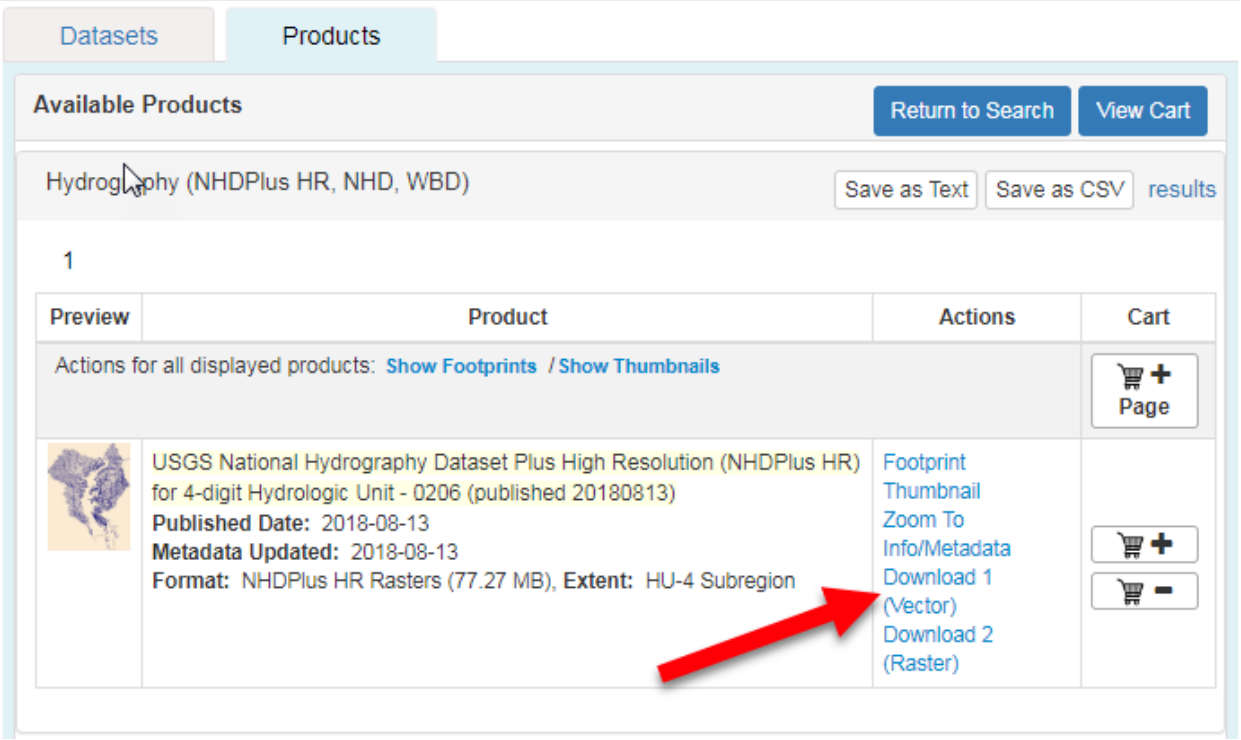
NHDPlus High Resolution Navigation Workshop Hands-on Exercise (Reduced ArcGIS Pro Version)

Getting Started

A. On your C: or D: Drive create a file pathway that contains a folder called NHDPlusHR_Workshop_0206

B. Obtain the 0206 GDB file from the National Map website: https://viewer.nationalmap.gov/basic/#productSearch
   a. Click on the **Advanced Search Options** and enter 0206
   b. Check the box: **NHDPlus High Resolution (NHDPlus HR) Beta**
   c. Click the **Find Products Box**
   d. Click on the **Download 1 (Vector)**
   e. Should download as NHDPLUS_H_0206_HU4_GDB.gdb



C. Open a new ArcGIS Pro Session and connect to the folder created earlier (NHDPlusHR_Workshop_0206)
   a. Within NHDPlusHR_Workshop_0206, create a new File Geodatabase (GDB) called Results.gdb

D. Secondary Data Location: http://prd-tnm.s3.amazonaws.com/index.html?prefix=StagedProducts/
    a. Hydrography/NHDPlusHR/Beta/GDB/NHDPLUS_H_0206_HU4_GDB.zip

Navigating with Network Attributes

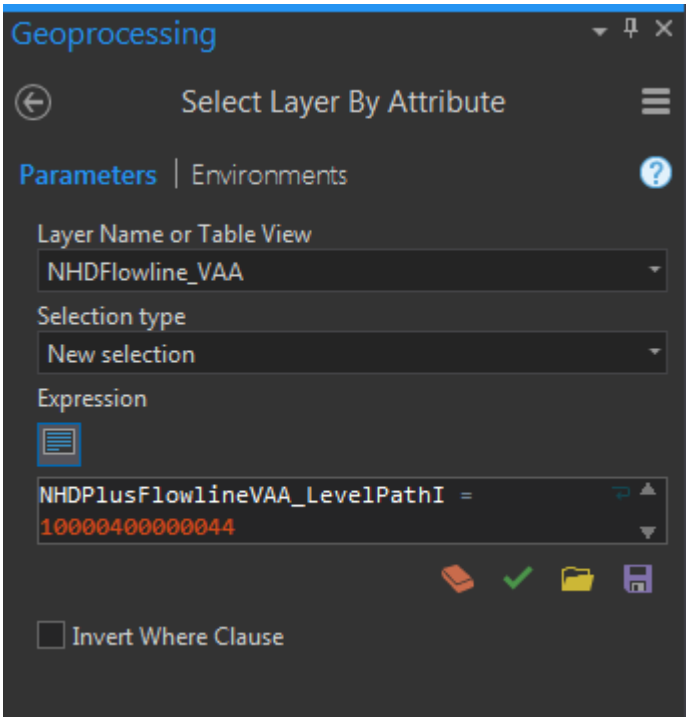
a. Navigating *Upstream Mainstem* is relatively easy.

    i. Open both the NHDFlowline layer and NHDPlusFlowlineVAA table located in the NHDPLUS_H_0206_HU4_GDB.gdb

    ii. Join the Tables based on NHDPlusID and **do NOT Keep all Records**
        1. Export Joined table to a new layer called NHDFlowline_VAA and save to Results.gdb

    iii. Open the NHDFlowline_VAA attribute table and inspect that the VAAs are now included along with the NHDFlowline attributes (LevelPathI, Hydroseq, DnLevelPat, DnMinorHyd, ect.).

    iv. Then select the LevelPathID of the Patuxent River (NHDPlusFlowlineVAA_LevelPathI=10000400000044). This will select 378 flowlines from where the Patuxent River discharges into the Chesapeake Bay to the top of this level path. This is an **Upstream Mainstem Navigation**.

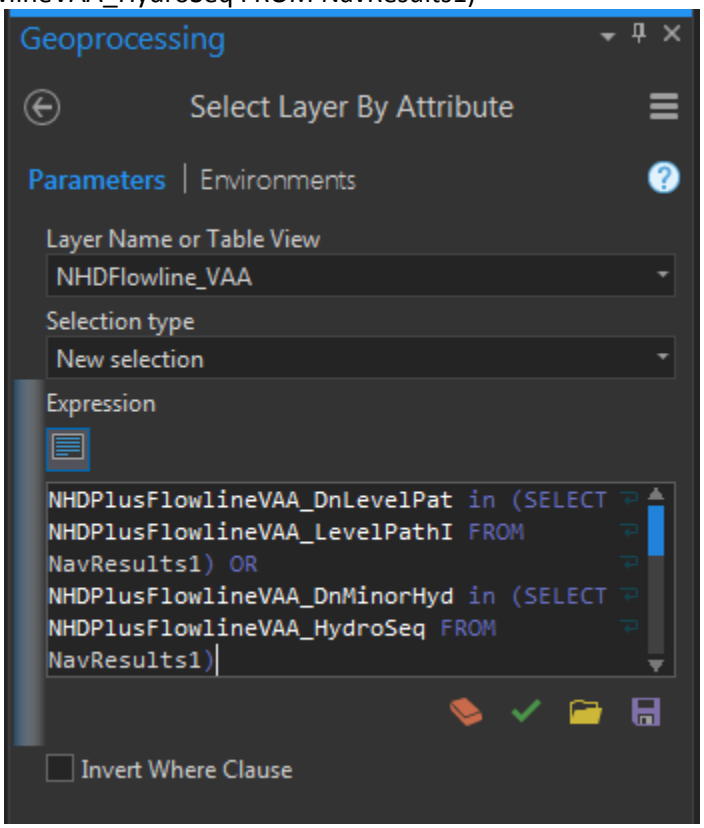


b. To navigate *Upstream with Tributaries* from the bottom of a level path is more complex and requires an iterative process.

i. Starting with the Mainstem navigation from above, Export the selected NHDFlowline_VAA (For the Patuxent River's LevelPathI = 10000400000044) to \NHDPlusHR_Workshop_0206\Results.gdb\NavResults1

ii. This iterative process involves performing a **Select By Attributes** query on the Joined NHDFlowline layer. Enter the following text in the **Select By Attributes** dialog:

iii. NHDPlusFlowlineVAA_DnLevelPat in (SELECT NHDPlusFlowlineVAA_LevelPathI FROM NavResults1) OR NHDPlusFlowlineVAA_DnMinorHyd in (SELECT NHDPlusFlowlineVAA_HydroSeq FROM NavResults1)



This selection statement above involves a SQL sub-query, which only works on geodatabase feature classes. This code will *not* work on shapefiles.

The query is looking for any records from NHDFlowline_VAA whose "DnLevelPat" value is also located in the "LevelPathI" field in the NavResults feature class, OR any records from NHDFlowline_VAA whose "DnMinorHyd" value is also located in the "Hydroseq" field from NavResults1.

Basically, since NavResults1 is the mainstem of the Patuxent River, this Select By Attributes query is looking for any tributaries in NHDFlowline that flow into that mainstem.

c. Compare the number of selected records in NHDFlowline_VAA to the number of records in NavResults<m>. *Note: the first time through this procedure substitute 1 for <m>, then next time through this procedure substitute 2 for <m>, then 3 and so on.*

    i. If the number of selected records in NHDFlowline_VAA is less than or equal to the number of records in NavResults<m>, then the process ends because all of the waters have been found that flow into flowlines that have already been navigated.

    ii. If the number of selected records in NHDFlowline_VAA is greater than the number of records in NavResults<m>, then the Upstream with Tributaries navigation is still finding new waters that into flowlines that have already been navigated.

    iii. Each time this selection query is run, Export the selected NHDFlowline records to a new geospatial feature class called: \NHDPlusHR_Workshop_0206\Results.gdb\NavResults<m+1>

    iv. So the file name should be NavResults2 the first time through this step, then NavResults3 next time, etc.

    v. When prompted, add NavResults<m+1> to the map.

d. Increment the value of m by 1, substitute m's new value for <m> in the query below. Cut and paste the query into a new **Select by Attributes** from NHDFlowline_VAA.

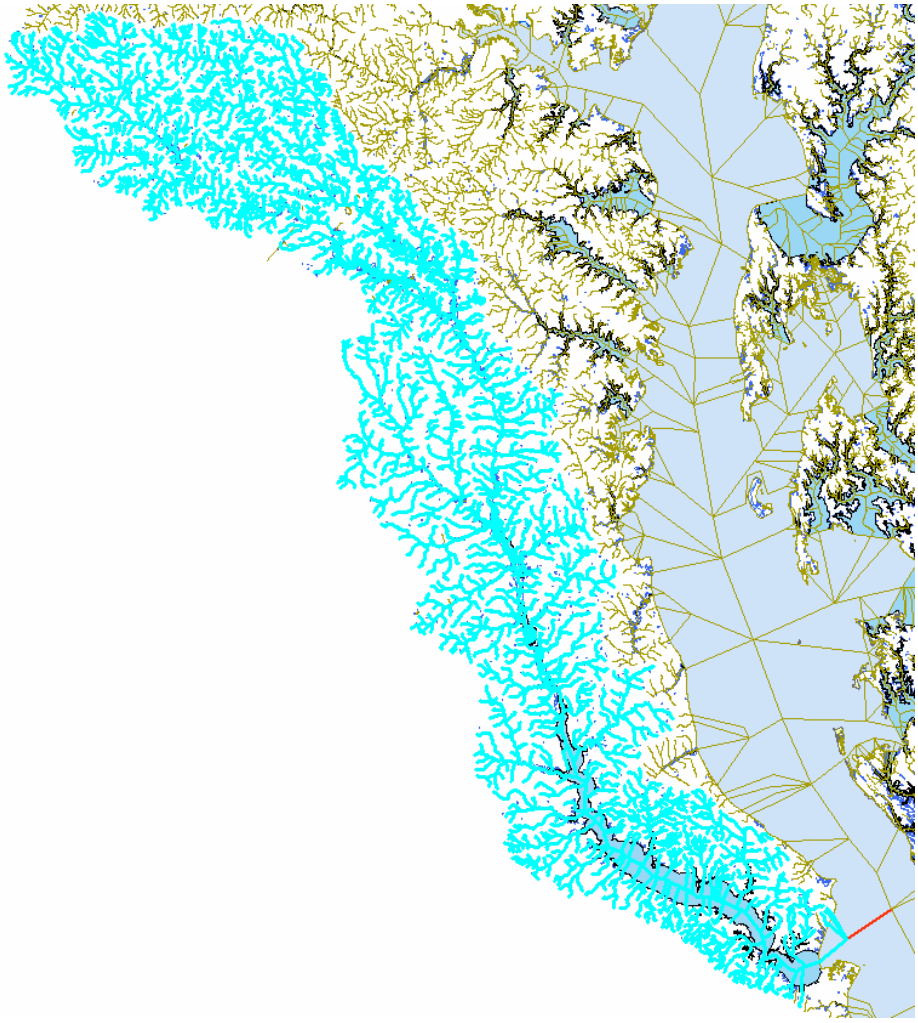
    i. NHDPlusFlowlineVAA_DnLevelPat in (SELECT NHDPlusFlowlineVAA_LevelPathI FROM NavResults<m>) OR NHDPlusFlowlineVAA_DnMinorHyd in (SELECT NHDPlusFlowlineVAA_HydroSeq FROM NavResults<m>)

    ii. The query is looking for any records from NHDFlowline_VAA whose "DnLevelPat" value is also located in the "LevelPathI" field in the NavResults<m> feature class, OR any records from NHDFlowline_VAA whose "DnMinorHyd" value is also located in the "Hydroseq" field from NavResults<m>.

    iii. Basically, each time the Select By Attributes is performed, another level of tributaries is added to the select. We started with the Patuxent River main stem, then added the tributaries to the Patuxent, and then added the tributaries to the tributaries, and so on until we reach the top of the network that drains into the Patuxent River.

    iv. After the query is executed, go to Step c and repeat steps c and d.

e. The final result of this *Upstream with Tributaries* navigation looks like this:



Optional: Rename Map *Upstream Navigation*

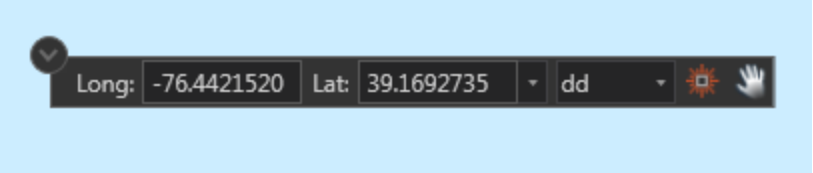
There is an NHDPlus desktop tool that performs all of these VAA navigations from an ArcMap toolbar. This navigation performs point-to-point navigations and has many options. The tool is callable from Python. The High Resolution NHDPlus VAA Navigator is available on the NHDPlus HR website.

Find all the tributaries in the Patapsco River

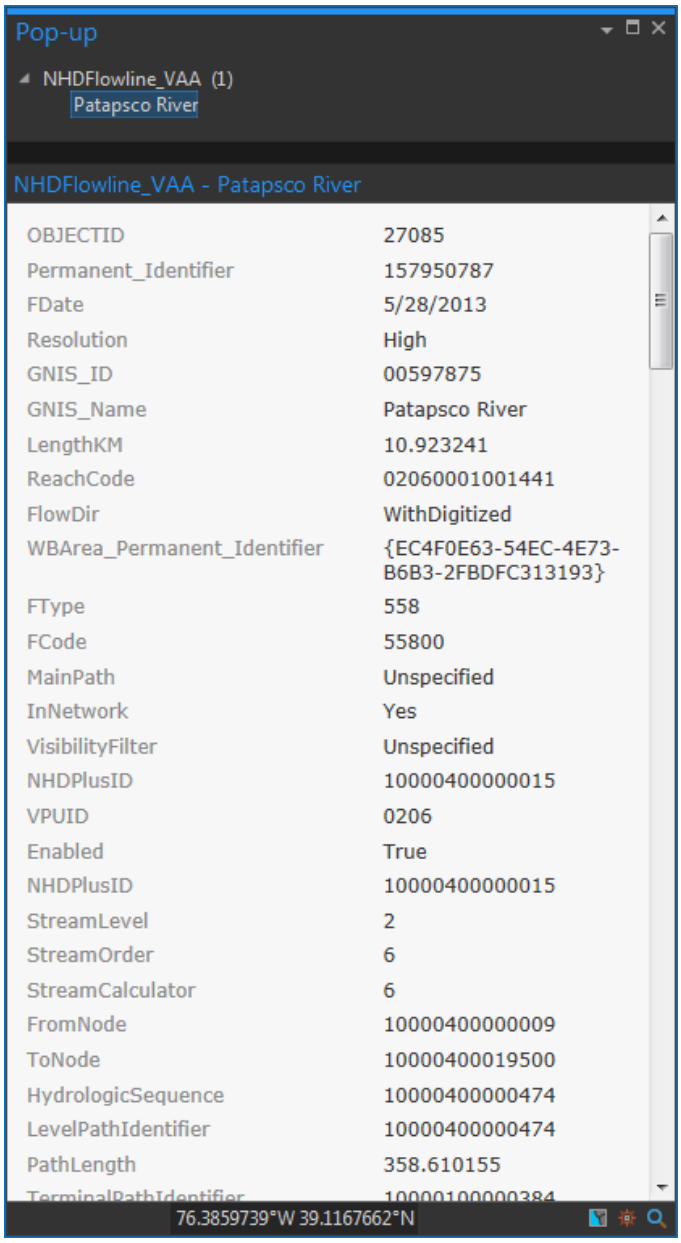
a. In the Catalog sidebar create a new map and name it *Find Tributaries* and add the layer NHDFlowline_VAA from the previous section.

b. Use the **Go To XY** tool on the ArcMap toolbar and zoom to the coordinates pictured below. This is the mouth of the Patapsco River.

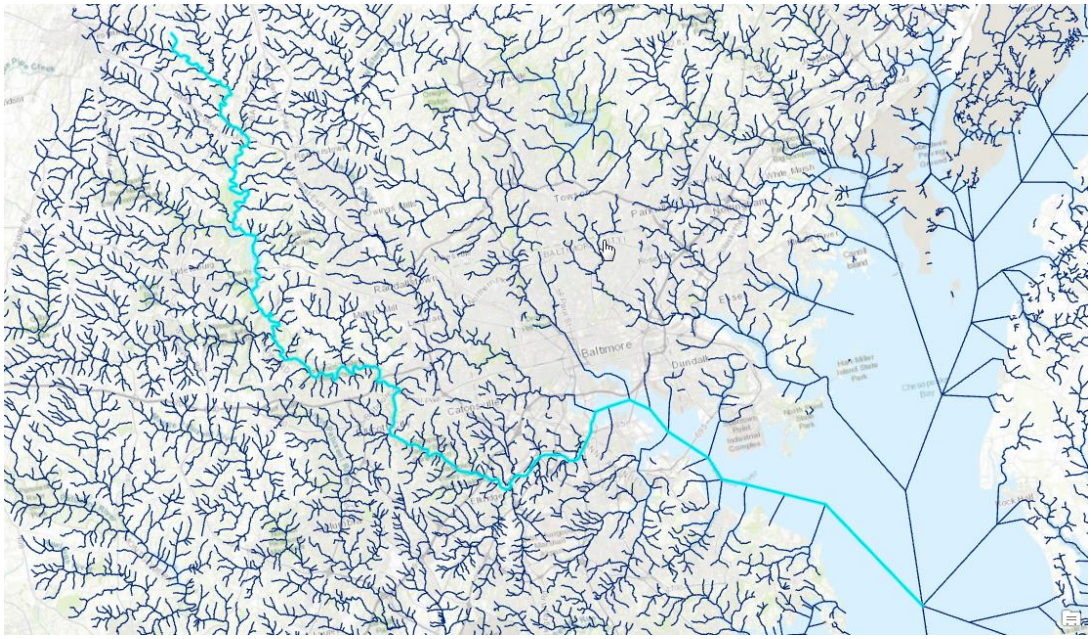
Long: -76.4421520 **Lat:** 39.1692735 **Type:** dd



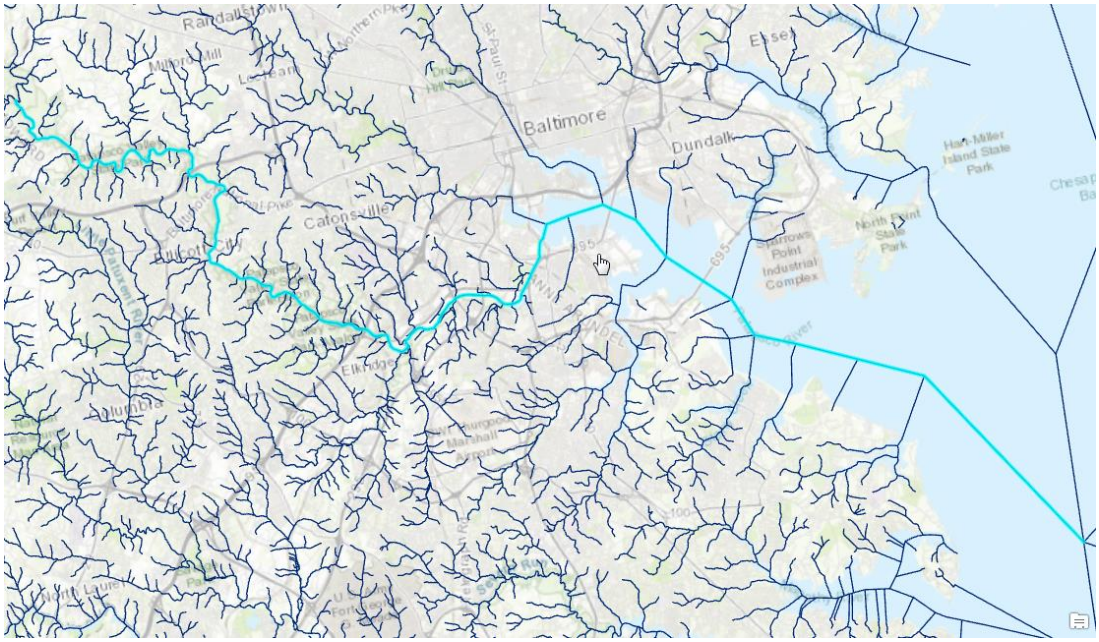
c. Use the **Identify** tool to display the NHDFlowline_VAA attributes for the most downstream flowline. Note that the LevelPathIdentifier is 10000400000474. This is a unique ID that defines the main path from the mouth of the Papapsco River to the main headwater flowline.



d. To see the entire water course, from the mouth of the Patapsco River to the main headwater, do a select NHDPlusFlowlineVAA_LevelPathI = 10000400000474 and zoom to selected.



e. To see the entire Patapsco River, do a select NHDPlusFlowlineVAA_LevelPathI = 10000400000474 AND NHDFlowline_GNIS_ID = '00597875'. **Zoom to Selected**.



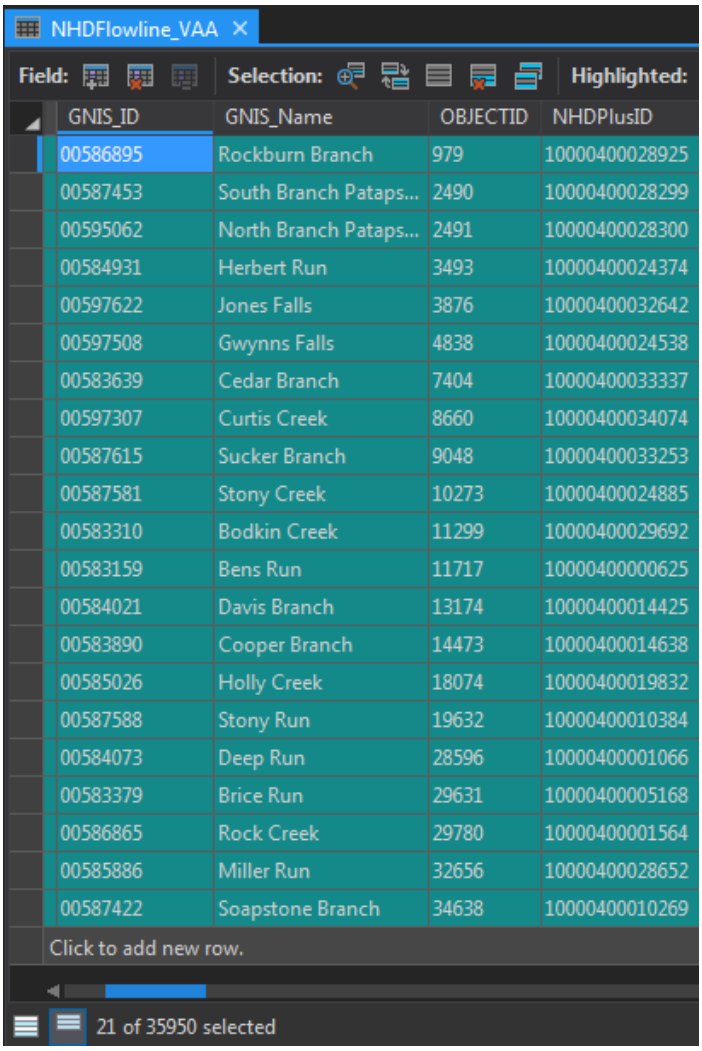
f. Note that when zooming to a named stream it's always best to use the GNIS_ID rather than the GNIS_Name. This is because the GNIS_ID is a unique identifier for the named feature and if there are multiple streams with the same name (e.g. Mill Creek is a very popular name), each named stream has a unique GNIS_ID.

g. Find the tributaries to the Patapsco River: Open the NHDFlowline attribute table, and display the selected records. Sort ascending on Hydrologic Sequence (Hydroseq). Record the minimum and maximum Hydrologic Sequence of the Patapsco- 10000400000474 and 10000400001357.

h. To find the tributaries, perform a selection as follows:

NHDPlusFlowlineVAA_DnLevelPat = 10000400000474 And NHDPlusFlowlineVAA_DnHydroSeq >= 10000400000474 And NHDPlusFlowlineVAA_DnLevelPat = 10000400000474 And NHDPlusFlowlineVAA_DnHydroSeq <= 10000400001357 And NHDFlowline_GNIS_ID <> '00597875'

i. In English, this statement says, select any NHDFlowline features whose immediate downstream flowline is the Patapsco River and whose downstream hydroseq is greater than or equal to the minimum hydroseq on the Patapsco and whose downstream hydroseq is less than or equal to the maximum hydroseq on the Patapsco and which is not the Patapsco itself.



GNIS_ID	GNIS_Name	OBJECTID	NHDPlusID
00586895	Rockburn Branch	979	10000400028925
00587453	South Branch Pataps...	2490	10000400028299
00595062	North Branch Pataps...	2491	10000400028300
00584931	Herbert Run	3493	10000400024374
00597622	Jones Falls	3876	10000400032642
00597508	Gwynns Falls	4838	10000400024538
00583639	Cedar Branch	7404	10000400033337
00597307	Curtis Creek	8660	10000400034074
00587615	Sucker Branch	9048	10000400033253
00587581	Stony Creek	10273	10000400024885
00583310	Bodkin Creek	11299	10000400029692
00583159	Bens Run	11717	10000400000625
00584021	Davis Branch	13174	10000400014425
00583890	Cooper Branch	14473	10000400014638
00585026	Holly Creek	18074	10000400019832
00587588	Stony Run	19632	10000400010384
00584073	Deep Run	28596	10000400001066
00583379	Brice Run	29631	10000400005168
00586865	Rock Creek	29780	10000400001564
00585886	Miller Run	32656	10000400028652
00587422	Soapstone Branch	34638	10000400010269

j. And we find that there are 21 (Named) tributaries to the Patapsco River in High Resolution NHDPlus.

k. **Bonus:** The above process only finds the tributaries that are named GNIS features. It is possible to find the remaining tributary features by using the **Add to Current Selection** function and Query:

   NHDPlusFlowlineVAA_DnLevelPat = 10000400000474 AND NHDFlowline_GNIS_ID IS NULL

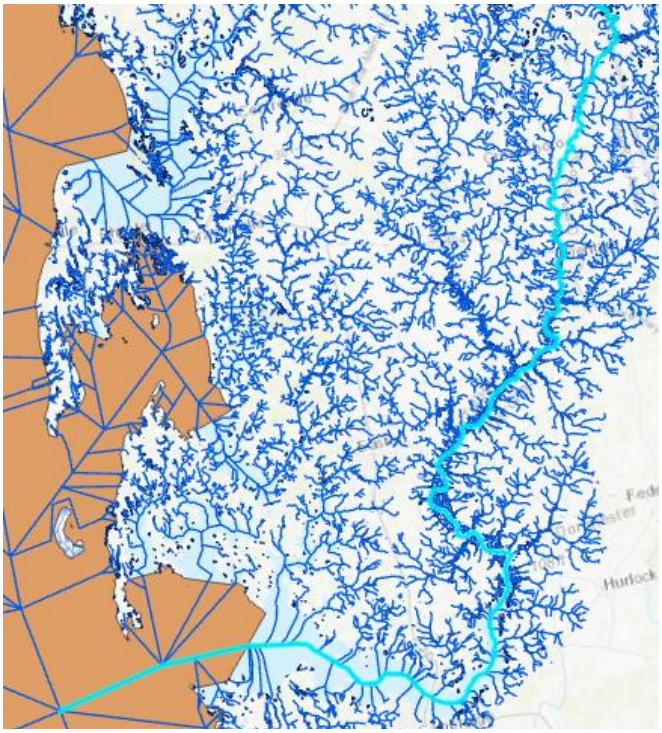
   This will add 85 more tributaries to the Patapsco River in NHDPlus HR for a total of 106.

How Many Lakes are along the Choptank River? How far are the lakes from the mouth of the Choptank River? How far apart are the lakes from each other?

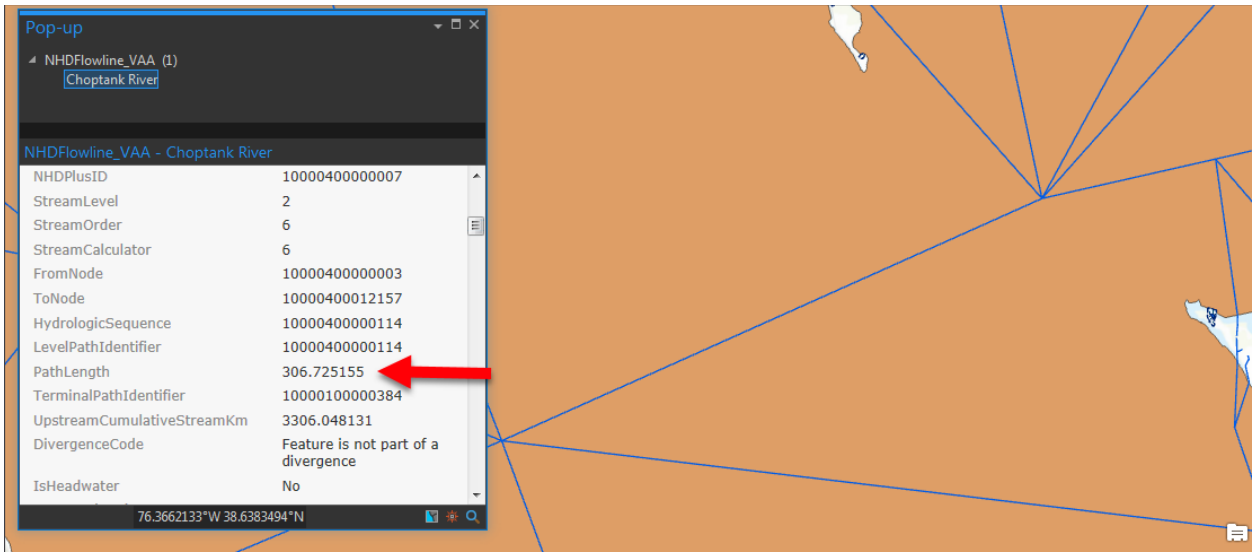
Let's find out.

a. Create a new map named *Find Lakes* and add NHDFlowline_VAA and NHDWatebody layers to the map

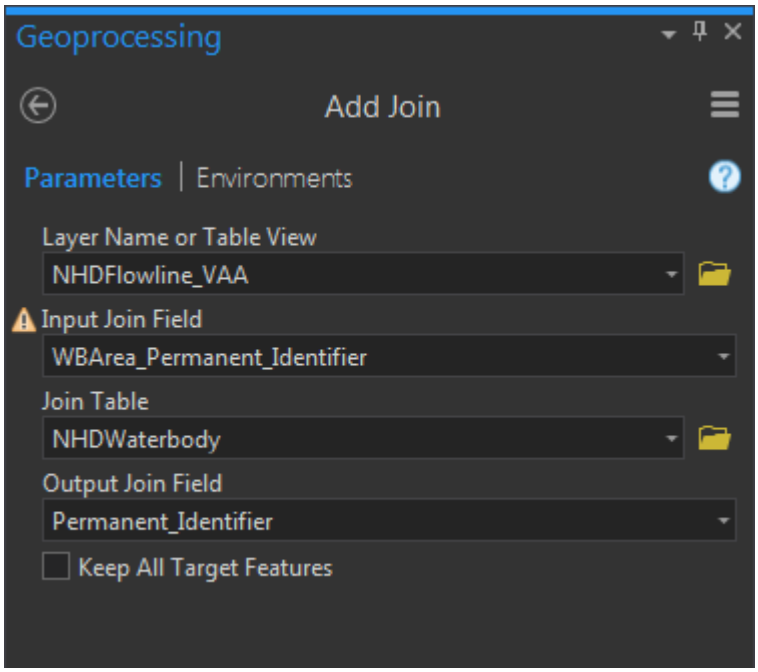
b. Find the Choptank River by opening the NHDFlowline_VAA attribute table and select: NHDPlusFlowlineVAA_LevelPathI = 10000400000114 AND NHDFlowline_GNIS_ID = '00213797'. Zoom to selected.



c. Zoom in to the mouth of the Choptank River and do an **Identify** on the most downstream flowline. Make note of the PathLength (306.725155). This is the distance from the mouth of the Choptank and to the bottom of the **Chesapeake Bay.**



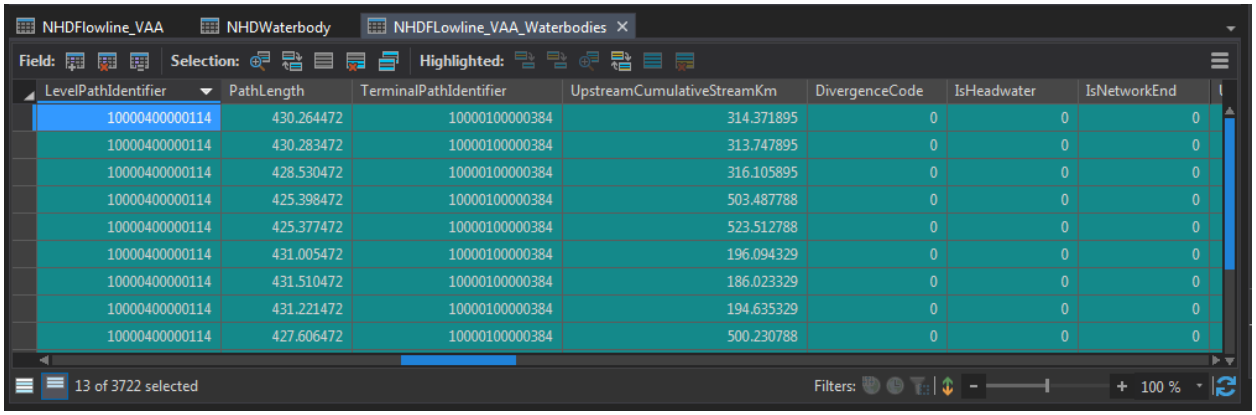
d. To find the lakes on the Choptank River, start with **joining** NHDFlowline_VAA with NHDWaterbody based on the following:



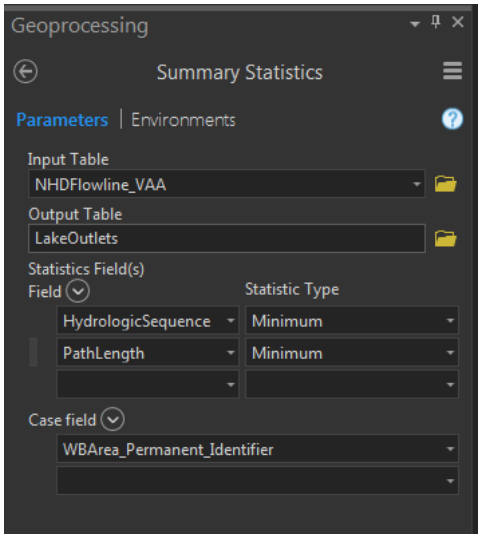
Export the joined layer to the Result.gdb folder and name it NHDFlowline_VAA_Waterbodies. Remove join from NHDFlowline_VAA

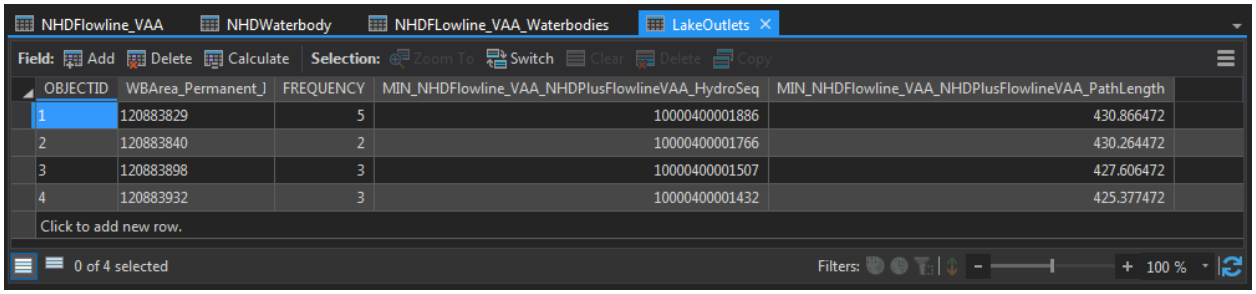
e. Make a selection from NHDFlowline_VAA_Waterbody using:
NHDFlowline_VAA_NHDFlowline_GNIS_ID = '00213797' And
NHDFlowline_VAA_NHDPlusFlowlineVAA_LevelPathI = 10000400000114 And
NHDWaterbody_FType = 390

f. There are 13 NHDFlowlines inside lake features along the Choptank.



g. Determine the lake outlets. Right click on the NHDFlowline_VAA table WBArea_Permanent_Identifier and **Summarize** computing minimum Hydroseq, minimum Pathlength, and WBArea_Perminant_Identifier as the Case field creating a table… \NHDPlusHR_Workshop_0206\Results.gdb**LakeOutlets**.

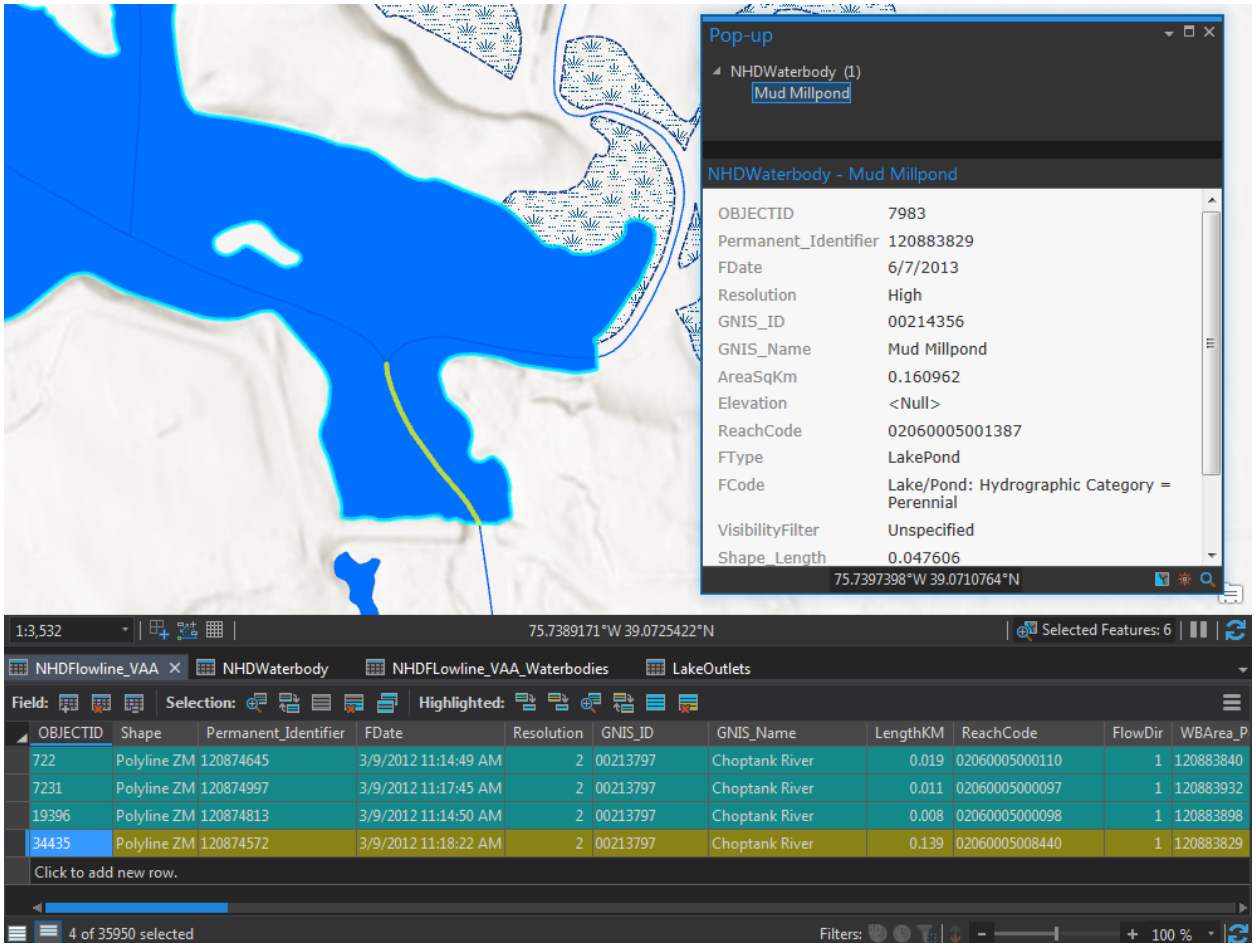




h. There are 4 lakes on the Choptank River. Each lake's outlet is the NHDFlowline that has the Hydroseq value in the Minimum_Hydroseq column.

i. Open LakeOutlets table. From **Table Options, Joins and Relates** -> **Relate,** relate LakeOutlets. Min_HydroSeq to NHDFlowline_VAA HydrologicSequence. Assign a name to the Relate if you wish. Select all LakeOutlet records and execute the Relate. Highlight the last selected

NHDFlowline and **Zoom to Highlighted.** Perform an **Identify** on the lake. This is the outlet of the lake.



j. For LakeOutlets, **Table Options, Add Field ->** RiverKM double. Right click on RiverKM and use the **Field Calculator** set it to (Minimum_Pathlength - 306.725155).

PathLength is the distance from the bottom of the NHDFlowline feature to the network terminus and, in this case, the bottom of the Chesapeake Bay. Remember from above that 306.725155 is the PathLength for the mouth of the Choptank River. Therefore, RiverKM now contains the distance of the mouth of the Choptank for each of the 4 lakes. And, of course, by subtracting any two values in this column, we know how far apart the outlets of the lakes are from each other.