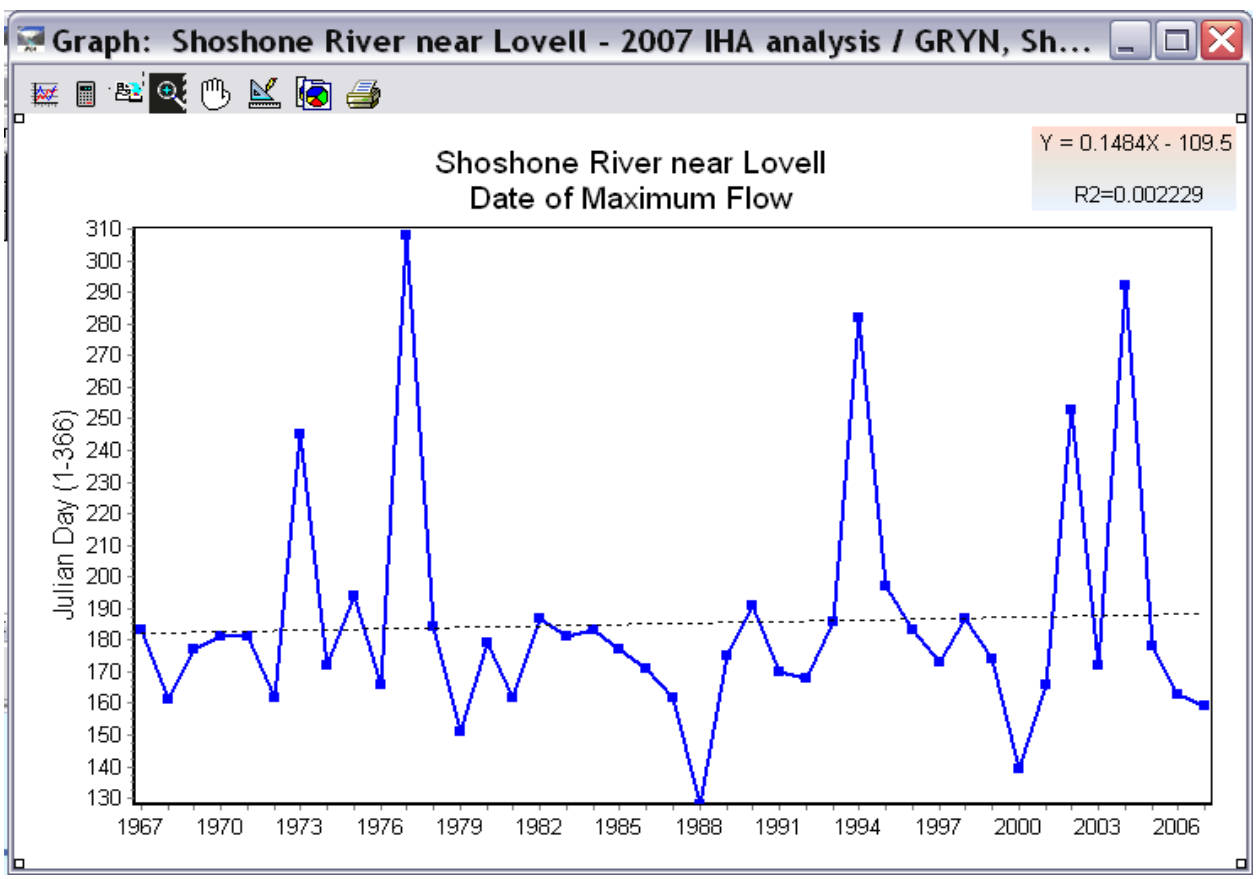
Now Click on View Results button, and select New Graph. This will bring up the IHA Graph Options screen. Graph options will vary depending upon the analysis required.

1.4.1 Instruction for "Date of Maximum Flows"

This analysis will be run for the entire period of record. Select the IHA Parameter tab, Other, and select Date of Maximum Flow, then click OK



The following graph will be generated:

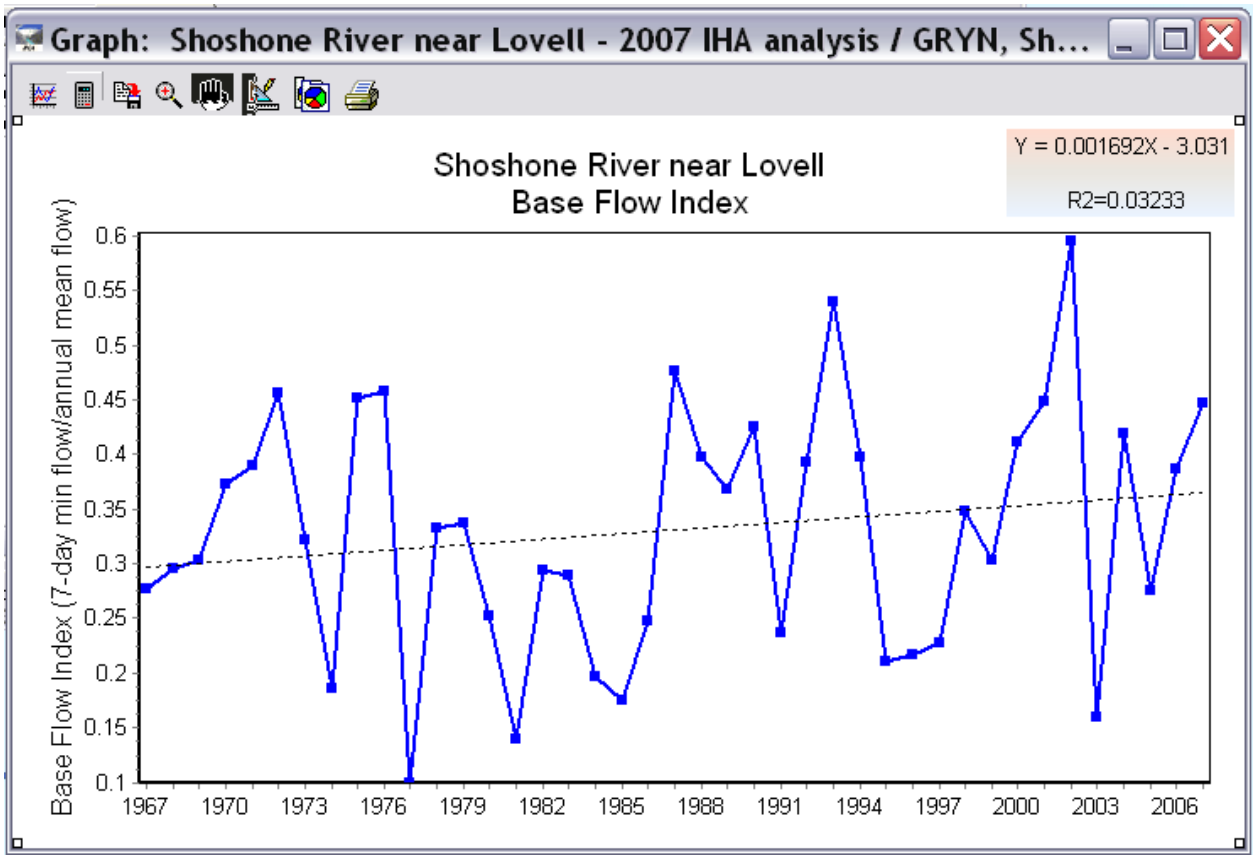


Proceed to Section 1.7 for instructions on saving graphs.

1.4.2 Instructions for baseflow analysis:

This analysis will be run for the entire period of record. Select the IHA Parameter tab, Other, and select Base Flow Index, then click OK.

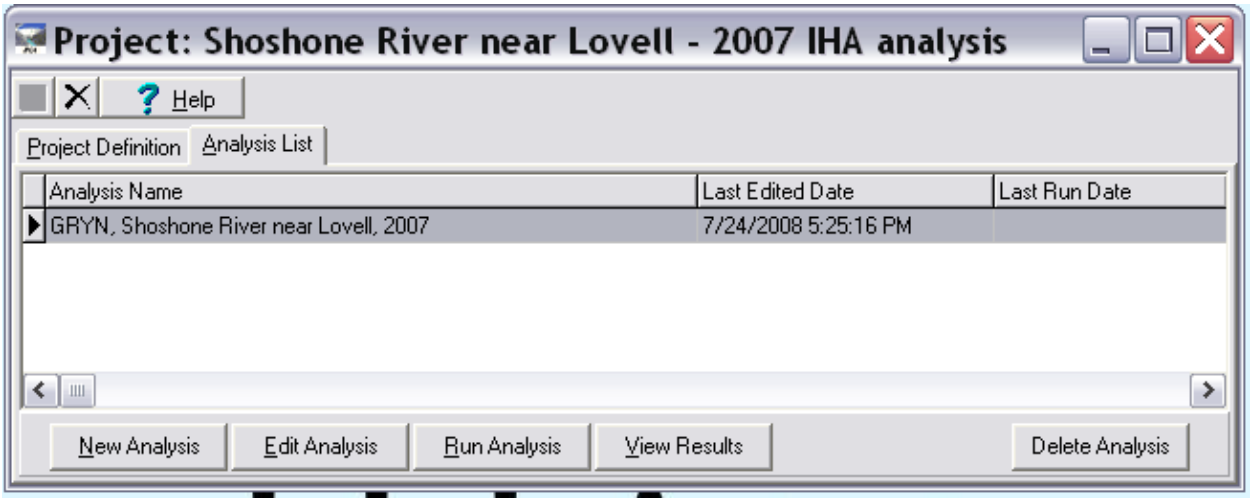
The following graph will be generated:



Proceed to Section 1.7 for instructions on saving graphs.

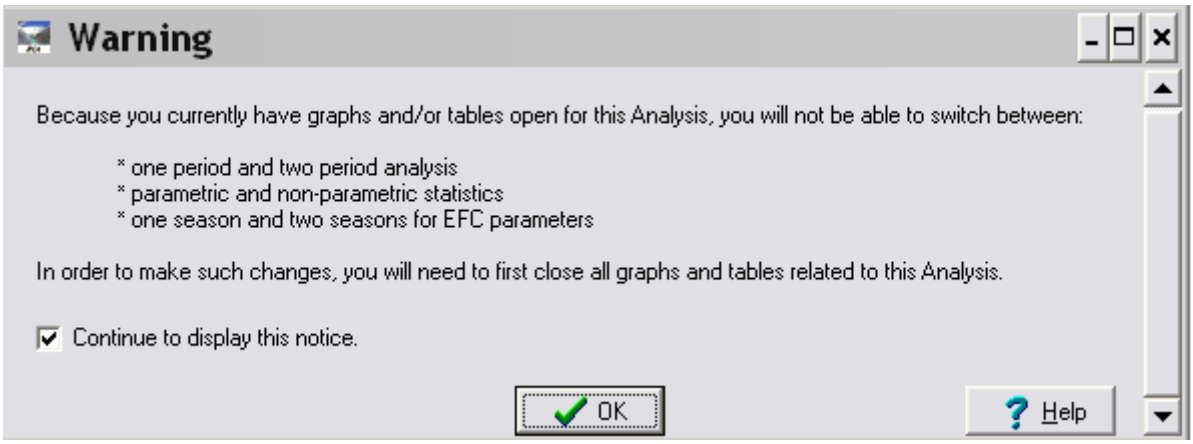
1.4.3 Instructions for generating annual hydrographs for a specified period of record

Go to the Project window:



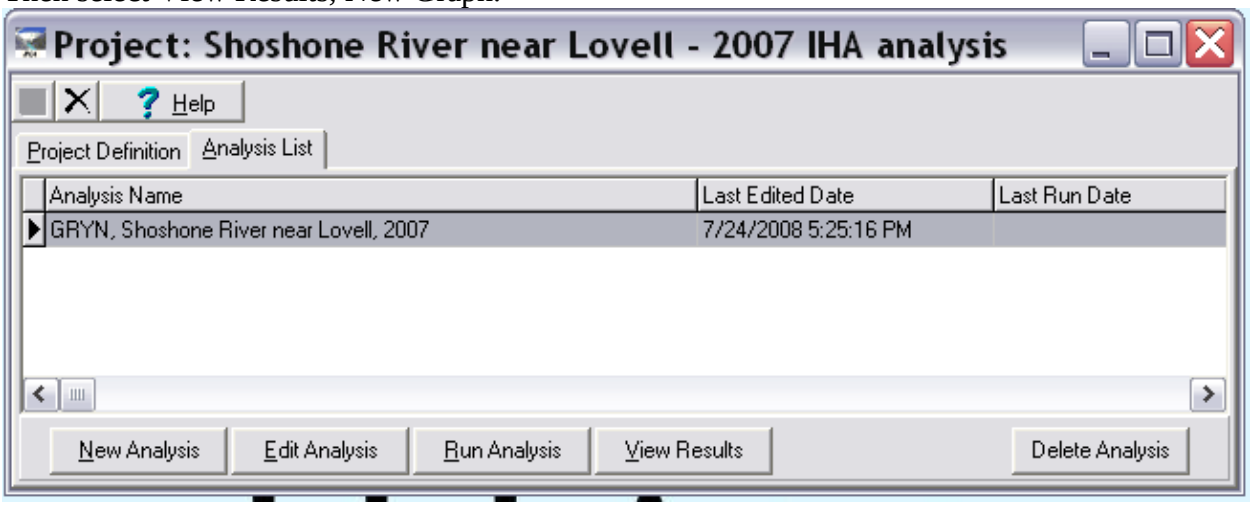
and click the Edit Analysis button:

Click Okay to the WARNING message:

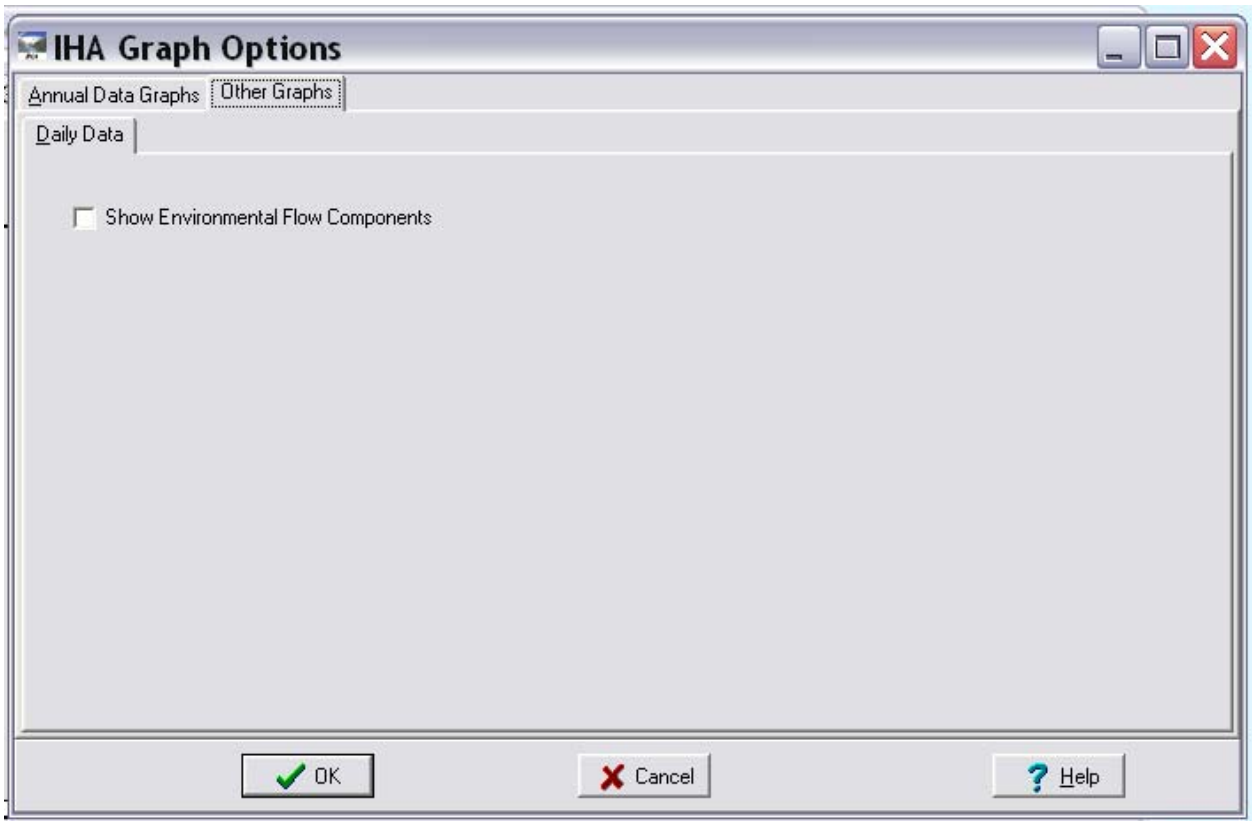


Select the tab for Analysis Years, and slide the bar to include the specified (in the park specific objective) number of years. In the example below, the five-year period 2003-2007 has been selected. Click Save.

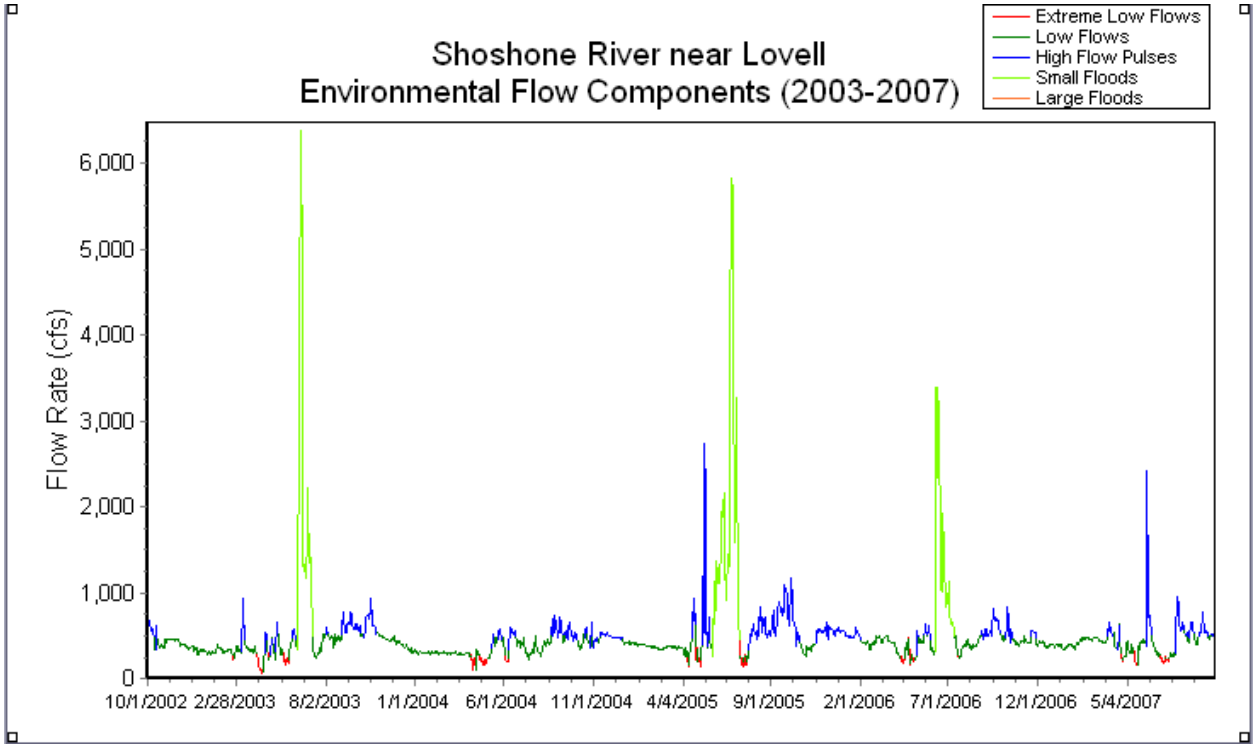
Then select View Results, New Graph.



Then select the Other Graphs tab. Checking the Show Environmental Flow Components box will generate color coded hydrograph, for the specified period of record, shown below, after you click Okay:



If the EFC box is not checked, the graph will not include any color coding and associated legend.

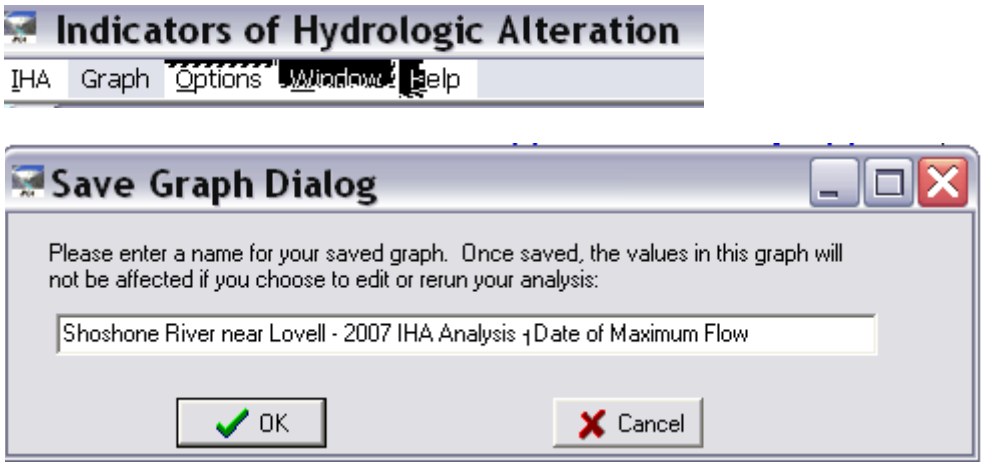


Proceed to Section 1.7 for instructions on saving graphs.

1.5 Saving and using IHA graphs for reporting

1.5.1 Saving the graph

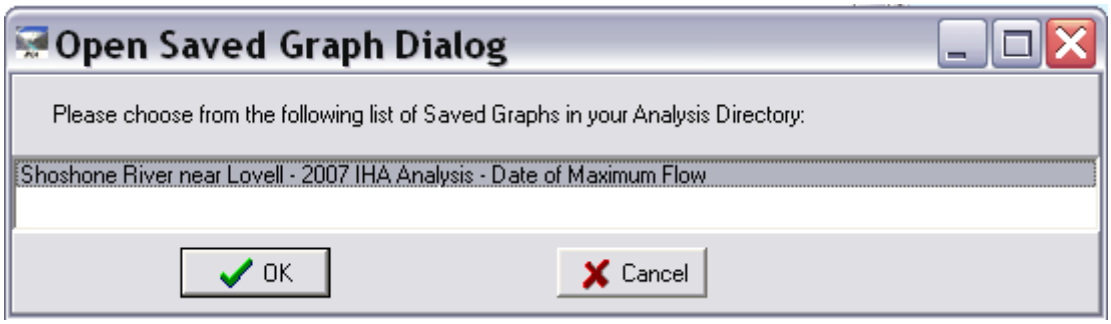
As soon as your graph is created, it should be saved within the working project to make it available for reporting purposes. While the recently created graph is still the active window, in the upper left of the IHA main window, select Graph. This will bring up the Save Graph Dialog:



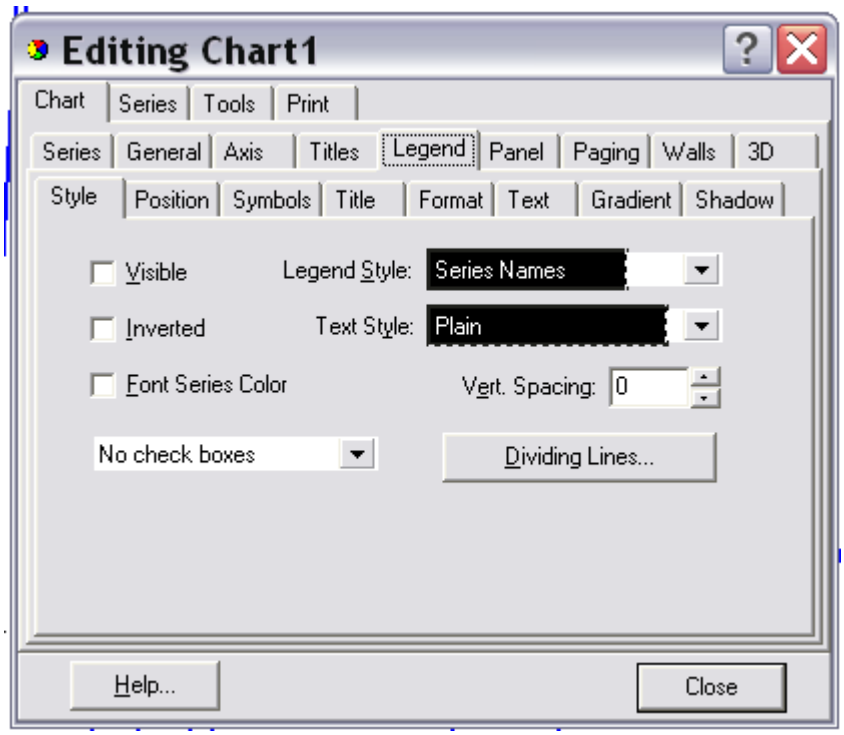
Name the graph, using the convention illustrated above. Click OK. This will insure that the graph is saved for use in preparing a report.

1.5.2 Retrieving the graph for reporting

The graph can later be retrieved, exactly as saved, copied to your clipboard and then inserted appropriately. After being saved and closed, the graph can be viewed again by choosing the View Saved Graphs option from the View Results button. Saved graphs are specific to each analysis, so your saved graph will only be available if the appropriate analysis is selected. All saved graphs will continue to be accessible even if the Analysis settings have been altered and the Analysis re-run. Note that this is the only way to save edited features on a graph, if the graph is closed without saving, all changes will be lost.



Click OK to open the saved graph of interest. You can then edit the chart, if needs be:



In general, all that will be necessary at this point is to copy the graph to your computer's clipboard, and paste it into your report.

2.0 REPORTING

The graphical outputs should be reviewed by a hydrologist/resource specialist to provide interpretation and analysis. Trends in baseflow indices, dates of maximum streamflow and annual hydrographs will be routinely reported upon in a one- to two-page resource summary document or resource brief. Each park will also receive a report, based on the specific objective as detailed in the protocol narrative (O'Ney 2008). These summaries and reports may be updated as frequently as annually, or perhaps only every 5 or 10 years, depending upon individual park needs

Suggested Report Outline

TITLE PAGE
Title
Author(s)
Institutions
Prepared for
Date

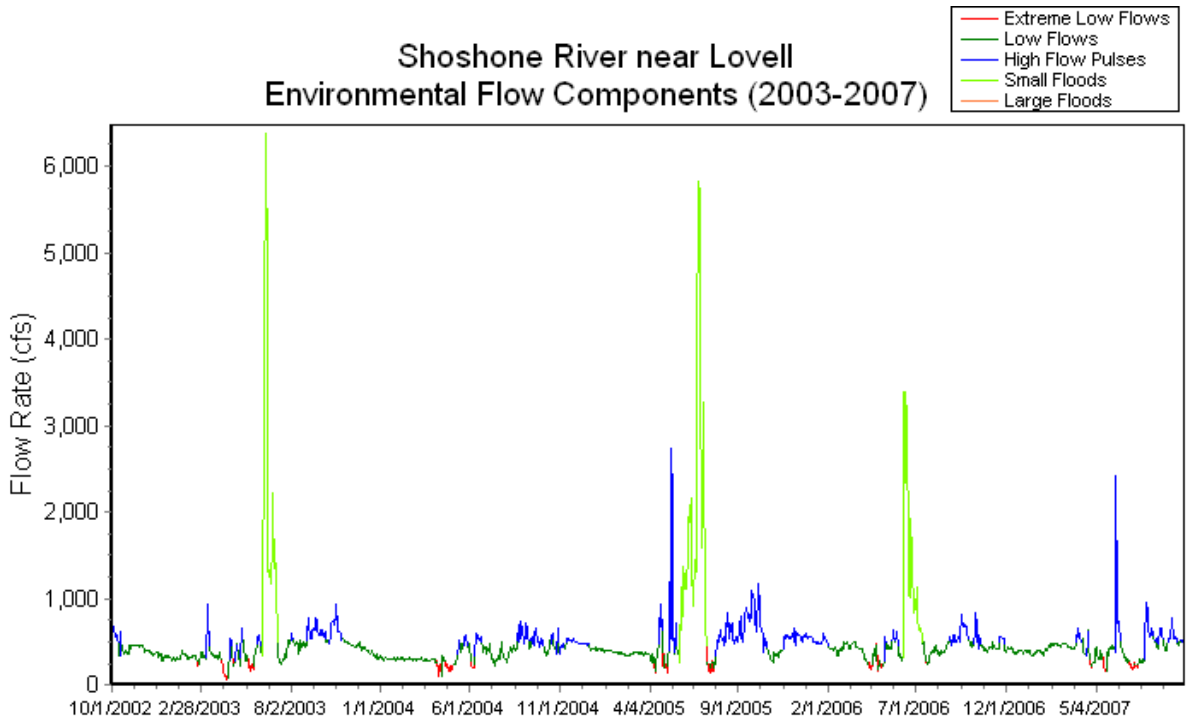
TABLE OF CONTENT PAGE

1.0 INTRODUCTION
A brief introduction, reiterating the purpose of the protocol

2.0 METHODS
A brief description of the IHA

3.0 RESULTS
This section will consist of one page of output for each objective, and will include the written objective and the associated graphic output. In many cases an objective will generate more than one page, based on the number of stations referred to in that objective. The following is an example of this section of the report for BICA, for the one gaging station in the objective to compare annual hydrographs and Environmental Flow Components (EFCs) for the five most recent years of record at the USGS gaging station #06285100 (Shoshone River near Lovell, WY).

OBJECTIVE: Compare annual hydrographs and Environmental Flow Components (EFCs) for the five most recent years of record at the USGS gaging station #06285100 (Shoshone River near Lovell, WY).



4.0 DISCUSSION

This section will provide a narrative interpretation of the graphical results, if necessary.