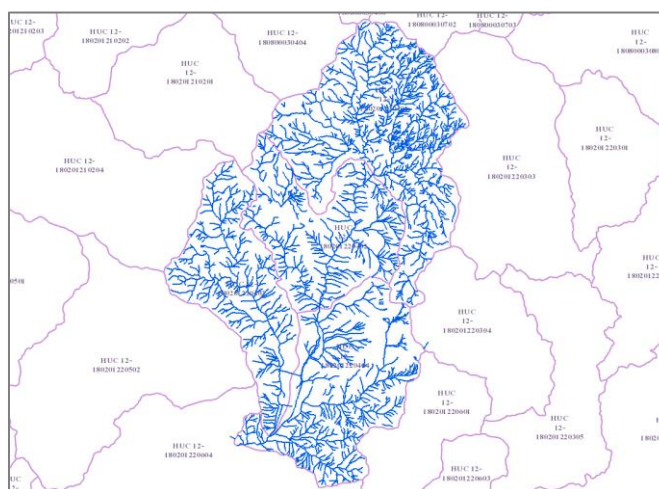


# EXERCISE 2

## How does my data relate to the National Hydrography Database?



### Introduction

The preparation of hydrographic data that will be used to update the National Hydrographic Database (NHD) involves determining which standardized Hydrologic Unit corresponds to the update extent, as well as ensuring that existing NHD content within that extent is considered appropriately during the update process. Particularly when using the NHD GeoConflation workflow to preform batch updates to the NHD, it is necessary for stewards and editors to consider the full suite of NHD content across the entire update extent. There are several topological criteria between NHD datasets that need to be addressed when preparing data for an update – this holds true even when only one layer or component of the NHD is scheduled for update. This exercise will not delve into the topological considerations for the NHD, but rather focus on familiarizing users with how to quickly determine the spatial relationship of an update extent to the NHD and how to access the existing suite of NHD for that update extent. Those topological considerations will be addressed in Exercise 3.

### Objectives

- Learn how to determine which portion of the NHD corresponds to a hydrographic update extent
- Learn how to access and obtain a copy of the NHD content that corresponds to a hydrographic update extent.

## Required Data

- **USFS\_Streams\_Subset.gdb** – file geodatabase that contains the feature class titled “Streams\_Subset” and will be used for this exercise. The features within the “Streams\_Subset” feature class are a subset of data that were compiled by USFS staff on the Plumas National Forest for use in updating the NHD.
- **NHD\_H\_18020122\_HU8\_GDB.gdb** – file geodatabase containing the full suite of NHD and Watershed Boundary Database (WBD) content that corresponds to the 8-digit Hydrologic Unit (HU8) titled “18020122”. This geodatabase is freely available for download via the following URL, but is also provided with this exercise to circumvent potential issues where users could encounter firewall or download issues: <http://prd-tnm.s3-website-us-west-2.amazonaws.com/?prefix=StagedProducts/Hydrography/NHD/HU8/HighResolution/GDB/>

**Note:** As well as links to dynamic map services, the USGS provides static copies of the current NHD content that are available for download in a variety of spatial extents from the following link: <https://nhd.usgs.gov/data.html>. At a minimum, users will need all the current NHD content that is coincident with the spatial extent of their newly created hydrographic content.

## Prerequisites

- ESRI ArcGIS Desktop v10.5.1 (or newer) is installed on the user’s computer
  - “Standard” or “Advanced” level ArcGIS Desktop license required – exercise will not work with “Basic” level ArcGIS Desktop license.
- User has a basic level of experience with the ArcMap interface.
- User has access to an internet connection for portions of this exercise.
- User requires permission to connect to an external internet mapping service via standard HTTP protocols from within ArcMap

**Disclaimer:** this exercise has been written for users who do not undertake regular NHD Stewardship activities and likely would not have the requisite credentials for the USGS Hydrography Maintenance Portal or the USGS NHD Update Toolset. **IMPORTANT** - For any credentialed NHD Stewards who reference this exercise, Part 2 of the exercise should be substituted with standard NHD transaction protocols whereby data is requested through the training version of the Hydrography Maintenance Portal and acquired by download with the NHD Update toolset -

[https://hydromaintenance.nationalmap.gov/HMP\\_Training](https://hydromaintenance.nationalmap.gov/HMP_Training).

**An overview of the process to be used by credentialed NHD Stewards or sub-stewards is provided within the exercise folder titled Appendix A.**



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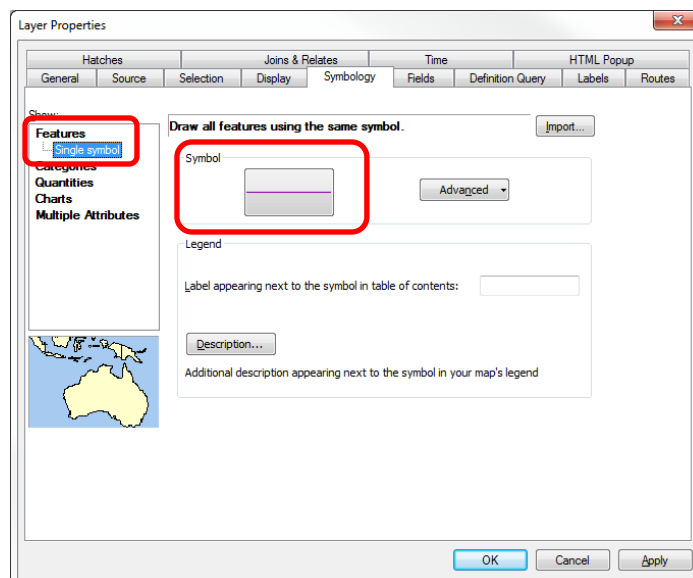


## Part 1: Determining Watershed Boundary Extent

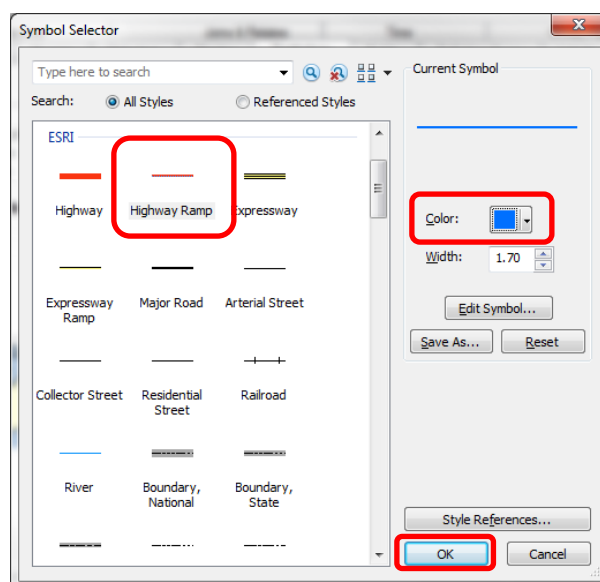
Because hydrographic data is often collected on the basis of watershed boundaries, users often know in advance how a particular dataset corresponds to a particular NHD/WBD extent. However, for this exercise, the assumption is that an editor or data steward has been tasked with working on a streams dataset without having prior knowledge of the datasets extent relative to the NHD or WBD. Also, in order to transact NHD content with the national database, NHD Stewards are required to know which 10-digit Hydrologic Units (HU10s) and/or 8-digit Hydrologic Units (HU8s) are to be checked out during the eventual NHD update process.

### A. Load the stream data into ArcMap and symbolize the features

1. Launch ArcMap from the start menu by clicking **Start, Programs, ArcGIS, ArcMap 10.5**.
2. Click the **Add Data** button and navigate to where you placed the course material.
3. Open the **USFS\_Streams\_Subset** geodatabase, select the **Streams\_Subset** feature class, and then click **Add**.
4. Right click on the **Streams\_Subset** dataset in the table of contents (TOC) and select **Properties**.
5. In the Layer Properties dialog box, select the **Symbology** tab and confirm that features are being symbolized as **Features-Single Symbol**.



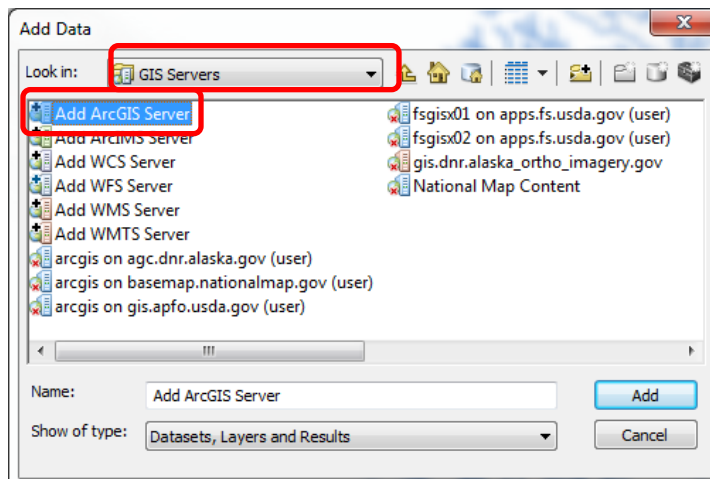
6. Next, click on the line feature within the Layer Properties dialog box, choose the predefined Esri symbol titled **"Highway Ramp"**, set the color to a shade of **Blue**, and click **OK** (see below).



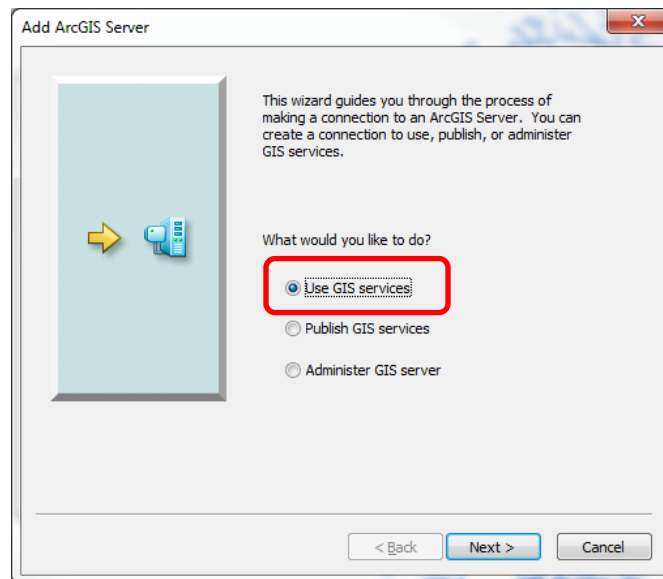
7. Turn on the layer in the TOC (if it's not already displayed in the map) to see your map zoomed to the full extent of the **Streams\_Subset** dataset.

## B. Connect ArcMap to the NHD and WBD web mapping services

1. Click the **Add Data** button, from the dropdown menu select **"GIS Servers"**, select **"Add ArcGIS Server"**, and then click **Add**.

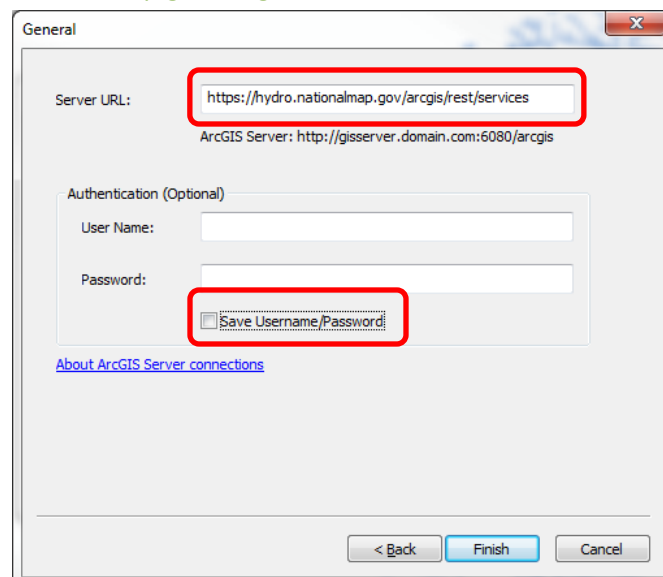


2. When the Add ArcGIS Server window opens, select **"Use GIS services"** and click **Next** as shown below.

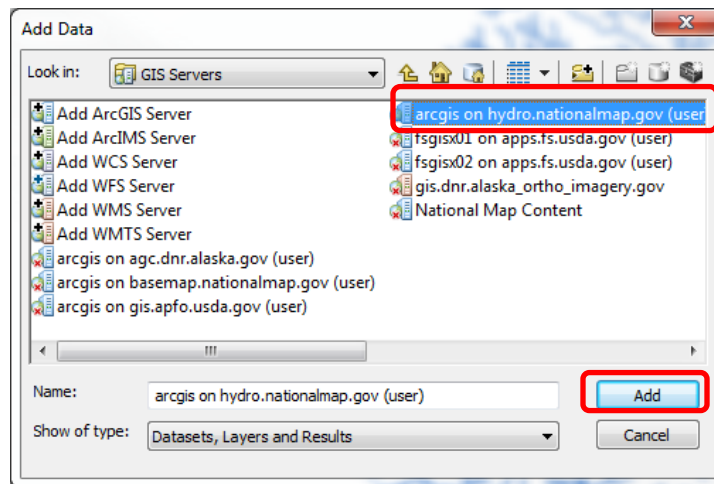


3. In the General window, paste the URL bulleted below into the “**Server URL**” parameter and make sure the box next to the “Save Username/Password” parameter is unchecked. Then click **Finish**.

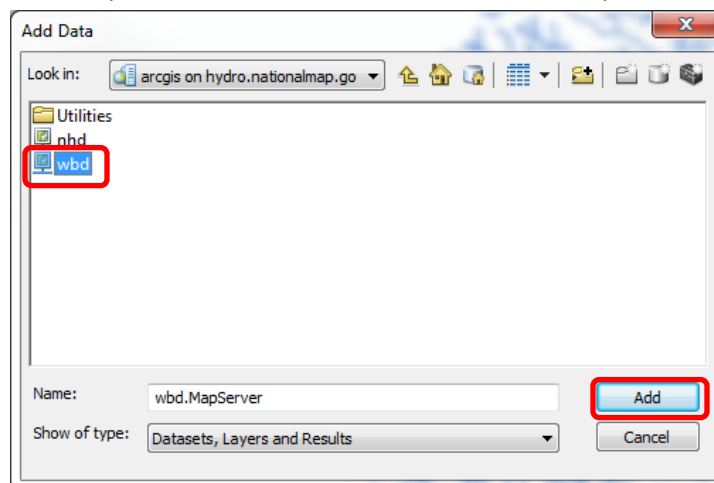
- i. <https://hydro.nationalmap.gov/arcgis/rest/services>



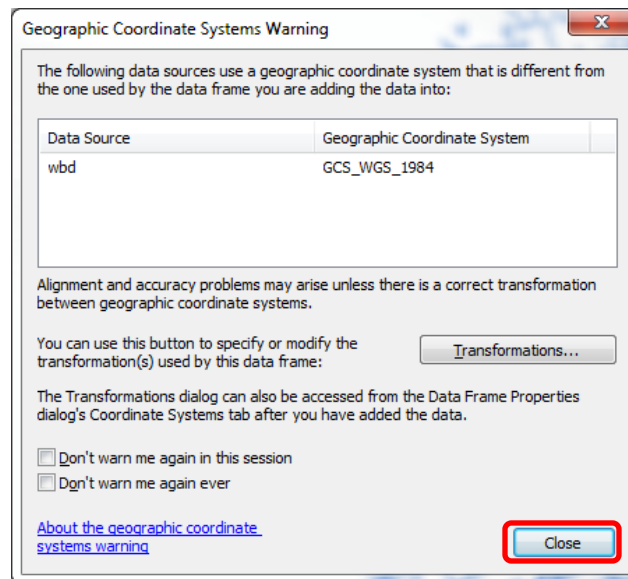
4. Upon clicking Finish, ArcMap then maps a connection to the ArcGIS services that are published at the URL endpoint specified above. Notice that the new service connection has been added within the Add Data window shown below.



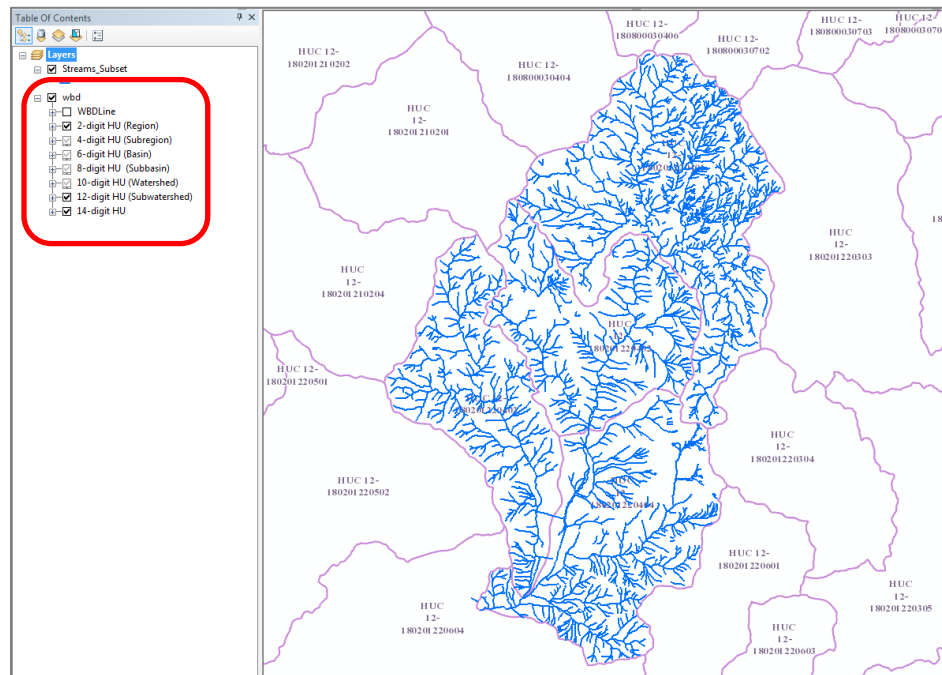
5. Select the newly added connection point and click **Add**. The Add Data window will then display the available map service content available from the newly added connection point.




6. Within that connection point, the user now has access to cached map content which shows nationwide NHD and WBD content. Included in these services are the core spatial NHD content such as NHDArea, NHDFlowlines, NHDLines, NHDPoints and NHDWaterbodies, as well as all of the various hierarchical levels of WBD boundaries. For this exercise, we're only concerned with how the spatial extent of our **Streams\_Subset** dataset relates to the national data management extents (i.e. watershed boundaries), so select "**wbd**" and click **Add**.
7. Note that upon clicking Add, ArcMap immediately presents a **Geographic Coordinate Systems Warning** window. This warning is letting us know that the coordinate system used by our **Streams\_Subset** dataset and the current Data Frame within ArcMap differs from the newly added web map content. For this exercise, we can ignore the warning and click **Close**.



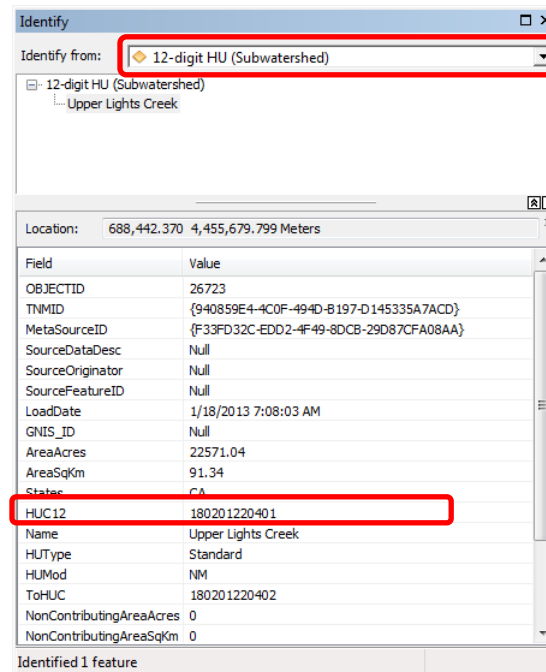
8. In the TOC, click on the + symbol next to the **wbd** layer to expand the list of contents and turn on the **wbd** layer as shown below.



9. We can now see how our **Streams\_Subset** dataset overlays with the current 12-digit Hydrologic Units (HU12s) within the WBD.
10. Within this example, we can see that our Streams\_Subset dataset spans 4 different HU12s – “180201220401”, “180201220402”, “180201220403”, and “180201220404”.
11. Information about these various HU12s is discoverable by using the **Identify** tool  found on the “Tools” toolbar. Select the Identify tool and click anywhere in the map to open the Identify window.



12. Within the Identify window, select “12-digit HU (Subwatershed)” from the dropdown list and then click the cursor on any of the 4 HU12s that are underlying the Streams\_Subset features. The features 12-digit identifier is listed next to the HUC12 attribute field as shown below.

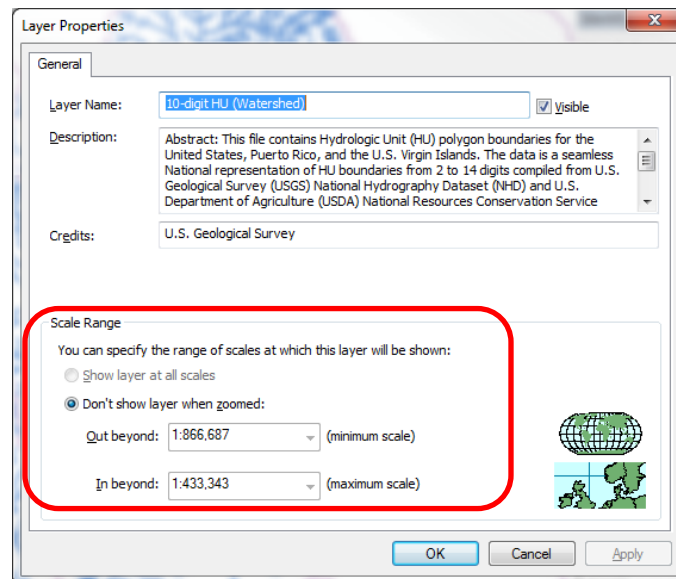


**Note:** Features within the WBD are nested hierarchically in that the smaller number of digits assigned to a particular boundary, the larger the extent of that watershed boundary. For example, 4-digit boundaries contain 6-digit boundaries; 6-digit boundaries contain 8-digit boundaries; so on and so forth.

NHD Stewardship and maintenance are typically done on the basis of HU10s or HU8s. So, while it may be of interest which HU12s or the number or HU12s cover an area of interest, we have to determine specific HU10 or HU8 information (depending on the size of an update extent) in order to check out the corresponding NHD data from the national production database for eventual update.

### C. Determining which HU10s and/or HU8s correspond to an update area

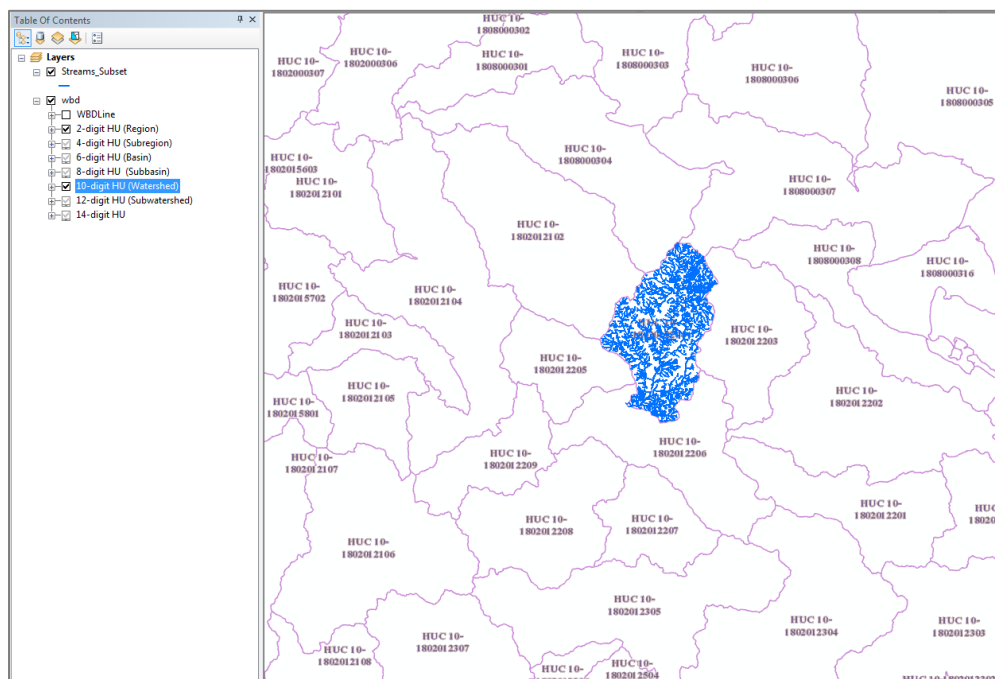
1. Notice that there are a number of other Hydrologic Boundary layers that are available within the map service which are currently grayed out/not visible in the TOC. Because these are cached images of features within a nested dataset, the features are only visible at pre-determined zoom levels/map scales.
2. In order to determine what map scale is required to see features within other specific layers, we can assess their properties. In the TOC, right click on the layer titled “10-digit HU (Watershed)” and select **Properties**. At the bottom of the Layer Properties window, the **Scale Range** information reveals the visibility thresholds for the HU10 layer.



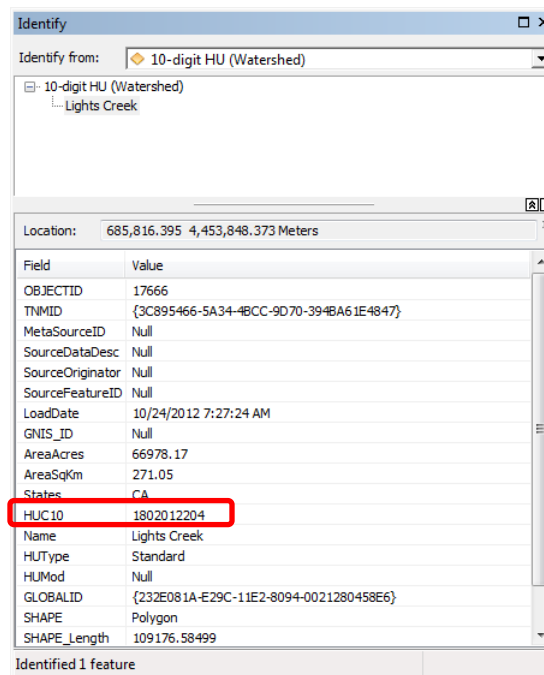
3. The parameter titled “In beyond: 1:433,343” tells us that we must be zoomed into a scale smaller than that on the map in order to see the features in that layer. With that information, we can now close the Layer Properties window and adjust our zoom level within the map.
4. In **Map Scale** on the **Standard** toolbar, paste **1: 450,000** (note 1:450.000 falls within the HU10 visibility thresholds of 1: 866,687 and 1: 433,343) and click **Enter** on the keyboard.

1:450,000

5. When that value is entered in the Map Scale, the map immediately zooms to that map scale, the HU12 features are no longer visible, and the HU10 features become visible in the map.



- Returning to the Identify tool, from the dropdown list we can now change the selection to “10-digit HU (Watershed)” and click the cursor on the HU10 feature underlying our Streams\_Subset dataset to see that our data largely encompasses the entire HU10 coded as “1802012204”.



- Considering the close match between the extent of the **Streams\_Subset** dataset and the extent for the underlying HU10 (i.e. 1802012204), it is likely that this HU10 will serve as the extent with which we can use to interact with the NHD production database at a later date (e.g., for checking data out from the NHD for updates). We check to confirm this potential match in Part 2 of the exercise.
- Notice that the HU10 value “1802012204” is consistently present in each of the 4 formerly identified HU12s underlying the Stream\_Subset dataset. This is due to the hierarchical nature of the WBD coding system. With that in mind, we also now know the HU8 which corresponds to our Streams\_Subset dataset – simply drop the last two digits off of the HU10 value to get the corresponding HU8 value of “**18020122**”. In Part 2 of the exercise we will use that information to access a static copy of the current NHD and WBD data to assess how the Streams\_Subset features relate to the existing NHD and WBD content.
- In the TOC, turn off the **wbd** catalog of content so that just the Streams\_Subset data remains visible. Zoom to the full extent of the Streams\_Subset layer and close any tool windows that are open.

## Part 2: Obtaining the related NHD and WBD content

When preparing new hydrography data for an NHD update, **stewards and editors need to consider all the existing core NHD content within their particular area of interest** (i.e. WBD extent). Even if users are only planning to update a particular component of the NHD (e.g. NHDFlowlines), the associated content within an Area of Interest (AOI) still needs to be considered to ensure that updated features

meet topologic criteria, as well as ensure that unaltered NHD content is not inadvertently deleted from the production database during the update process. As an example, where stewards or editors are only interested in updating the NHDFlowlines layer, they must also consider and account for the existing NHDArea, NHDLine, NHDPoint and NHDWaterbody content – **failure to do so could result in existing valid content being deleted from the NHD**. To this end, the US Geological Survey (USGS) provides regularly updated NHD/WBD content for download via a publicly accessible website. Once users know how their new hydrography data corresponds to the NHD/WBD they can then retrieve copies of the associated NHD/WBD data.

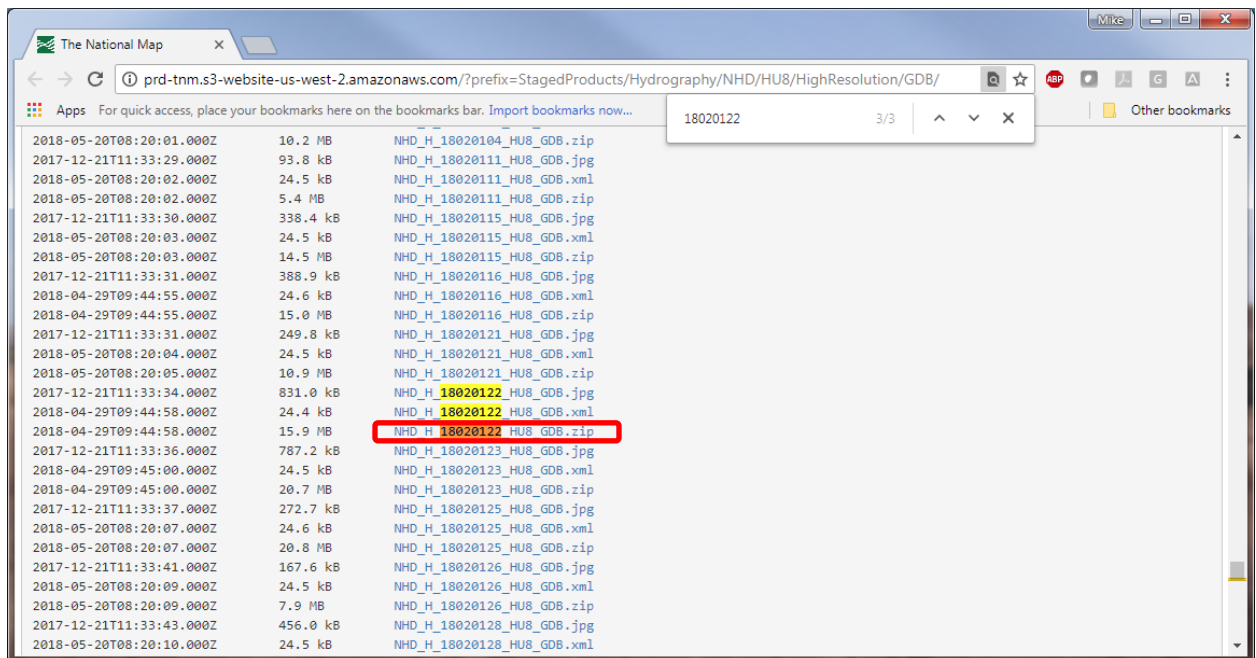
**Disclaimer:** *this part of the exercise has been written for users who do not undertake regular NHD Stewardship activities and likely would not have the requisite credentials for the USGS Hydrography Maintenance Portal or the USGS NHD Update Toolset. **IMPORTANT** - For any credentialed NHD Steward who references this exercise, this part of the exercise should be substituted with standard NHD transaction protocols, whereby production data is requested through the [training version of the Hydrography Maintenance Portal](#) and acquired via download with the NHD Update toolset. Those protocols are covered within the NHD Basics Training documentation available on the USGS Hydrography Data Community website or by contacting Joel Skalet within USGS Partner Support - <https://www.usgs.gov/staff-profiles/joel-j-skalet>. In addition to these resources, an overview of the process to be used by credentialed NHD Stewards or sub-stewards is provided within the exercise folder d **Appendix A**.*

## A. Download staged NHD data for the related HU8

1. In part one of the exercise we determined that the Streams\_Subset dataset corresponds to the 1802012204 HU10 watershed and its parent, the **18020122** HU8 subbasin. Using the HU8 information we can retrieve a current snapshot of that data from the USGS website. Open a web browser on the computer and paste the following link into the address bar – <http://prd-tnm.s3-website-us-west-2.amazonaws.com/?prefix=StagedProducts/Hydrography/NHD/HU8/HighResolution/GDB/>

**Note:** *The USGS makes copies of the NHD available for download at a variety of scales with HU8 information being the smallest of the available extents (as per this exercise). The data is also available for download by HU4, by State, and at National scale. All of the publicly available NHD related data products are discoverable at <https://nhd.usgs.gov/data.html>.*

2. Once on the USGS Staged Products Directory webpage, hold down the **Ctrl** button and hit the “F” key to open a search window in the browser window. Type “**18020122**” into the search box and hit **Enter**. The search should result in 3 results similar to what is shown below.

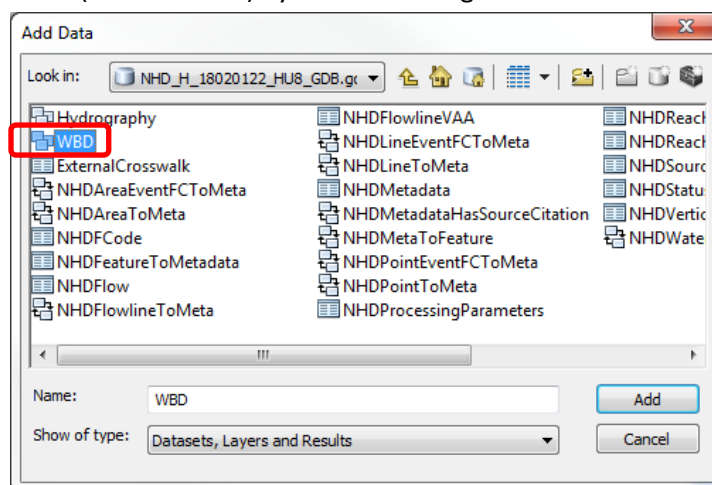


- Of the 3 results shown above, the bottom result with the “.zip” file extension is the one users will select for download and choose to save to their local machines. Once saved, the zipfile can then be **uncompressed** to a directory of the users choosing.

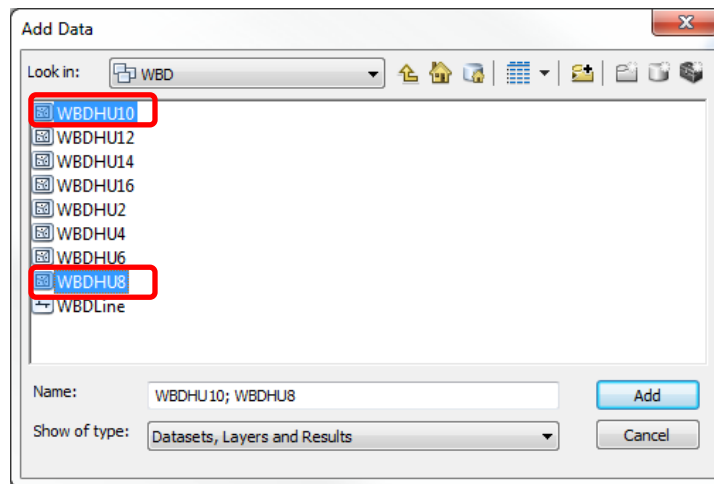
*Alternatively, if users are unable to download or save the information to their local machine, a copy of the file geodatabase has also been provided along with the data that has been provided for this exercise. The copy provided with this exercise is titled “NHD\_H\_18020122\_HU8\_GDB.gdb”*

## B. Add the HU8 and HU10 features to ArcMap

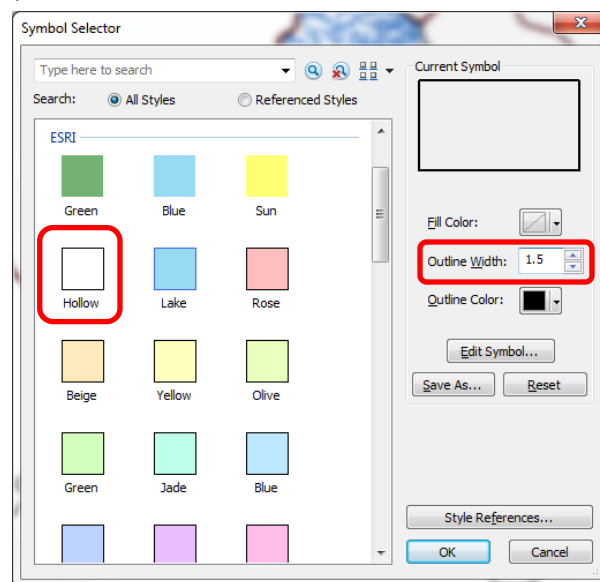
- In ArcMap, click the **Add Data** button and navigate to where you placed the uncompressed file geodatabase titled **NHD\_H\_18020122\_HU8\_GDB.gdb**. Within that geodatabase, open the WBD feature dataset (shown below) by double clicking **WBD**.



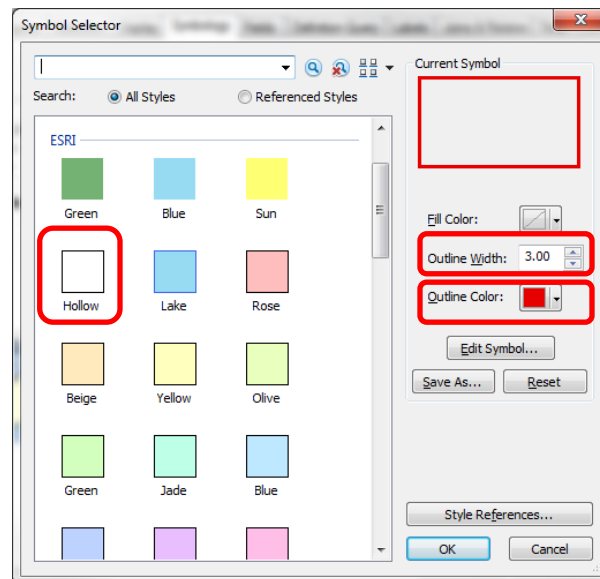
- Within the WBD feature dataset, while holding the **Ctrl** key, select **WBD10** and **WBD8**. Add the 2 selected datasets to the map.



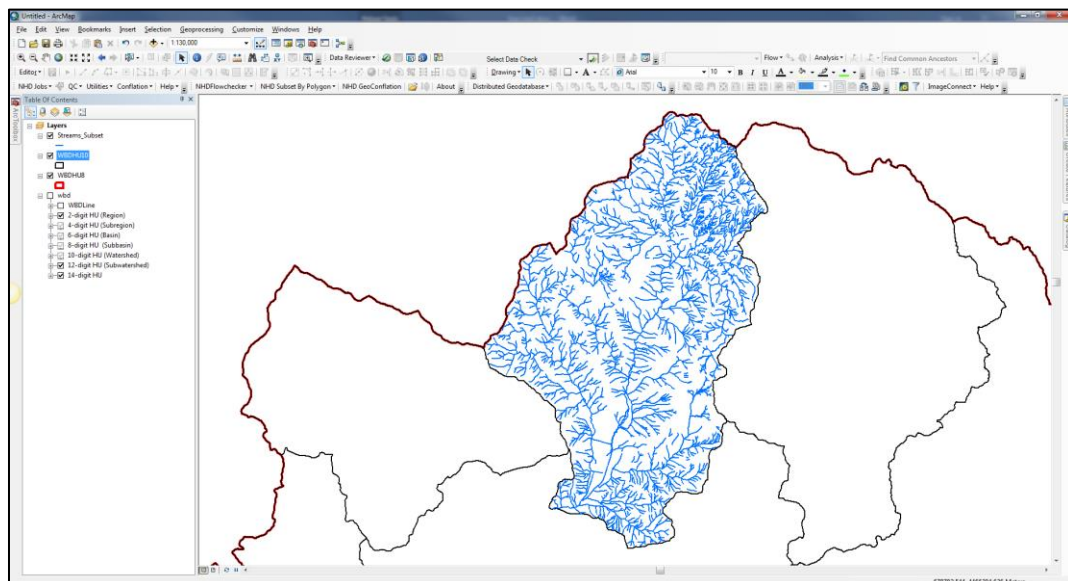
3. Right click on the **WBDHU10** layer in the TOC and select Properties.
4. In the Layer Properties dialog box, select the **Symbology** tab and confirm that features are being symbolized as **Features-Single Symbol**.
5. Next, click on the rectangle/polygon feature within the Layer Properties dialog box, choose the predefined Esri symbol titled **"Hollow"**, increase the **Outline Width to "1.5"**, and click **OK**.



6. Next, right click on the **WBDHU8** layer in the TOC and select Properties.
7. In the Layer Properties dialog box, select the **Symbology** tab and confirm that features are being symbolized as **Features-Single Symbol**.
8. Next, click on the rectangle/polygon feature within the Layer Properties dialog box, choose the predefined Esri symbol titled **"Hollow"**, increase the **Outline Width to "3"**, set the color to a shade of **Red**, and click **OK**.



9. Turn on the WBD10 and WBD8 layers in the TOC. The resulting map should now contain the Streams\_Subset layer shown in relation to the WBDHU10 and WBD8 and look similar to the example below.



10. At this map scale (approx. 1:130,000), users should be able to see that the features within the **Streams\_Subset** layer are largely confined to a single polygon within the HU10 boundaries. Similarly, if not more importantly, we can also see that the features within the **Streams\_Subset** layer are largely confined to the single HU8 polygon in the map. These visual checks confirm the 2 following things:

- i. The HU10 boundary containing the stream features (1802012204 as identified in Part 1 above) will serve as a comprehensive AOI polygon for users to select and compare any related NHD content against the new stream features.



- ii. The stream features are also contained by the larger HU8 boundary (18020122), so there is no need to download additional NHD catchments from the USGS website for an NHD update involving the **Streams\_Subset** dataset.

**Note:** It is not uncommon for features like headwater streams or terminal downstream segments to cross watershed boundaries **within** a HU8; nor is it uncommon for more significant features such as large waterbodies or major rivers to cross actual HU8 boundaries. Because NHD update transactions use the principle of intersection for extracting a subset for update, users just need to be aware that they are also responsible for the maintenance of any features that may intersect their AOI and flow in from a neighboring waterbody. Uncontained features are not a concern for this exercise, but something to be aware of since users may notice features that meet the above criteria occurring in the next part below.

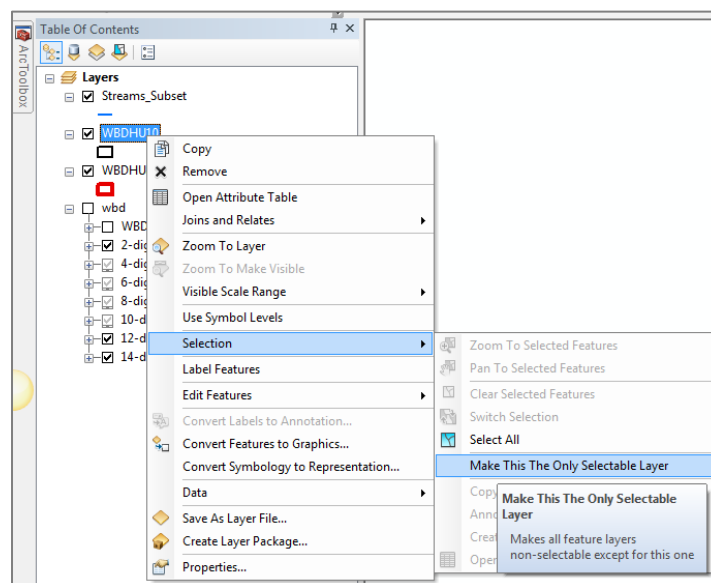
11. In the next/last part of this exercise, we will create a subset of the NHD that corresponds to the Streams\_Subset feature for subsequent use when assessing the stream data for NHD update potential.

## Part 3: Creating an NHD subset for later reference


When preparing new hydrography data for an NHD update, stewards and editors need to consider all of the existing core NHD content within an update area to ensure that new data meets topologic criteria with respect to existing NHD content, as well ensure that no unaltered NHD content gets inadvertently deleted. In this part of the exercise, users will identify the subset of NHD content particular to the HU10 and take copies of those features for later use in the overall update process.

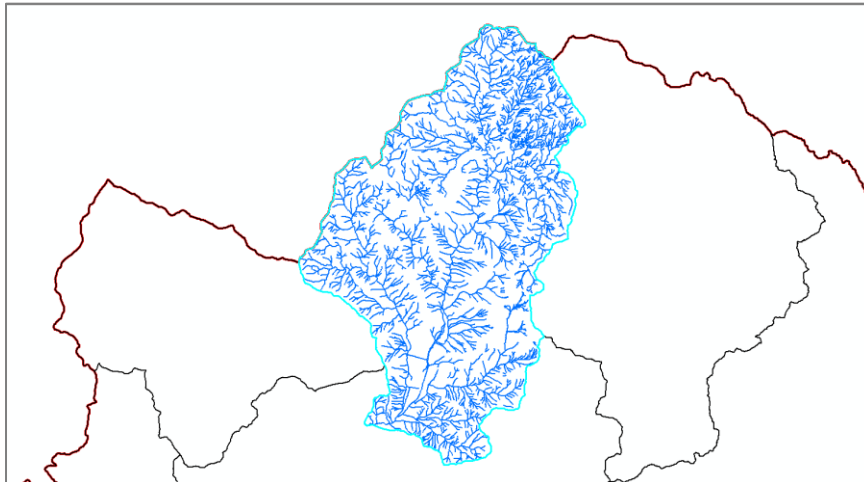
### A. Extract the area of interest polygon from the WBD

1. In the TOC, right click the **WBDHU10** layer, choose **Selection**, and then left click “**Make This the Only Selectable Layer**”.

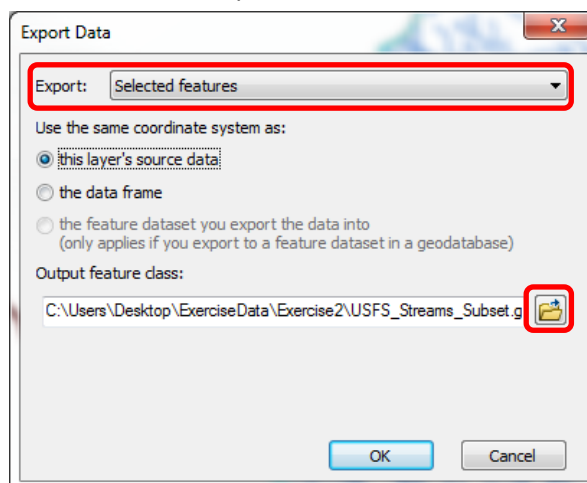




- Using the **Select Features** tool  on the **Tools** toolbar, left click once on the HU10 feature underlying the **Streams\_Subset** features. Once selected, the boundary of the HU10 polygon will appear light blue as shown below.

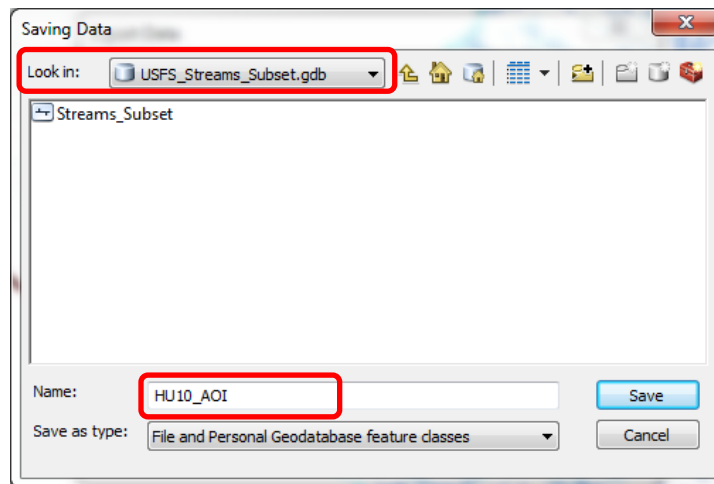


- In the TOC, right click on the **WBDHU10** layer, choose **Data**, and then left click “**Export Data**”. When the resulting Export Data window opens, ensure that “**Selected Features**” is the option shown on the dropdown menu at the top of the menu as shown below.

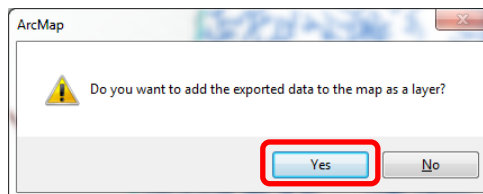


- Next, using the folder icon on the Export Data window, navigate to the **USFS\_Streams\_Subset** file geodatabase, choose to name the saved content as “**HU10\_AOI**”, click **Save** and then **OK**.

**Note:** You may need to change the **Save as Type** to “**File and Personal Geodatabase feature classes**” in order to see the **USFS\_Streams\_Subset.gdb** (see below image).



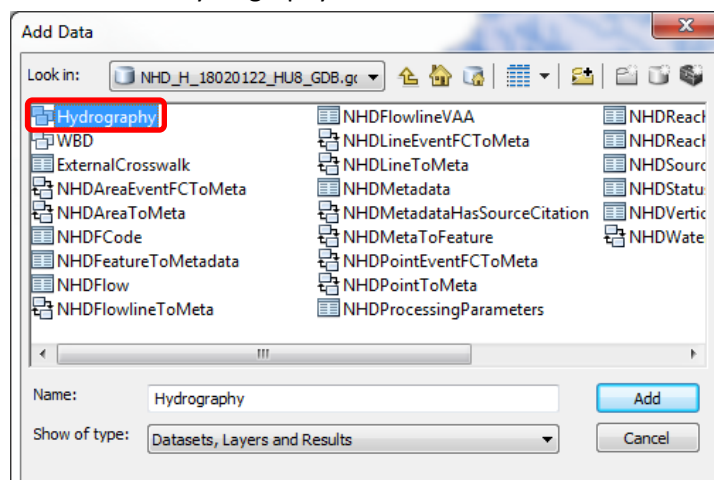
- Once saved, ArcMap will present a window asking the user whether or not to add the newly created layer to the map. Choose **Yes** so that the new HU10\_AOI feature is added to the map.



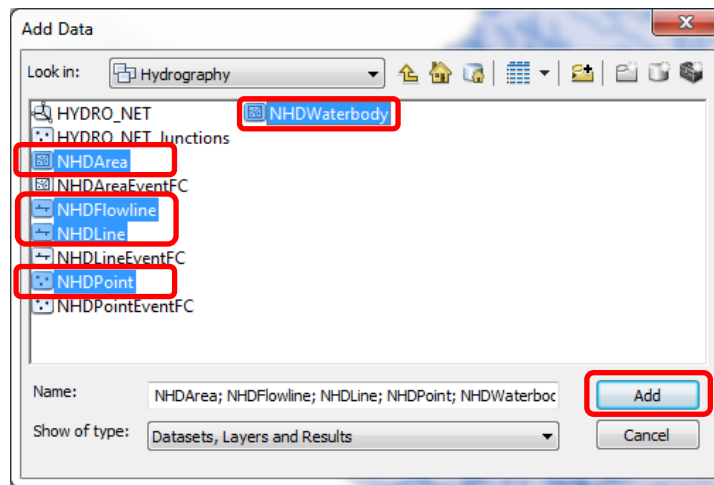
- Whatever symbology ArcMap assigns to the new HU10\_AOI layer when its added to the map document is okay – we’re only concerned with the features extent from this point forward in the exercise. At this point we now have an AOI polygon saved that that can be used to determine which features from the exiting NHD need to be extracted for comparison against the **Streams\_Subset** features.

## B. Extracting NHD content that is coincident with an update area or an area of interest

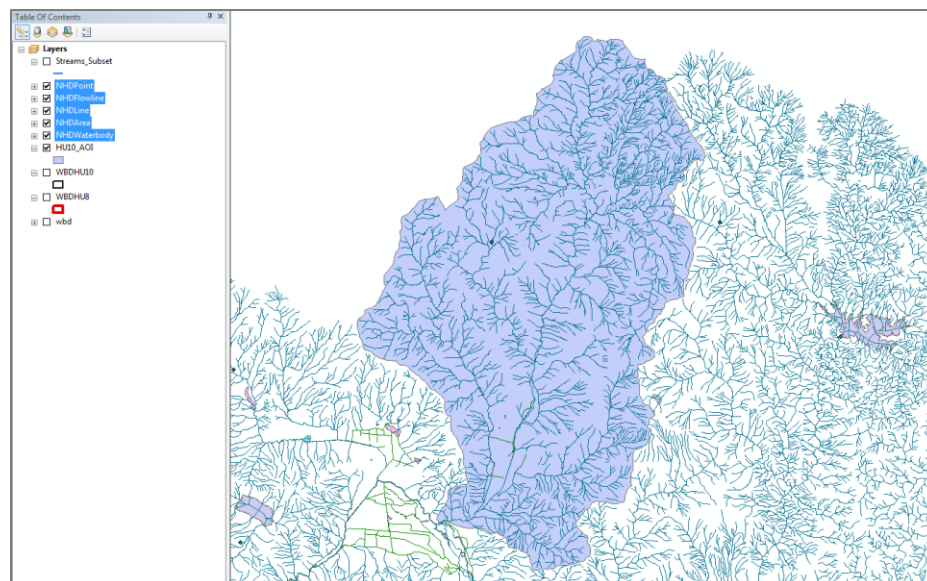
- In ArcMap, click the **Add Data** button and navigate to where you placed the uncompressed file geodatabase titled **NHD\_H\_18020122\_HU8\_GDB.gdb**. Within that geodatabase, open the NHD feature dataset named “Hydrography” as shown below.



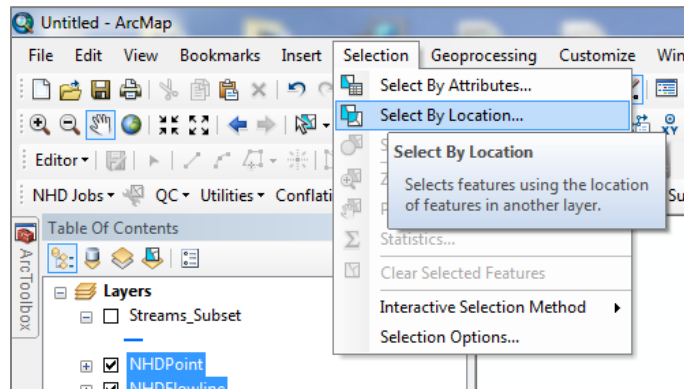
2. Within the NHD feature dataset, while holding the Ctrl key, select **NHDArea**, **NHDFlowline**, **NHDLine**, **NHDPoint**, and **NHDWaterbody**. Add the 5 selected datasets to the map.



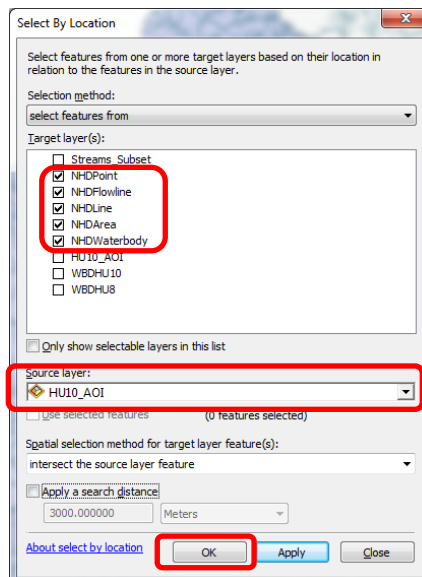
3. In the TOC, turn each of the newly added NHD layers on, however, compress each of the layers as shown below (click “-” symbol next to file name in TOC). Default map symbology is okay for each of the five NHD layers. Also, you may now turn off the **Streams\_Subset**, **WBDHU10**, and **WBDHU8** layers in the TOC.



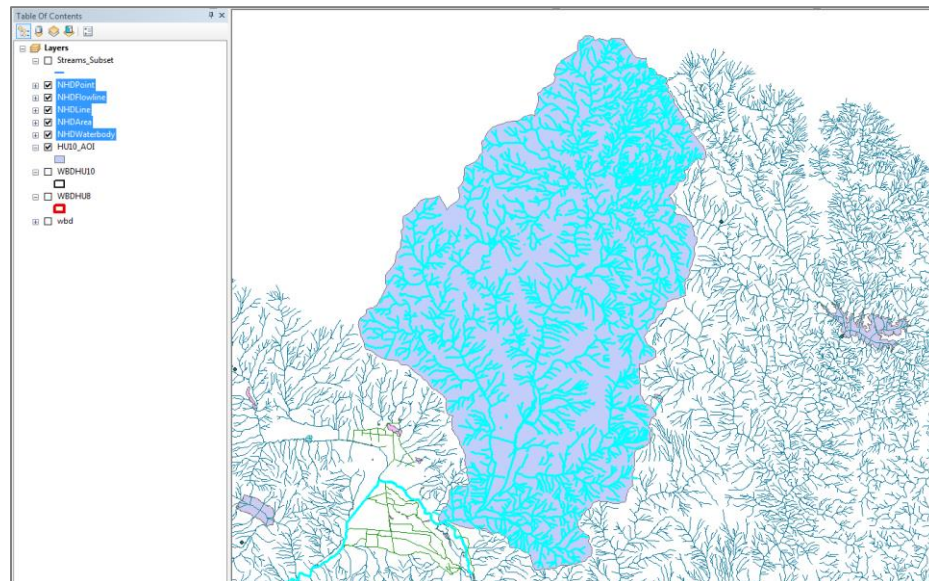
4. From the **Selection** menu at the top left of the ArcMap window, click **Select By Location**.



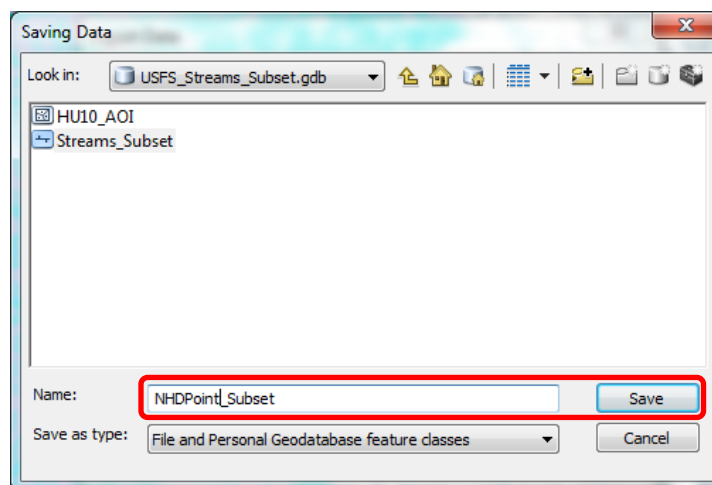
5. Within the **Select By Location** window, check the boxes next to the **NHDPoint**, **NHDFlowline**, **NHDLine**, **NHDArea**, and **NHDWaterbody** layers. From the Source layer dropdown menu, choose the **HU10\_AOI** layer. Click **OK** once your Select By Location window matches the below image.



6. The results of the select by location process will now be highlighted in the map document.



7. Each of the selected features in the map document are NHD features that the user will need to consider while preparing the Streams\_Subset layer for eventual NHD update. With this in mind, copies of these features will now be saved for later assessment.
8. In the TOC, right click on the NHDPoint layer, choose **Data**, and then left click “**Export Data**”. When the resulting Export Data window opens, ensure that “**Selected Features**” is the option shown on the dropdown menu at the top of the menu.
9. Using the folder icon on the Export Data window, navigate to the **USFS\_Streams\_Subset** file geodatabase, choose to name the saved content as “**NHDPoint\_subset**”, and click **Save**. Then click **OK** to export the data.

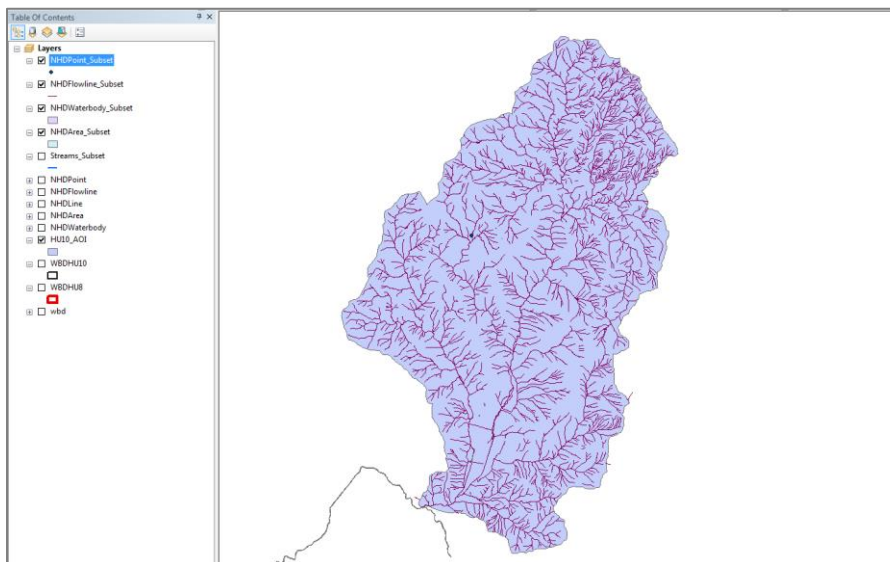


10. Click Yes when ArcMap asks whether you want to add the exported data to the map as a layer. The default symbology assigned to the newly added layer is okay and does not need to be modified at this point
11. All the previously selected features should still be highlighted in the map. If they are not, then the user will need to repeat the **Select By Location** described in step 5 above. With all of the formerly selected NHD content still highlighted in the map, users should repeat steps 8

through 10 above for each of the remaining NHD layers, except NHDLine (see note below). Assign each layer its original name followed by the suffix “\_Subset”.

**Note: users will not be able to export Selected Features from the NHDLine dataset in this exercise.** Since there happens to be no NHDLine content within this particular AOI, none of the NHDLine features are selected in the map. As a result, users do not need to create a new layer titled “NHDLine\_Subset” for this exercise.

12. When complete, users should have 4 newly added NHD\_Subset layers visible within the TOC. Turn each of the newly added subset layers on in the TOC and turn off all 5 of the original NHD layers. The resulting map should now look similar to the example below.



13. The features identified and saved as new datasets throughout this exercise can now serve to inform users how the **Streams\_Subset** layer needs to be further modified to bring into topologic conformity with NHD standard.
14. Users need not save the map at the conclusion of this exercise and may now close ArcMap without saving.

**Congratulations!** You have successfully completed this exercise and have been introduced to methods used for assessing how newly created hydrographic content relates to the existing NHD content. You have also learned how to capture related NHD content for subsequent assessment against NHD topologic requirements of data that will eventually be used to update the NHD.