

## **TITLE: Incorporating Local Knowledge Provides Better Hydrography Data for All, Part 2**

Author: Idaho Department of Water Resources (IDWR)  
Danielle Favreau (Danielle.Favreau@idwr.idaho.gov)  
Address: 322 E. Front St., P.O. Box 83720, Boise, Idaho 83720-0098  
Phone/Fax: (208) 287-4800/(208) 287-6700

### **ABSTRACT:**

The Idaho Department of Water Resources (IDWR), as the Data Steward for the National Hydrography Dataset (NHD) in Idaho, is developing approaches to make it easy for local water managers to submit changes and updates to the NHD. One of the approaches for submitting updates is a tool that uses ArcGIS, but does not require specialized hydrography editing knowledge. Using a custom attribute entry form and feature classes in ArcGIS, local agencies can review current NHD and other relevant hydrography data and submit updates to the IDWR. The Burley Irrigation District served as an initial case study. The Northside Canal Company, the City of Jerome, and the City of Nampa agreed to test the second iteration of the tool and provide insight of further development needs.

### **INTRODUCTION:**

Water managers, be it on a local or regional level, rely on accurate hydrographic data for planning, modeling and other tasks. Currently, much of this data is retained local knowledge or on paper maps maintained by irrigation districts, city planners, and other water managers. The goals of this project are to develop simple and straight forward approaches to collect this data.

The NHD is a nationwide dataset containing hydrologic features such as streams, canals, lakes, and ponds. Currently the NHD in Idaho is available at a medium resolution (1:100,000) and high resolution (1:24,000). While the NHD is managed by the United States Geological Survey (USGS), many States have Data Stewards and are working in conjunction with the USGS with collecting and submitting updates to the NHD in their jurisdictions. The IDWR is the Data Steward in Idaho, and strives to improve the high resolution NHD dataset. Once the IDWR receives updates from local water managers, the IDWR edits the NHD and submits those edits to the USGS for inclusion into the national NHD database. Direct editing of the NHD requires specialized NHD GeoEditing Tools and detailed training on those tools.

The NHD consists of a variety of feature classes. The NHDFlowlines feature class represents features such as streams, canals, and pipelines. IDWR developed a customized tool contains editing tools that are designed to assist local water managers in submitting data to the NHD Data Steward for update the NHDFlowline feature class. It was determined that the following attributes must be captured for NHDFlowline as part of the customized tool: "FTYPE", which indicates whether a feature is a canal, pipeline, artificial path, or a stream and the "GNIS\_NAME", which is a name that is accepted by the Board on Geographic Names (BGN), and included in the national Geographic Names Information System (GNIS). After initial testing of the tool, it became clear that more information about flow direction and connectivity was required.

In addition to NHDflowline features, there was a great interest in capturing point of diversion data, such as pump, fish screen, checkgate and weir locations. A point feature class was added to the edit collection database and tools were created to collect point of diversion information. Attributes for the point features include "POD\_Type" and "POD\_Name". The water source of the diversion is ("H2O\_From") as well as where the diversion is directing water to ("H2O\_To") is also collected.

ESRI ArcGIS software was chosen as the development environment for the IDWR NHD Editing Tool due to its prevalence among Irrigation Companies and other local irrigation organizations in Idaho. Although the software is prevalent, most irrigation organization staff has limited GIS skills. Given the varying levels of licensing, it was important that the tools work at a minimum of ArcView 9.x license level.

The Burley Irrigation District (BID) served as the initial case study. Suggestions and comments made by BID as well as those from the NHD Technical Point of Contact while updating the dataset with BID data were incorporated into the second iteration of the Tool. These changes included procedures that would allow the local editors to indicate and adjust flow direction and connectivity, and functionality for collecting point of diversion information. The Northside Canal Company, the City of Jerome, and the City of Nampa agreed to test the second iteration of the tool.

#### **METHODS:**

Because local water managers with limited GIS skills are being asked to provide updated NHDFlowline and Point of Diversion information, the developed procedure needed to be as straightforward as possible and still produce the edits needed for Data Stewards to meet the USGS requirements for NHD updates. Using the IDWR Customized NHD Editing Tool, local editors are asked to draw new lines for NHDFlowline edits or new points for Points of Diversion. Editors are also asked to adjust attributes, transfer geometry from existing shapefiles or geodatabase feature classes. A local editor does not need to delete features, or move vertices on an existing line. If the local editor makes an error, they can simply draw another feature rectifying their mistake. When multiple features with similar geometry exist, only the last edit added to the table (with the highest FID number) is accepted. Once a sketch or feature transfer is completed, a dialog box with drop-down lists appears to collect all relevant information for the feature that was just drawn. Only a limited number of attributes are collected per feature in order to maintain productivity.

#### **Tool Description:**

The IDWR Customized NHD Edit Tool is written in Visual Basic for Applications and is associated with an ESRI ArcMap project (.mxd). The Tool acts on an ESRI file geodatabase consisting of two feature classes and a stand-alone table along with associated domains. The feature classes are Edits\_Canals used for indicating edits to the NHDFlowline and Edits\_PODs used for indicating edits to Points of Diversion. Editing these feature classes via the Editor Toolbar will trigger scripts that will generate attribute entry forms. In addition, a toolbar with 5 button

tools were also created. These button tools run scripts that allow transfer of geometry from existing shapefile or geodatabase feature classes into the Tool feature classes, correction of arc direction, and creation of an additional feature class to indicate line intersections, and addition of Name attributes into the stand-alone table. This geodatabase maintains the information needed by the NHD Steward to update the NHD.

#### Attributes Collected:

It was determined that only 3 primary attributes per line feature are needed for the NHD Steward to update the NHDFlowlines; EDIT\_ACTION, FTYPE, and NAME:

- The “EDIT\_ACTION” allows users to select whether the sketch represents a line that needs to be added, deleted or modified. ArcObjects was used to populate the “EDIT\_ACTION” listbox with edit options set up in a geodatabase domain.
- The “FTYPE” listbox is populated with the domain values for the most common FTYPES encountered Burley Irrigation District. The default is canal/ditch. ArcObjects code is used to populate the listbox with the description verse of the numeric value that is stored.
- The “NAME” listbox is populated from a table containing the names found in the NHD for the area and the appropriate GNIS\_ID. These local names are stored in a stand-alone table in the provided geodatabase. If a name of a feature does not currently exist in the listbox, it can be added. When a user adds a new name, ArcObject code adds the name to the name table and a negative GNIS\_ID is assigned. This negative GNIS\_ID allows the Data Steward to identify the additional names. Because the listbox domain is generated on form opening, the new name is added to the “NAME” listbox and is available for future edits.
- A “COMMENT” text box is also available to allow additional data about a feature to be documented.

It was determined that only 4 primary attributes per feature are needed to adequately describe Points of Diversion; POD\_TYPE, POD\_NAME, H2O\_FROM, and H2O\_TO:

- The “POD\_TYPE” allows users to select what type of Point of Diversion the point represents. ArcObjects was used to populate the “EDIT\_ACTION” listbox with edit options set up in a geodatabase domain.
- The “POD\_NAME” listbox is populated with existing names previously entered in this attribute field. This is the name given to the diversion structure represented.

- The “H2O\_FROM” listbox is populated from a table containing the names found in the NHD for the area and the appropriate GNIS\_ID. If a name of a feature does not currently exist in the listbox, it can be added. The same table and procedure is used as the “NAME” attribute.
- The “H2O\_TO” listbox is populated from a table containing the names found in the NHD for the area and the appropriate GNIS\_ID. If a name of a feature does not currently exist in the listbox, it can be added. The same table and procedure is used as the “NAME” attribute.
- A “COMMENT” text box is also available to allow additional data about a feature to be documented.

The arc direction of a flowline is very important in developing the NHD network. A Change Flowline Direction button tool adds a standardized arrow symbol layer to the map to indicate flowline direction. If flowline direction is incorrect, the user selects features of the layer and clicks the button again to flip the arc direction.

If a node at intersecting lines represents a canal flowing into another, or represents the location of a diversion structure directing water over or under another canal or stream, this information needs to be captured correctly. Connectivity and vertical relationships are very important when developing the NHD flowline network and are difficult to determine in agricultural or urban areas without local knowledge. A Connectivity button tool was developed to help capture information about these areas of intersection. Users place a Point of Diversion point at these areas of questionable connectivity and indicate how the water is travelling. Users are directed to use the Connectivity button tool after completing very large portions of their system. The tool will create points in areas where line segments of different names either intersect or are within a 5 meter buffer distance of each other. Users can then either create a new point at the diversion structure location, or use the Transfer Point to POD button tool to transfer the geometry of selected connectivity points to the POD\_edits feature class, and attribute accordingly.

An ArcMap project (.mxd) with the current NHD data, the code comprising the IDWR NHD Editing Tool, and feature classes, was provided to Northside Canal Company, the City of Jerome, and the City of Nampa. IDWR personnel provided approximately ½ day of training to each of these sites in the use of the customized tool. The testers were also provided a “Users Guide” document. The City of Jerome and the City of Nampa were asked to test the procedure and associated tools and send a report back to IDWR on its effectiveness. Northside Canal Company (NSCC) was asked to use the tool to indicate Points of Diversion along its canal system and indicate any inconsistencies in the system linework. When finished, NSCC provided IDWR with a report on the tool’s effectiveness and a copy of the POD and linework edits for incorporation into the NHD.

## RESULTS:

Below is a summary of the weaknesses and strengths of the tool as reported from the case study participants.

### Strengths

Overall Performance:

- *Simplicity*  
Several of the case study participants reported that the tool was easy to use and simple to understand.
  
- *Time savings*
  - For the City of Jerome, this exercise took an average of approximately one week, including ½ day of setup and training to complete a majority of the areas. Participants were able to input a vast amount of their service areas in a short amount of time.
  - Northside Canal Company estimated that they took approximately 1 hour to record 100 points. At the end of the 6 week trial period, they had recorded nearly 1300 points of diversion.
  
- *Limited amount of options/domains*  
These standardized options allow for less data input mistakes to be made. Having too many options can make it confusing on the editor.
  
- *Data entry friendly*  
Attribute data entry supports both tabbing and mouse click. This allows the editor to possibly input data at a faster rate.  
  
Users liked being able to type the 1<sup>st</sup> letter of each name to populate the field, and the fact that it retained each name for subsequent entries.
  
- *Import existing data as well as create new data.*  
One of the most powerful strengths of this tool is the capability to import existing data. This could be especially useful for agencies that have already created or maintained existing data. Users liked the flexibility of being able to create new or modify existing data.

Specific Tool Functions:

- *Import names tool*  
Being able to upload an existing names database makes the data entry very efficient and saves time.

## Weaknesses

### Overall Performance:

- *Attribute Form*
  - *Attribute form takes longer and longer to load as more data is added.*

After a significant amount of data was added to the geodatabase, the attribute form began taking a noticeably long time to load. This time waiting could be spent adding data.
  - *Attribute form locks map extent, table of contents, etc.*

When editing data in the attribute information form, the user is unable to communicate with the map document, table of contents and toolbars until the form is closed. This can be a problem when the map extent doesn't show the feature corresponding to the edit form. Allowing for a zoom capability, while adjusting attributes was suggested.
  - *Attribute Options*

Users would like to be able to populate a new feature with the attributes from the previous entry and edit as necessary.
  - *Null attribution before saving creates an error.*

One user noted that they sketched in one ditch and forgot to change any attributes before clicking on save changes. It gave an error message and deleted the ditch sketch. Better error trapping that returned the editor to the attribute screen is necessary.
- *Inability to edit multiple items at once*

Currently, each line segment and point must be attributed individually. This could prove to be a very time consuming task, especially true when using the "Transfer Line Geometry" tool.
- *Setting up snapping and tolerances*

Not actively addressed in tool setup or documentation. At minimum, additional documentation suggested.
- *Status bar for processing tasks*

Adding status bars for transferring geometry and connectivity determination tasks was suggested.
- *Switching from editing to not editing among tasks*

The editor tool bar is used to create new features, both flowline and point of diversion. Using the button tools (Transfer Geometry, Connectivity, etc.) requires the user to exit any edit session to avoid schema locks. This can be initially confusing to the user.

- *Symbology*
  - *Overlapping symbology for multiple edits on a line segment confusing*  
Optimally, only the “latest” line segment for a flowline would be displayed.
  - *Labels*  
One editor found the default label symbology difficult to see. Suggested adding halos and increasing text size as this is something less experienced GIS users may not know how to do.

Specific Tool Functions:

- *Auto populate the edit action for NHDFlowline edits*  
Repeatedly indicating the type of edit action (adding, deleting, or modifying a feature) can be a point of confusion. A suggestion is have individual buttons for each task.
- *Bulk Deletion*  
One user had a need for a bulk deletion option.
- *Connectivity tool doesn't pick up all intersections*  
The connectivity tool seems to only pick-up a limited amount of line intersections.
- *Transfer Line Geometry*
  - *Error: Occasionally, the Transfer Line Geometry process would generate an error.*  
The standard warning about the number of segments dialog would appear but then an internal error stating that no selection had been made would display. The data was actually copied over to the Edits\_Canals layer though but the attribute info form didn't open.
  - *Data input seems to jump around based on selection: When utilizing the “Transfer Line Geometry” tool the input selection seemed to jump around when adding the attribute information.*

**Tool Adjustments Made Based on Tester Feedback**

- *Attribute Form Adjustments*
  - The methods used to create the lists of the combo boxes on the attribute entry forms have been adjusted with the intent of increasing form load speed.
  - A button has been added to the attribute entry forms so that users may auto-populate the form with entries from the last saved record.
  - The form code has been adjusted so that a Null field in the forms upon saving no longer creates an error.
- *Appendix in the User Guide for the Tool have been developed to address:*

- Setting Up Snapping and Snapping Tolerances
- Label Modification
- Bulk Deletion of Points
- *Progress dialog box has been added to the Connectivity tool.*  
A Connectivity Tool Progress Dialog Box has been added. Progress dialog boxes were not added to the Transfer line/point geometry tools because the majority of the transfers are for under 24 points or segments and the dialog box does not remain open long enough to be useful.
- *Transfer Line Geometry Error:*  
The error in the Transfer Line Geometry tool was isolated and corrected.

### **Adjustments that will Need to be Addressed in Future Versions**

- *Attribute form locks map extent, table of contents, etc.*  
When editing data in the attribute information form, the user is unable to communicate with the map document, table of contents and toolbars until the form is closed. It is suspected that this is a result of the single thread coding of this project. It would require a significant research and time to write multi-threaded code to resolve this issue.
- *Inability to edit multiple items at once.*  
Currently, each line segment and point must be attributed individually. The challenge is to allow for the geometry to be added then prompt the user could select a data subset for attribute editing while not missing any added segments. By allowing the user to create subsets, it allows for the possibility of null attribution on missed segments. More research and testing is required to address this issue.
- *Switching from editing to not editing among tasks.*  
The editor tool bar is used to create new features of both Flowline and PODs. There is a toolbar with buttons for other actions. This issue will be addressed in future versions.
- *Overlapping symbology for multiple edits on a line segment confusing.*  
Optimally, only the “latest” line segment for a flowline would be displayed. This issue requires further research before implementing a fix.
- *Auto populate the edit action for NHDFlowline edits.*  
This issue can be addressed if toolbar buttons are created for each edit action for each feature. This solution could create problems with toolbar overcrowding. Additional research is required to develop an appropriate fix.
- *Connectivity tool doesn't pick up all intersections.*

The connectivity tool seems to only pick-up a limited amount of line intersections. This can be a result of several functions built into the tool including the buffer distance default of 5 meters. More testing may be required to determine if the default distance should be adjusted to a more appropriate level.

- *Transfer Line Geometry: Data input seems to jump around based on selection.*  
When utilizing the “Transfer Line Geometry” tool the input selection seemed to jump around when adding the attribute information. This seems to be a result of the OID order in the original data layer. Determining a way to analyze the added segments and display them in a way that does not appear to “jump around” to the user requires further research.

## **CONCLUSION:**

Simplified editing tools allow IDWR, as the NHD Data Steward, to acquire updates from local agencies and include them into the NHD. Local agencies benefit by having their most current data in the NHD for up-to-date map development and for the ability to incorporate the NHD into their business operations and for data analysis. This approach has demonstrated to be an effective way to extract data out of the “heads of local water managers” and into an easily accessible national database for better hydrographic planning, modeling, and other tasks.

“While some of the weaknesses I mentioned above are a result of this tool’s simplicity, I think that its ease of use is a much more powerful strength than it is a weakness. I think that this tool is well suited for the intended audience...To me the editing tool covers all the necessary editing scenarios.”

*Craig Tarter, City of Nampa*

“I have already started using the data. A stockholder came in and wanted to know about a farmer’s delivery point... I didn’t have to call for help as everything I needed to know was right in front of me. It was great and saved a lot of time.”

*Terry Walters, Northside Canal Company*

## **ACKNOWLEDGEMENTS:**

Thank you to the USGS for providing cost share funding for IDWR NHD Edit Tool development and testing.

Thanks to Christian Marie for developing the Universal Data Entry Form v. 1.5 which served as a starting point for the attribute entry form development, to Zach Maillard (IDWR) for the new name table procedure and invaluable technical assistance, to Wilma Robertson for her support and contributions during the testing of the tool’s first iteration and in diligently processing canal company line work and getting it all into the NHD, to Genna Ashley (IDWR) for managing subcontracts and insightful input, to Theresa Teeter (BID) for her patience and dedication to the editing process, and to Terry Walters (NSCC), Joan Appell (City of Jerome), and Craig Tarter (City of Nampa) for their time and effort in testing the tool.