Wisconsin DNR 24K Hydrography
User's Guide
Version 6

Wisconsin Department of Natural Resources
Bureau of Enterprise Information Technology & Applications
Last Updated: July 2007

What's New in Hydro Version 6?

The FY08 release of the WDNR 24K hydro database is called 24K Hydro ***Version 6****. Version 6 has some significant enhancements which are summarized below. For more technical information about the database, please refer to Appendix A of this document.*

- ***New WBICs are assigned to 99.9% of the primary flow paths (97% of all flow) and ALL area features (e.g. lakes, flowages etc.) in the hydro layer that did not previously have them****. Secondary flow (side channels etc.) was not included. This was accomplished through the use of an automated methodology for aggregating unnamed/unwbiced water. This methodology was reviewed and approved by the Water Body Oversight Committee (WBOC). For more details on the methodology used, click here. These auto-assigned WBICs are differentiated from other, previously culturally defined WBICs by a WBIC_type code (see New Attributes section below). Approximately 42,462 new stream WBICs and 72,903 open water WBICs have been added to hydro and entered in the Register of Waterbodies (ROW) system.*

- ***Strahler Stream Order*** *has been added to the stream arcs. This information is also recorded in ROW.*

- ***New attributes added:***

  STREAM_ORDER: *Strahler Stream Order*

HYDNW924.AAT *Coverage (load source for other formats)*	**HYDLARC** *Shapefile*	**EN_SURFACE_ WATER_LN_24K** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
STREAM_ORDER *2 integer*	STREAM_ORD *2 short integer*	STREAM_ORDER *2 short integer*	Strahler Stream Order designation. Strahler's (1952) stream order system is a simple method of classifying stream segments based on the number of tributaries upstream. A stream with no tributaries (headwater stream) is considered a first order stream. A segment downstream of the confluence of two first order streams is a second order stream. Thus, a n^{th} order stream is always located downstream of the confluence of two $(n-1)^{th}$ order streams. Values: 1, 2, 3, 4….

WBIC_TYPE: *Indicates the type of WBIC number (C = Cultural, P = programmed).*

HYDNW924.AAT *Coverage (load source for other formats)*	**HYDLARC** *Shapefile*	**EN_SURFACE_ WATER_LN_24K** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
WBIC_TYPE *2, 2 character*	WBIC_TYPE *2 text*	WBIC_TYPE *2 text*	Type of WBIC • C = cultural (e.g. name or other cultural criteria used) • P = programmed • NA = not applicable (for non-flow features)
HYDNW924 .PATSHAID *Coverage (load source for other formats)*	**HYDRSHAI.SHP** *Shapefile*	**EN_SURFACE_ WATER_SHAID_ AR_24K** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
WBIC_TYPE *1, 1 character*	WBIC_TYPE *1 text*	WBIC_TYPE *1 text*	Type of WBIC (SHAID • C = cultural (e.g. name or other cultural criteria used) • P = programmed

- ***Dropped attributes****: These attributes will no longer be delivered in the hydro database that users see. This information is being maintained in the production coverage (coverage used for making edits).*

  WBIC_BY: *Indicated which person from the original WBIC assignment team delineated the WBIC on 24K hydro.*

  WBIC_STAT: *Indicated whether the WBIC assignment was reviewed and approved or not.*

- ***EDITS:*** *Many edits were completed in preparation for the automated WBIC assignment. Types of edits include:*
  - *ensuring one and only one primary flow path out of open water polygons*
  - *fixing incomplete closure lines*
  - *resolving a WBIC flowing into 0 WBIC feature*
    - *stream WBIC flowing into another stream without a WBIC*
    - *stream WBIC flowing in and WBIC flowing out of lake are different and centerline WBIC = 0*
    - *stream WBIC starts at the outflow of a lake or stops inside the lake*
  - *linear type assignment errors (extensions vs centerlines)*
  - *Other edits include modifications to lake and reservoir boundaries and Washington Island is now coded as an "island" (IS) instead of upland.*

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I. Introduction to Using WDNR 24K Hydro

The 24K hydro database has been designed from multiple perspectives to satisfy the many users with distinctly different needs – mapping, basic queries, intense analysis, flow modeling, and network tracing. However, to fully take advantage of the flexible design of the database, understanding at least the basics of the data model is *essential*. The more that you learn about the data *before* you use it, the more effective and valuable the data will be for you. Therefore, *we highly recommend that you read the* ***WDNR 24K Hydro Database Design*** document *before you proceed with the rest of this User Guide.* Once you understand the fundamentals of the 24K hydro data model, you will be better prepared to begin using the data.

When using the 24K Hydro database, the tasks performed can be simple, or they can become extremely complex. This guide does not provide a click-by-click approach to using the data, nor does it delve into the complexities of any specific application. Rather, it explains the fundamentals on how to utilize the various feature classes and their attributes in the data model – to get you started using the data to suit your needs. This Guide is primarily written for the ArcView 3.x or ArcView 8.x user. ArcInfo users can apply similar selection logic (with the same item names and values) on the hydnw924 coverage features. While you can use the ArcInfo coverage features in ArcView, the shape files are recommended in part because they are faster and we've included specially created legend files.

For assistance in using the 24K Hydrography layer or if you have questions about how to submit corrections, you may contact the 24K Hdyrography File Manager: ann.schachte@wisconsin.gov or call her at 608.267-2301.

II. Creating Subsets and Clipping of 24K Hydro Data

Selecting Hydro by boundary theme

Since the 24K hydro database is a statewide coverage, you may choose to work with a smaller portion of the data. Other GIS data layers in the same projection can be used to subset the hydro layer to the desired area. For example, if you would like to make a map of Dodge County, use statewide county polygon GIS layer (coverage or shapefile) to subset the Hydro layer. Below is an example as how to perform a subset.

To select by theme the hydro data to the area of Dodge County, use the county boundary data layer (ctypw91c).

- Add hydro lines (arcs) and SHAIDs as themes in a view
- Add the county theme coverage or shapefile with which Hydro will be selected out.
- Select Dodge County
- Make Hydro lines (arcs) the active theme
- From the Theme menu choice, choose *'Select By Theme'*
- For *'Select features of active themes that'* , choose Intersect/CompletelyContain/Are Within a Distance of - depending on what you need subset; and, for *'the select features of'*, choose the county boundary theme and pick *'New Set'*
- Then from the Theme menu pick *'Convert to Shapefile'* and give it a name and location to save to.
- The product is a hydro line shapefile subset to the boundary of Dodge County.
- Repeat this process for SHAIDs.

Subsetting Hydro is different than clipping as described above. Clipping actually cuts features where as *selecting by theme* allows a user to subset out an area of Hydro based on a Boundary layer. The result of the *select by theme* may result in features bleeding outside of the desired area when using *Intersect* or not including features along the border of the desired area when using *Completely Contain*. The process of Clipping Hydro using the Geoprocesser resolves those issues.

Clipping Hydro using Arcview's Geoprocesser

Please note that if you clip the hydro data for analysis purposes, performing a clip in ArcView does not re-calculate areas, lengths or perimeter of the water features. A process can be used to update those values, which are described below. If you don't run the update any analysis could be affected for that clipped data. In ArcInfo, performing a clip will not have this result. ArcInfo allows you to maintain correct area information on the clipped data by applying the "build" command.

To clip Hydro:

- Add Hydro lines and SHAIDs as themes in view
- Add the boundary theme with which the Hydro database will be clipped.
- Using the project window, locate the Geoprocessing Extension under File, then Extensions
- Return to the view and under View, choose Geoprocessing
- A box will pop up at which time choose *Clip one theme based on another*
- Input theme should be the Hydro theme to be clipped (SHAIDs or Lines)
- The polygon overlay theme should be the boundary theme
- Specify the output file (the clipped shapefile)
- Choose finish and the new clipped shapefile will be created

After clipping Hydro, use the following to update the length, area and perimeter fields.

Select the Table menu and choose 'start editing'

Using the Field Calculator:

- For length, type the following into the expression box:

[Shape]. ReturnLength

- For area:

[Shape]. ReturnArea

- For perimeter:

[Shape]. ReturnLength

When Finished, 'stop editing'

III. Querying Names and WBICs

Note: It is assumed that the user already understands the fundamentals of querying in ArcView3.x ("Query Builder") and Arcview 8.x ("Selection"). Therefore, specific step-by-step instructions for initiating a query are not included here.

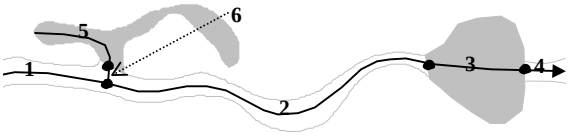
The following section explains how you can query the names and WBICs of linear water features, such as streams, and area water features, such as lakes.

Querying Names and WBICs on Hydro Lines (streams, ditches, canals, centerlines, etc.)

Perform your query against the **hydlarc.shp** shapefile (or the arcs in the **hydnw924** coverage).

When you perform a query on the linear water features, you will use the "river system" concept. A *river system for linear water features* includes the lines that carry the flow of the main river channel that run through all SHAIDs along that main river, and all of the lines that carry flow stemming from that main river into adjacent backwaters, inundation areas, and secondary channels. Tributaries entering the main river are *not* included in the same river system.

To query names and WBICs on linear water features, use the items RIVSYSNAME(GNIS) or RIVROWNAME(ROW) and RIVSYSWBIC.



ARCS 1-5: *RIVSYSNAME = Yellow River*

Figure 1: To query names on linear water features, use the item RIVSYSNAME(GNIS) or RIVROWNAME (ROW).

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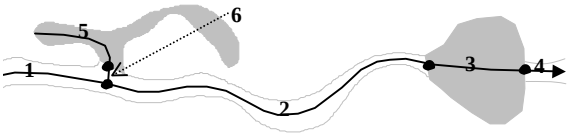


ARCS 1-5: *RIVSYSWBIC = 1234567*

Figure 2: Similarly, for WBICs on linear water features, use the item RIVSYSWBIC.

Selection Logic

To make a query that selects a river system that includes all of the connectivity features that flow into flowages, lakes, and other features that fall along it, simply query on the "RIVSYS" fields, RIVSYSNAME(GNIS) or RIVROWNAME(ROW) and RIVSYSWBIC.

Active Theme	Field	Operator #1	Value	Operator #2	Notes
Hydlarc.shp (lines)	RIVSYSNAME	=	"Wolf River"		Works the same for RIVSYSWBIC

Once the river system is selected if only part of the system is really desired, you can apply reselection logic on the item LINEAR_TYP (linear type) to return the desired features. For example, if your question were to find just the main flow channel of the Wolf River, you would want to include all of the centerlines through the lakes and flowages, but not flow potentials that run into backwaters. So, your queries would look like this:

Active Theme	Field	Operator #1	Value	Operator #2	Notes
Hydlarc.shp (lines)	RIVSYSNAME	=	"Wolf River"	and	
	LINEAR_TYP	<>	"FP"	and	No flow potentials
	FLOW	=	"P"		Only primary flow

(Note that there are actually two Wolf Rivers in Wisconsin – compare WBICs and locations to get the set you want.)

Querying Names and WBICs on SHAIDs and River Systems (lakes, wide rivers, reservoirs, flowages, etc.)

Perform your query against the **hydrshai.shp** shapefile (or the region subclass SHAID in the hydnw924 coverage).

For water areas, you can perform two types of queries for names and WBICs. One is for specific simple hydro areas, or SHAIDs, and the other is for river systems.

<u>To Query for SHAIDs</u>
A lake is a SHAID, a flowage is a SHAID, and a backwater is a SHAID. A main wide river channel can be made up of many SHAIDs, separated by the reservoir and flowage SHAIDs that fall along it. To query by the names and WBICs of these sorts of individual water features, use the items SHAIDNAME(GNIS) or SHDROWNAME(ROW) and SHAIDWBIC.

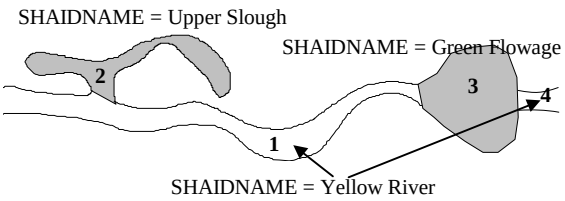


Figure 3: To query names of specific "simple hydro areas" (or SHAIDs), use the item SHAIDNAME(GNIS) or SHDROWNAME(ROW).

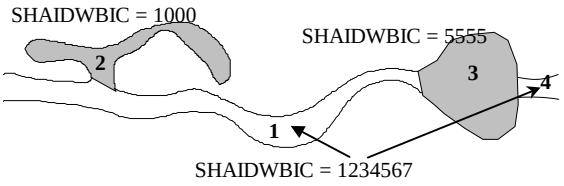


Figure 4: Or, use the item SHAIDWBIC to select based on Water Body Identification Code.

To Query for River Systems

A *river system for area water features* includes the main river channel SHAIDs plus all of the adjacent reservoir, flowage, lake, backwater and inundation area SHAIDs falling along the main river channel. Stream tributaries entering the main river are not included in the same river system. To select the SHAIDs that compose a river system, use the same logic using RIVSYSNAME(GNIS) or RIVROWNAME(ROW) and RIVSYSWBIC, as used for selecting a river system of linear features (above).

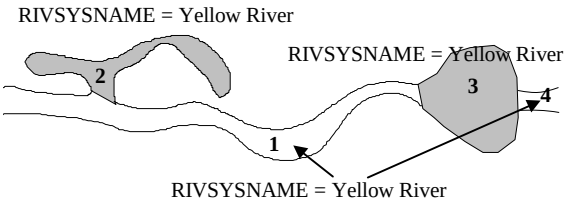


Figure 5: To query names of river systems (which include the SHAIDs of any lakes, reservoirs, flowages, backwaters, and inundation areas along the main river channel), use the item RIVSYSNAME(GNIS) or RIVROWNAME(ROW).

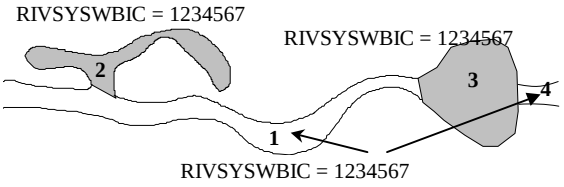


Figure 6: Likewise, use RIVSYSWBIC to select river system SHAIDs based on WBIC.

Selection Logic

The ability to select by SHAID name or WBIC or by the river system name or WBIC allows for flexibility in your queries.

Use SHAIDNAME(GNIS) or SHDROWNAME(ROW) and SHAIDWBIC when you want to select individual water features like lakes, flowages or backwaters or just a main river channel (the wide river areas, coded SHAID_TYP = "ST") *excluding* intervening lakes, flowages, backwaters and other features that fall along it.

For example:

Active Theme	Field	Operator #1	Value	Operator #2	Notes
Hydrshai.shp (SHAIDs)	SHAIDNAME	=	"Lake Wisconsin"		The name of the shaid

But, if you want to select a river system *including* all of the lakes, flowages, backwaters, and other features that fall along it, use the RIVSYSNAME(GNIS) or RIVROWNAME(ROW) and RIVSYSWBIC fields of SHAIDs.

Active Theme	Field	Operator #1	Value	Operator #2	Notes
Hydrshai.shp (SHAIDs)	RIVSYSNAME	=	"Wolf River"		The name of the system

Once the river system is selected and only part of the system is really desired, you can query on the specific type of water feature with the field SHAID_TYP (SHAID type) to return the desired features. For example, if your question was to find the Wolf River, and you wanted to include the flowages that fell along it, but not the backwaters and inundation areas, your queries would look like this:

Active Theme	Field	Operator #1	Value	Operator #2	Notes
Hydrshai.shp (SHAIDs)	RIVSYSNAME	=	"Wolf River"	and	The name of the system
	SHAID_TYP	<>	"BA"	and	No backwaters
	SHAID_TYP	<>	"IA"		No inundation areas

Important Note: The river system concept has been applied to all rivers in Wisconsin. However, the more complex rivers, such as the Mississippi and Wisconsin Rivers, may not fully represent the river system as defined. This is because these rivers can have so many channels, backwaters, inundation areas, pools, and so forth, that checking for their complete inclusion within the systems would have exceeded our development time frame. As a maintenance task for the database, quality assurance will continue for the complex river systems, but in the meantime, please be aware of this issue when performing your queries.

IV. Defining Theme for Hydro Network for Analysis (Selecting the Flow of Surface Water for Study)

To select the hydro network for analysis, use the **hydlarc.shp** shapefile (or the arcs in the **hydnw924** coverage).

Present in the line (arc) attribute table for the **hydlarc.shp** shapefile (and in the **hydnw924** coverage) is a field called FLOW, meaning "surface water lines that carry flow", which is the hydro network. Lines where FLOW = P (Primary) and S (Secondary) represent the hydro network, and include the following linear types: steams, ditches, canals, cranberry bogs, stream centerlines, extensions, wetland gap connectors, and flow potentials. Sometimes these features may be desired on a map. Lines where FLOW = NA represent the linear features that are *not* included in the hydro network, including shorelines, closure lines, original channels, and channels in water areas.

Active Theme	Field	Operator #1	Value	Operator #2	Notes
hydlarc.shp (Lines)	FLOW	=	"P"	or	The primary flow portion
	FLOW	=	"S"		and secondary flow

Use the ArcView legend file **hydlarc _flow.avl** to symbolize the network in a display.

Important Note: Even though we have quality assured all connectivity in the hydro network in the hydnw924 coverage, errors in the network have been discovered in the hydlarc.shp shapefile. (This shapefile was derived from the arcs in the coverage, so the quality *should* be consistent.) The few imperceptible gaps that exist in the shapefile network are due to an ArcInfo bug in the conversion process from coverage format to shapefile. At this time nothing to our knowledge can be done about the problem.

V. Querying the Change Flags

To see how features have changed from the previous release, use the change flag items found in arcs, SHAIDs and STEMs.

Arcs contain the Geometry Change Flag (GEOM_CHFLG), Natural Change Flag (NAT_CHFLG), GNIS Change Flag (GNIS_CHFLG), WBIC Change Flag (WBIC_CHFLG), Reference Change Flag (REF_CHFLG) and Flip Change Flag (FLIP_CHFLG). SHAIDs contain the Geometry, Natural, GNIS and WBIC Change flags. The STEMs contain the Geometry and Flip Change Flag. All feature classes share the NEW Features Flag (NEW).

The Change Flag items contain 1's for features that have been altered and 0's for those that have not.

An example application would be a user who would like to see any WBIC changes made on the arcs:

Active Theme	Field	Operator #1	Value	Operator #2	Notes
hydlarc.shp (Lines)	WBIC_CHFLG	=	1		This selects all WBIC changes for arcs

The Geometry Change Flag can be used in conjunction with the History Shapefiles to visually identify changes to the Hydro database. To see how geometry has changed from previous releases, select for Geometry Change Flag (GEOM_CHFLG) and bring up the history shapefiles to see how features appeared before the change.

VI. Querying the History Shapefiles

In addition to the standard shapefiles release, three History Shapefiles are available by request. The History Shapefiles consist of all features of that class that have been deleted or geometrically altered since the version 2 release. These shapefiles will contain the same attribute data that the standard shapefiles do with the addition of: Deleted and Retire Date. These items are useful for the following reasons:

- To show how water has changed over time
- Retire date shows date was retired from Hydro
- Users with located data against 24K hydro through use of the Locator Tool, could use the History Shapefiles to see how data was originally located along the original water feature. (NOTE: This will require that the user know how to use dynamic segmentation in Arcview along with the STEM shapefile to accomplish this.)

An example of using the History Shapefiles would be to see all deleted SHAIDs since the previous release.

Active Theme	Field	Operator #1	Value	Operator #2	Notes
hyhrshaid.shp	Deleted	=	1	AND	This selects all deleted SHAIDs
	Retiredate	>	Date of previous release		This selects those deleted from previous release

If a user wants to combine the geometrically changed features with the flipped features simply perform the following query:

Active Theme	Field	Operator #1	Value	Operator #2	Notes
Hyhlarc.shp	Flip_chflg	=	1	Or	The flipped portion
	Geom_chflg	=	1		Selects both Flipped and Changed

VII. Other Querying and Analysis

Querying Other Attributes

This section explains how you can query other important attributes of linear water features such as streams, and area water features such as lakes.

Querying Other Attributes on Hydro Lines (streams, ditches, canals, centerlines, etc.)

Perform your query against the **hydlarc.shp** shapefile or the arcs in the **hydnw924** coverage.

Attributes other than names and WBICs exist on the hydro lines, such as linear type, duration, landlocked, and flow codes. To see the complete list of linear attributes, please refer to the ***WDNR 24K Hydro Coverage Data Dictionary*** or the ***WDNR 24K Hydro Shapefile Data Dictionary*** (for shapefiles).

Querying Other Attributes on SHAIDs (lakes, wide rivers, reservoirs, flowages, etc.)

Perform your query against the **hydrshai.shp** shapefile or the region subclass in the hydnw924 coverage.

Attributes other than names and WBICs exist on the hydro areas (SHAIDs), such as SHAID type, duration, and landlocked. To see the complete list of linear attributes, please refer to the ***WDNR 24K Hydro Coverage Data Dictionary*** or the ***WDNR 24K Hydro Shapefile Data Dictionary*** (for shapefiles).

Performing Complex Analysis

Complex analysis using 24K hydro is probably best carried out in ArcInfo using the arcs and polygons of the coverage. A good knowledge of the topological relationships built into any ArcInfo cover as well as a good understanding of the data model is needed. Details of this level of analysis, because the goals would dictate the actual approach, are outside the scope of this document and the level of user support envisioned.

VIII. Displaying Map Features

To make a map of 24K hydro features, display hydro lines, hydro SHAIDs, and, if desired, islands and network features. Apply the mask to remove any outlying features beyond the state border. Each of these steps is explained below. Each of the explanations below also has a legend file associated with them. Legend files allow for quick symbolization of themes, which is important when using Hydro due to its size and complexity. Further explanation of the legend files and how they were made can be found at the **Appendix D.**

Displaying Cartographic Hydro Lines (streams, ditches, canals, and shorelines)

To include hydro lines in your map, use **hydlarc.shp** shapefile (or the arcs in the **hydnw924** coverage).

Present in the arc (or line) attribute tables for coverages and shapefiles is an item called CARTO, meaning "cartography", or map-making. Lines where CARTO = "YES" represents only the linear features desired for making a map, such as shorelines and streams. Other linear features that are not desired in map-making, such as centerlines and closure lines, have CARTO = "NO". Below is the method for displaying the linear water features on a map. Duration of Streams is often used in making maps and can be used with the item CARTO. Streams have a duration of *perennial* (PN) or *intermittent* (IT). Shorelines have duration of *not applicable* (NA). *To map only the major streams,* only display perennial streams; therefore, make intermittent streams transparent.

Active Theme	Field	Operator #1	Value	Operator #2	Notes
Hydlarc.shp (Lines)	CARTO	=	"YES"		This is the critical factor

To symbolize linear map features as recommended above, apply the Arc View legend file called **hydlarc**_duration.avl**.**

To map only the major streams, apply the same Arc View legend file called **hydlarc_duration.avl**. Then, from the legend editor, remove the intermittent stream value by clicking on the 'x' button.

Important Note: The following linear type (LINEAR_TYP) features are not considered to be "cartographic" features (CARTO = "NO"): *connectivity features* – CL (centerlines), EX (extensions), FP (flow potentials), WG (wetland gap connectors); XX (*closure lines)*; CW (*channels in water areas)*; and OC (*original watercourses)*. If you would like to display any of these features on a map, include them in your theme definition. For example, if you want to display centerlines on your map, define your theme as CARTO = "YES" and LINEAR_TYP = "CL". Because many of the connectivity features have a duration of FX (meaning *fluctuating*), the provided ArcView legend file should not be used, however. FX duration is not represented in the legend file, and so, those lines coded as duration = FX will not display. Therefore, symbolize using the standard manual Arc View method.

Displaying SHAIDs (lakes, wide rivers, reservoirs, flowages, etc.)

To include hydro areas (SHAIDs) in your map, use **hydrshai.shp** shapefile or the SHAID regions in the **hydnw924** coverage.

Remember that SHAIDs are Simply Hydro Areas. They represent individual bodies of water. What this means for map-making is as follows: SHAIDs are closed off where one body of water ends and the other begins. For map-making purposes, the segregated representation of water bodies is not desirable. Therefore, the outline of SHAIDs should remain transparent. The hydro lines (arcs) are used for displaying the appropriate water body outlines (the shorelines). Another aspect of SHAIDs is that SHAIDs only include water features. Islands and uplands are not included in SHAIDs. Therefore, no reselecting or pre-defining of the features is necessary, simply add the **hydrshai.shp** shapefile (or the SHAID regions from the **hydnw924** coverage) as a theme.

- To symbolize water area features as recommended above, apply the Arc View legend file called **hydrshai_shaids.avl.**

Displaying Islands

To include islands in your map, use **hydrupld.shp** shapefile or the polygons in the **hydnw924** coverage and define theme as:

Active Theme	Field	Operator #1	Value	Operator #2	Notes
hydrupld.shp	POLY_TYP	=	"IS"		

When using the **hydrupld.shp** shapefile to symbolize islands as recommended above, apply the Arc View legend file called **hydrupld_islands.avl.**

Applying a Mask to Your Map

To mask hydro features beyond the state border, use **hydpmask.shp** shapefile.

The 24K hydro data contains a buffered area up to a 1000 meters beyond the state border. When making a map along the state borders, you may desire to "mask" any of the outlying features. Below is the method for masking the linear and area water features on a map.

- To symbolize mask, apply the Arc View legend file called **hydpmask_mask.avl.**

VIII. Reporting Errors Discovered in the 24K Hydro Database

The scope of the SWIS project includes on-going maintenance of the 24K hydro data. Due to the size and complexity of the hydro database, errors are anticipated, such as miscoded features or missing Water Body ID Codes (WBICs). All corrections on the features will be dated and flagged in the attribute tables, so you will be able to identify the corrected features between versions.

Many other sources for hydrological features such as 1:12,000 scale USGS maps or orthographic photos exist and may be accessible to users in other formats, but that data will NOT be incorporated into the 24K Hydro layer.

If you would like to provide feedback on errors you have discovered, please send an email with the following information to ann.schachte@wisconsin.gov :

Your name
Date
SHAID_NO, or SW_NO of the feature that is in question
A description of the problem

The update cycles will run **approximately** every 12 months. Each new release of the data will be documented as a new hydro "version".

Appendix A: Product Information

Projection and Coordinate System

Wisconsin Transverse Mercator (WTM), North American Datum 1983 with a 1991 adjustment (NAD91). Linear measures are in meters. Area measurements are in square meters.

Precision

The 24K Hydro layer was processed at double precision to accuracy consistent with national map accuracy standards for 1:24000 scale geographic data

Size of Coverage and Shapefiles

ArcInfo Coverage Format:
hydnw924 coverage – approximately 445 megabytes

Arc View Shapefile Format:
hydlarc.shp (Hydro Line/Arc Shapefile) – approximately 300 megabytes
hydrshai.shp (Hydro SHAID Shapefile) – approximately 110 megabytes
hydrupld.shp (Hydro Upland/Island Shapefile) – approximately 87 megabytes
hydtstem.shp (Hydro STEM Shapefile) – approximately 180 megabytes
hydpmask.shp (Hydro Polygon Mask Shapefile) – approximately 3 megabytes

Combined total for all shapefiles (excluding hydppoly.shp) is approximately 673 MB.

hydppoly.shp (Hydro Polygon Shapefile) – 220 megabytes (Not essential for analysis and cartography. Therefore, this shapefile is only available upon request.)

For more information regarding the hydro shapefiles, please refer to *Section IV. Overview of Hydro Shapefiles.*

Names of 24K Hydro SDE Layers (Access limited to WDNR employees)

EN_SURFACE_WATER_LN_24K (Hydro Line/Arc Layer)
EN_SURFACE_WATER_SHAID_AR_24K (Hydro SHAID Layer)
EN_SURFACE_WATER_UPLND_AR_24K (Hydro Upland/Island Layer)
EN_SURFACE_WATER_STEM_LN_24K (Hydro STEM Layer)
EN_SURFACE_WATER_MASK_AR_24K (Hydro Polygon Mask Layer)

Appendix A cont'd.

Accompanying Arc View Legend Files

hydlarc.shp_duration.avl – Hydro lines legend file; colors hydro lines light blue and symbolizes on duration (perennial, intermittent).
hydrshai_shaids.avl - SHAIDs (Simple Hydro Areas) legend file; colors water bodies light blue and shorelines transparent.
hydrupld_islands.avl - Island legend file; colors islands light green and removes uplands.
hydlarc.shp_flow.avl - Flow legend file; colors the hydro network purple, symbolizes on primary and secondary flow.
hydpmask_mask.avl - Mask legend file; hides all features beyond the state border.

History Shapefiles (Available by request only)

Hyhlarc.shp - A shapefile made of only changes to Hydro lines involving flipped, shape change and deleted edits.
Hyhstem.shp – A shapefile made of only changes to Hydro STEMs involving flipped, shape change and deleted edits.
Hyhrshaid.shp – A shapefile made of only changes to Hydro SHAIDs involving shape change and deleted edits.

Documentation

WDNR 24K Hydro Database Design.doc
WDNR 24K Hydro Decision Rules.doc
WDNR 24K Hydro User's Guide.doc
WDNR 24K Hydro History Shapefile Data Dictionary.doc
WDNR 24K Hydro Data Dictionary for Coverage, Shapefile and ARCSDE Datasets

APPENDIX B: Description of 24K Hydro Shapefiles

hydlarc.shp – (Hydro Line/Arc Shapefile) A shapefile containing all arcs in the 24K hydro coverage. The arcs are attributed to easily define themes based on cartographic or modeling needs. The arcs contain names and Water Body ID Codes (WBICs). This shapefile should be used for cartographic, and analytic purposes pertaining to lines, and for hydrographic modeling and network traces.

hydrshai.shp – (Hydro SHAID Shapefile) A shapefile containing all SHAIDs (Simple Hydro Areas) in the 24K hydro coverage. SHAIDs are for hydro features only and do not contain islands or uplands. SHAIDs contain various descriptive attributes, including names and Water Body ID Codes (WBICs). Use this shapefile for cartographic and analytical purposes pertaining to water areas.

hydrupld.shp – (Hydro Upland/Island Shapefile) A shapefile containing all upland and island polygons in the 24K hydro coverage. This is a subset of **hydppoly.shp**. These polygons have descriptive attributes. Some islands may have names, but in most cases they are unnamed. No water body id codes exist for islands. Use this shapefile for analysis and cartographic purposes pertaining to uplands and islands.

hydtstem.shp – (Hydro STEM Shapefile) A shapefile containing all STEMs (Simple Transport Element Measurement) system in the 24K hydro coverage. The STEM system is the linear referencing system used for dynamic placement of water-related data along linear water features that carry flow (a.k.a. transport features). STEMs only contain attributes pertaining to linear referencing. This shapefile is to only be used for linear referencing purposes.

hydppoly.shp – (Hydro Polygon Shapefile) A shapefile containing all polygons in the 24K hydro coverage. Polygons contain various descriptive attributes, including names and water body id codes (WBICs). However, we do not recommend this shapefile to be used for cartographic or analytic purposes pertaining to water areas. The water areas are divided into many pieces due to the addition of network features and, in many cases, do not represent complete water bodies. This Shapefile is only available upon request. Use **hydrshai.shp** for analysis and cartographic purposes pertaining to water areas, and use **hydrupld.shp** for analysis and cartographic purposes pertaining to uplands and islands.

hydpmask.shp – (Hydro Polygon Mask Shapefile) A shapefile containing a combination of the Wisconsin state boundary and the shorelines along Lake Michigan and Lake Superior. This shapefile also has an outlying box that closes off the bounding area, and, therefore, can be filled in and used as a mask. The mask is to serve the purposes of covering over the 1000-meter hydro buffer that extends beyond the Wisconsin state boundary or out into the Great Lakes. In other words, the mask allows for a clean cut of the hydro features along the outer limits of the hydro layer when creating maps.

HYDRO HISTORY SHAPEFILES

The following is an overview of the four history shapefiles derived from the 24K hydro hydnw924 coverage and the shapefiles of the previous release:

Hyhlarc.shp – (Hydro Line/Arc History Shapefile) A shapefile containing all arcs that have been flipped, geometrically changed, and deleted from the 24K hydro coverage. The arcs are attributed with these codes along with a retirement date – the date in which the features were retired from the hydro database. The arcs also contain the original information as it existed in the hydro coverage, such as Water Body ID Codes (WBICs), GNIS names, linear type, and duration. This shapefile should be used for analysis of water changes over time.

Hyhrshaid.shp – (Hydro SHAID History Shapefile) A shapefile containing all SHAIDs that have been geometrically changed and deleted from the 24K hydro coverage. The SHAIDs are attributed with these codes along with a retirement date – the date in which the features were retired from the hydro database. The SHAIDs also contain the original information as it existed in the hydro coverage, such as Water Body ID Codes (WBICs), GNIS names, SHAID type, and duration. This shapefile should be used for analysis of water changes over time.

Hyhtstem.shp – (Hydro STEM History Shapefile) A shapefile containing all STEMs that have been flipped, geometrically changed, and deleted from the 24K hydro coverage. The arcs are attributed with these codes along with a retirement date – the date in which the features were retired from the hydro database. The STEMs also contain the original information as it existed in the hydro coverage, such as unique STEM numbers and from-to route measures. This shapefile should be used for analysis of water changes over time and where the locational data once existed on these features.

APPENDIX C: Which Features Do You Use To Perform A Particular Task?

Different data formats contain different data structures. Some have feature classes and others are individual data layers. For instance, the 24K Hydro ArcInfo coverage is one data set with different feature classes, such as arcs and polygons, routes and regions. 24K Hydro ArcView shapefiles are derived from the coverage and are actually separate data layers. GIS data in WDNR's Spatial Data Engine (SDE) are similar to shapefiles but are stored as tables on a central DNR server (for employees internal to the WDNR only).

In Table 1 below, you will find the 3 different data types separated out by feature classes or layers. The TASK column contains various types of tasks that you may want to perform on the 24K Hydro data, such as "Query and Analysis". The x's in each row indicate which feature class or layer you would use to perform each type of task. For example, if you have acquired the Hydro Arc View shapefiles and you would like to make a map, refer to the "24K Hydro Arcview Shapefiles" column and the "Make a Map" row. The x's in that row will line up with the shapefiles you can use to make a map.

TASK	Hydnw924 ArcInfo Coverage				24K Hydro Arc View Shapefiles					WDNR's Spatial Data Engine (SDE)					
	Arcs	Polygons	SHAIDs	STEMs	Hydlarc.shp.shp (Lines)	Hydrshai.shp (SHAIDs)	Hydrupld.shp (Upland/Island)	Hydrstem.shp (STEMs)	Hydpmask.shp (Mask)	EN_SURFACE_WATER_LN_24K (Lines)	EN_SURFACE_WATER_AR_24K (Areas / Polygons)	EN_SURFACE_WATER_SHAID_24K (SHAIDs)	EN_SURFACE_WATER_STEM_24K (STEMs)	EN_SURFACE_WATER_UPLAND_24K (Uplands/Islands)	EN_SURFACE_WATER_MASK_24K (Mask)
1. Make a Map	x		x		x	x	x		x	x		x		x	x
2. Query & Analysis	x		x		x	x	x			x		x		x	
3. Network Analysis	x		x		x					x					
4. Linear Referencing				x				x					x		
5. Metadata	x	x			x					x	x				

APPENDIX D: Description of 24K Hydro Legend Files

The following ArcView legend files accompany the Wisconsin DNR 1:24k Hydrography Shapefiles. These legend files can be loaded in the *Legend Editor* in Arc View 3.x.

hydlarc_duration.avl – Hydro lines legend file; colors hydro lines light blue and symbolizes on duration (perennial, intermittent).
Legend file was created by symbolizing on the item '**DURATION'** as follows:

- PN (Perennial) – light blue, solid line
- IT (Intermittent) – lighter blue, dashed line
- NA (Not Applicable (shoreline)) – light blue, solid line

hydrshai_shaids.avl - SHAIDs (Simple Hydro Areas) legend file
Legend file was created by symbolizing water bodies light blue and shorelines transparent.

hydrupld_islands.avl - Island legend file; colors islands light green and removes uplands.
Legend file was created by using the Hydrupld.shp shapefile and symbolizing on **Poly_typ** as follows

- IS (Islands) - Light green color, no outline

hydlarc_flow.avl - Flow legend file; colors the hydro network purple, symbolizes on primary and secondary flow
Legend file was created by symbolizing on **FLOW** as follows:

- P(Primary) – Dark Purple
- S (Secondary) – Light Purple
- NA (Not Applicable) - Removed

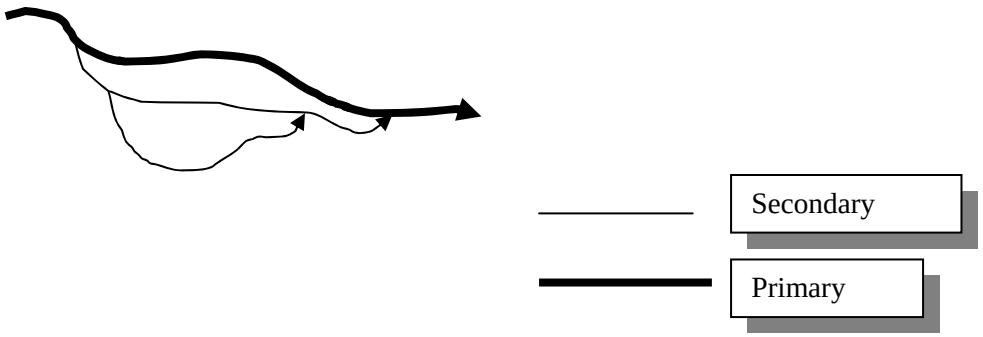
hydpmask_mask.avl - Mask legend file; hides all features beyond the state border
Legend file was created by symbolizing on the item **INSIDE** as follows:

- 0 - for outside the state with a white fill and black outline
- 1 - for inside the state made transparent

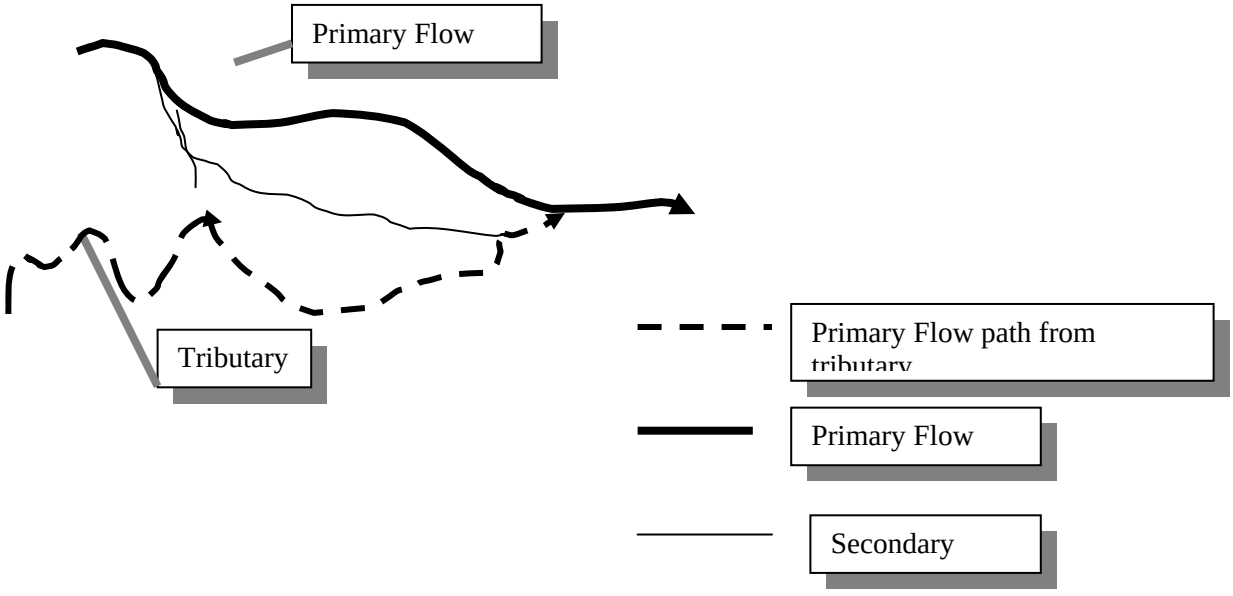
APPENDIX E: Arc Flow and Node Drain decision rules

Arc Flow – Primary and Secondary

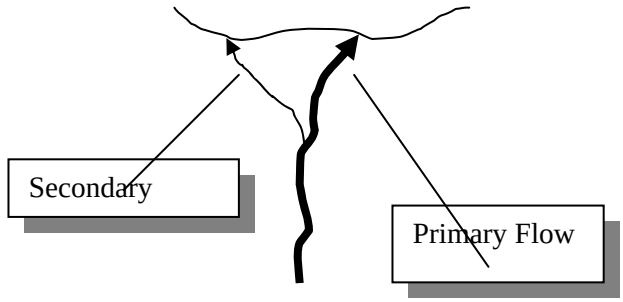
When a primary flow has no tributaries entering into its secondary flow paths, all arcs will remain secondary flows.



When a tributary enters into a secondary flow path area, the tributary must find the shortest path to the primary flow.

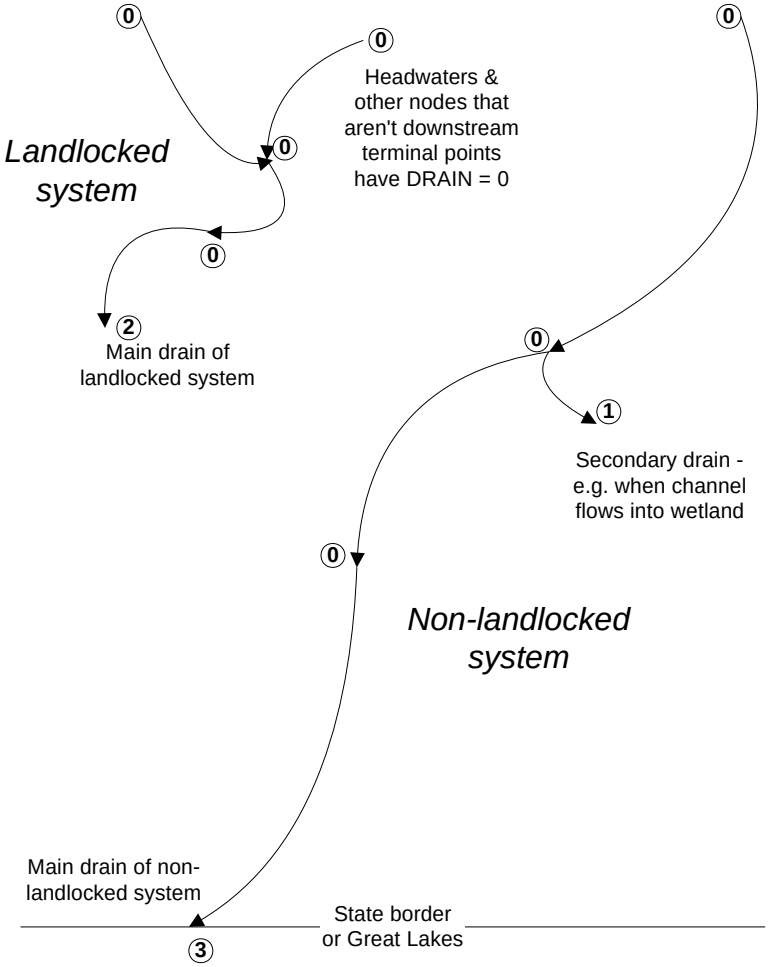


When a stream 'forks' into two or more stems, choose the primary flow (based on name and/or size) and make the rest secondary.



Other situations that cannot be solved for by using current decision rules can be addressed by communicating with WWI members, Hydro team members, and any other group that may have local knowledge of the particular area.

Wisconsin DNR 24K Hydrography
USER'S GUIDE
Node Drain Illustration



Glossary

Lines (or Arcs) – These include streams, ditches, canals, cranberry bogs, shorelines, original water courses through flowages, channels that may exist in water areas, and many network features allowing for flow through water areas. Each linear water feature contains useful information, such as water feature type; duration (whether it is perennial or intermittent); if it is primary or secondary flow; and whether or not it is landlocked. Some linear features also contain names from USGS's Geographic Name Information System (GNIS) and Water Body ID Codes (WBICs - WDNR's unique ids assigned too many water features in the state). The lines and their information allow the user to execute spatial and tabular queries about the data, make maps, and perform flow analysis and network traces.

Nodes – Nodes are the beginning and ending points of all arcs. Each node was attributed with a number indicating whether or not it is a "drain" of the water system.

Polygons – Polygons are areas in the 24K hydro coverage, which includes water polygons, uplands, and islands. Polygons are encoded with various descriptive attributes, including water feature types (lake, pond, fish hatchery etc.), duration (whether it is intermittent or perennial), GNIS names, Water Body ID codes (WBICs), and metadata information. The linear features (such as centerlines, extensions and closure lines) that were added to connect flow paths through the water bodies, split the water bodies into smaller polygons that no longer represent the complete features. We **do not** recommend polygons to be used for map-making or analytic purposes pertaining to water areas.

STEMS - (Simple Transport Element Measurement System) In the **hydnw924** coverage, STEMS are stored as a "route" system and rely upon the underlying arcs. STEMS was developed for a linear referencing system to be used in SWIS (the WDNR's Surface Water Integration System; please refer to the ***WDNR 24K Hydro Database Design*** document for more information regarding SWIS). "Measures" have been generated along each STEM, which allow for the placement of user data along the water features that carry flow, such as streams, ditches, canals, and connectivity features. You will not see shorelines and closure lines as a part of STEMS. They are located in the arc feature class.

SHAIDS – (Simple Hydrographic Area Identification System) In the **hydnw924** coverage, SHAIDs are stored as an ARC INFO "region". SHAIDs are made up of one or more polygons but appear as one entity. There is also a separate **hydrshai.shp** shapefile. SHAIDS contain useful information, such as water feature type, duration (whether it is perennial or intermittent); and whether or not it is landlocked. Some SHAIDS also contain names from USGS's Geographic Name Information System (GNIS) and Water Body ID Codes (WBICs - WDNR's unique ids assigned too many water features in the state). The SHAIDS and their information allow the user to execute spatial and tabular queries about the data, make maps, and perform area analysis. Each SHAID contains a unique id.

Hydro Network (and Connectivity Features) – The 24K Hydro data model supports flow modeling and tracing functionality, such as upstream/downstream-type queries. To accommodate this need, various "connectivity lines" (ex. stream centerlines, extensions, wetland gap connectors, and flow potentials) were added to form a statewide water network, known as a dendritic network. This complete connectivity

Glossary cont'd.

makes tracing possible, ensuring the flow of water through open water bodies, from one water feature to another.

Closure Lines – Closure lines are necessary to delineate water features and assign them attribute information. Backwaters and reservoirs are closed off from the main rivers so that they can be coded as separate entities from the rivers (e.g. closure lines are used to define the area in the Wisconsin River called "Lake Wisconsin"). Streams are closed off from lakes, and lakes of different names are closed off from each other.

NAME – The names stored in the 24K hydro database are from the USGS Geographic Name Information System (GNIS). Please refer to the ***WDNR 24K Hydro Database Design*** document for more information on GNIS names.

WBIC (Waterbody ID Code) - is a unique identifier for waterbodies. WBICs are managed in an existing WDNR tabular database called the Register of Waterbodies (ROW). ROW holds information pertaining to the surface water of Wisconsin. NOTE: Not all WBICs in ROW are found on the 24K hydro layer. Please refer to the ***WDNR 24K Hydro Database Design*** document for more information on WBICs.

Register of Water Bodies (ROW) - contains the official DNR water body names for Wisconsin surface waters and is more comprehensive than GNIS. To easily access the ROW names, a file called ROWNAME.DBF derived from the ROW database has been included along with the hydro data. The contents of the file are the WBICs and the ROW names. In order to see the ROW names for waterbodies, on needs to Join the field 'WBIC' in the table 'Rowname.dbf' with the field 'RIVSYSWBIC' in the attribute table of the Hydrshai.shp and Hydlarc.shp. Be sure to save your Project (APR) in order to use this join the next time you use the 24K Hydro database.

River System for Linear Water Features – A *river system for linear water features* includes the lines that carry the flow of the main river channel that run through all SHAIDs along that main river, and all of the lines that carry flow stemming from that main river into adjacent backwaters, inundation areas, and secondary channels. Tributaries entering the main river are *not* included in the same river system.

River System for Area Water Features – A *river system for area water features* includes the main river channel SHAIDs plus all of the adjacent reservoir, flowage, lake, backwater and inundation area SHAIDs falling along the main river channel. Stream tributaries entering the main river are *not* included in the same river system.

History Tracking – a system to track changes in the Hydro database. History Tracking includes both the Change Flags items and the History Shapefiles. The Change Flags are located in the Hydro database itself consisting of up to seven different items (Geometric, Flipped, Natural, GNIS, WBIC, Reference data, and New) depending on the feature class. The items can be used to identify differences in the database between versions. The History Shapefiles are separate from the Change Flags. These Shapefiles contain all the attribute information as the Hydro database plus four fields: "flipped", "geom_chng" (geometric change), "deleted" and "retiredate". Use the History Shapefiles to see how the Hydro database has changed over time. These shapefiles are appended to with each new version of Hydro, adding more features each time.