Building a Hydrologic Base Map

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Goals of the Exercise

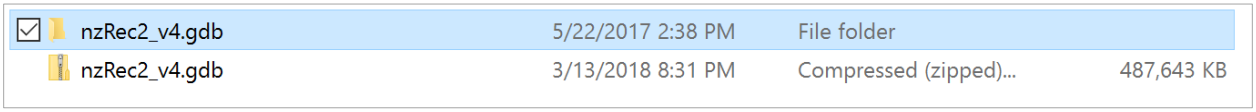
This exercise shows how to develop a hydrologic base map for a catchment showing the catchment boundary and the rivers and streams within it. This is done in two ways – for the Rakaia river in Canterbury using the NZ Digital River Network, and for the Puriri river catchment in Papua-New Guinea using ArcGIS Online ready to use Hydro Services.

Computer and Data Requirements

To carry out this exercise, you need to have a computer, which runs ArcGIS Desktop version 10.5. This exercise will also work with version 10.4.1 if you do not have access to Version 10.5. You will need a login and password for the University of Canterbury Organizational Account for ArcGIS Online.

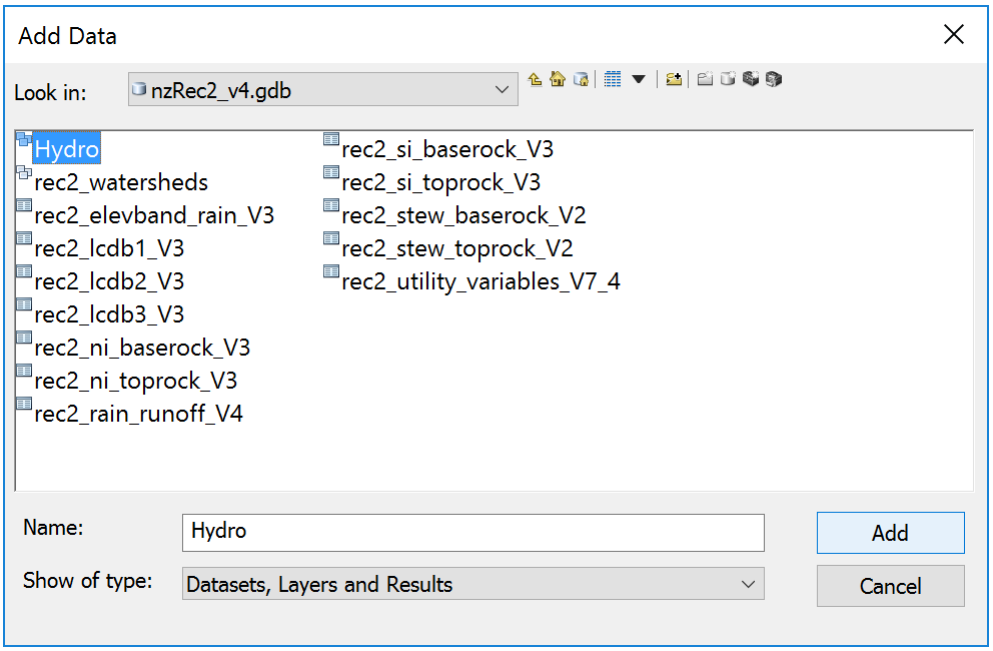
Part One: Basemap using the NZ Digital River Network

Check out information about the New Zealand Digital River Network, or REC (River Environment Classification) at https://www.niwa.co.nz/freshwater-and-estuaries/management-tools/river-environment-classification-0 You can download a copy of the dataset for all of New Zealand at: https://www.niwa.co.nz/static/web/nzRec2_v4.gdb.zip This is a 487 MB file, so you need a good Wifi connection or wired internet connection to do this. When you uncompress this file, it looks like this

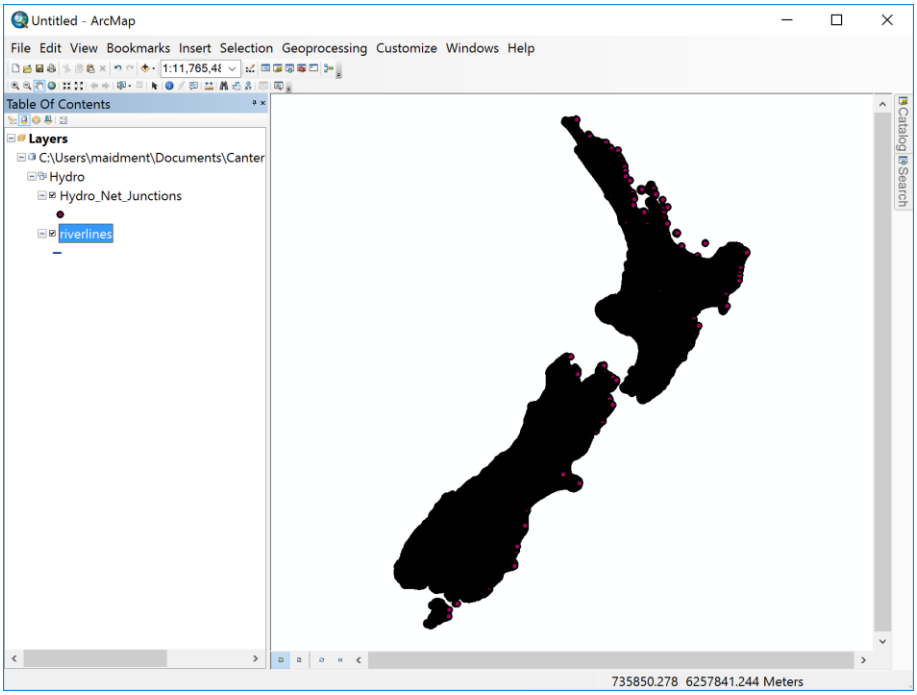


The **nzRec2_V4.gdb** is a 2.2 GB geodatabase covering all of New Zealand.

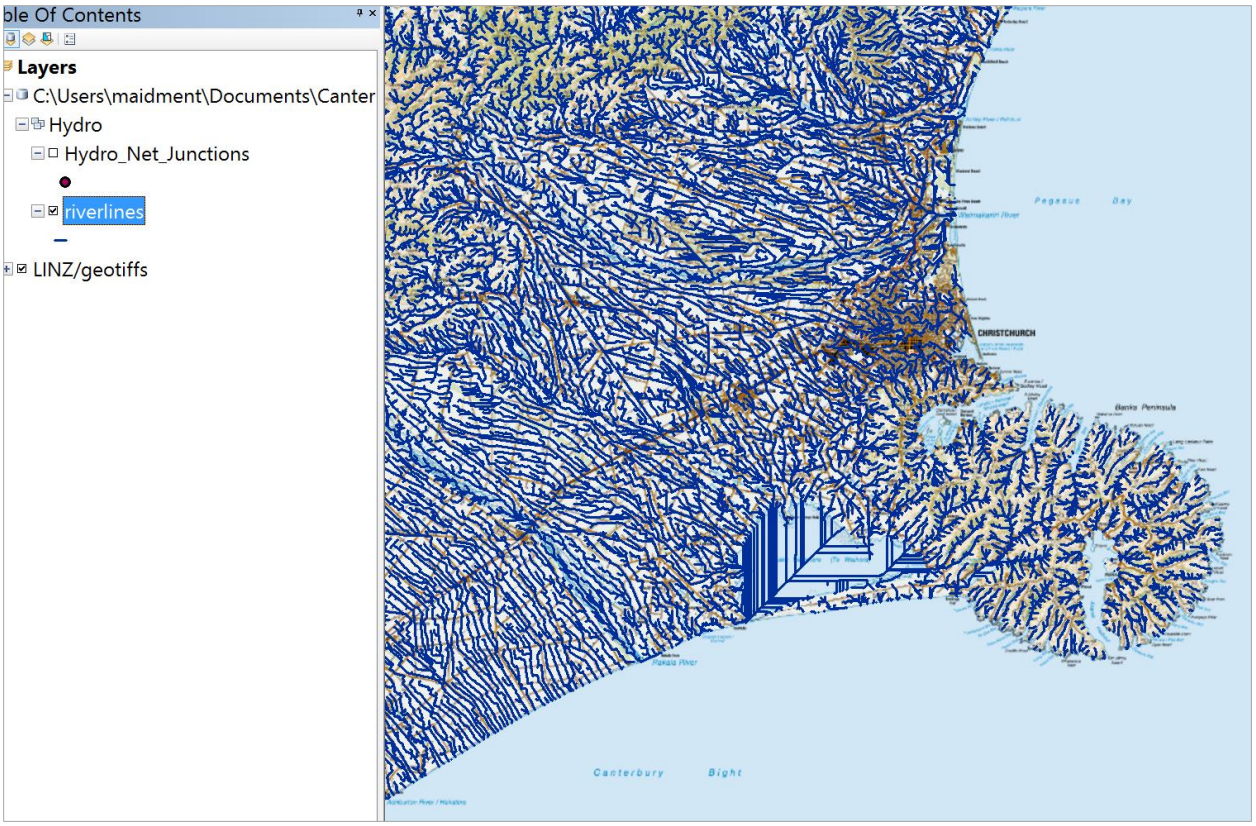
If you have the full REC database and you open ArcMap and look at the REC Geodatabase, below is what you see. The key items are the two Feature Datasets called **Hydro** and **rec2-watersheds** The other items shown are related attribute tables dealing with details of the REC classication of New Zealand Rivers that we are not going to get too much into in this class.



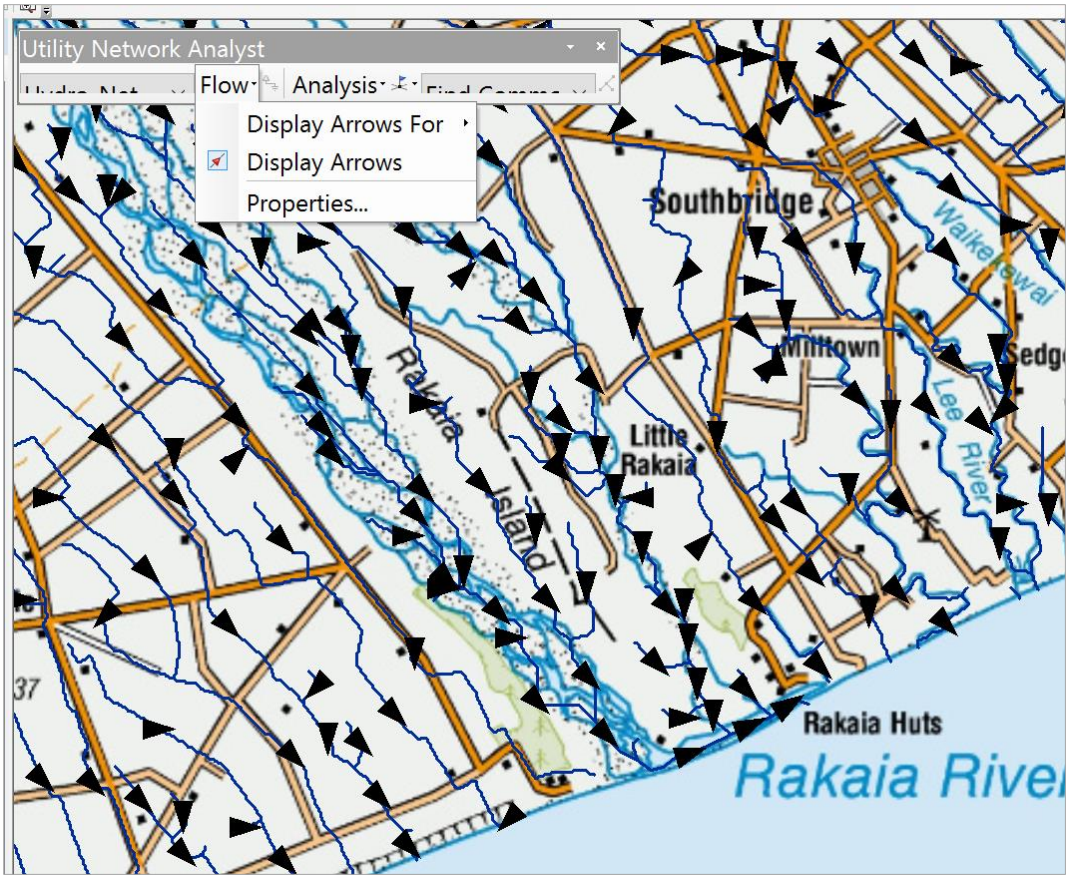
Click on the **Hydro** Feature Dataset and add it to the map display, and you'll see a detailed layout of all of New Zealand.



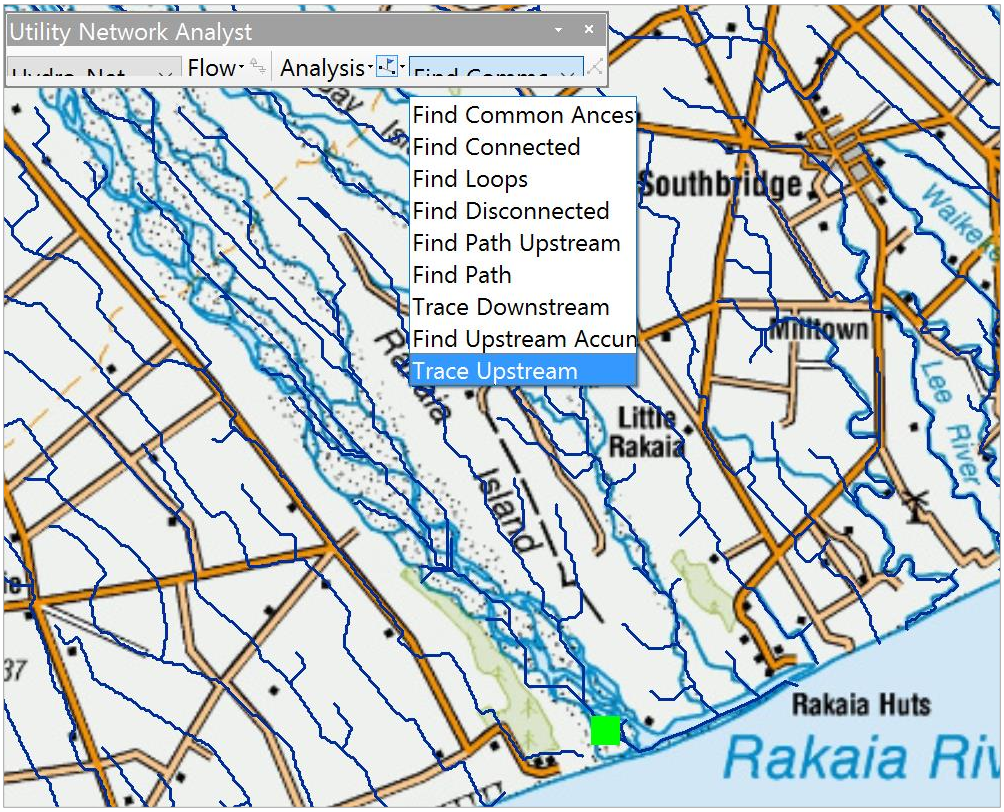
Let's zoom into Christchurch and see what is there. Turn off the **Hydro_Net_Junctions** layer and add the **NZ Topographic** basemap (scroll down in the Basemap layer display if all you see are world maps).



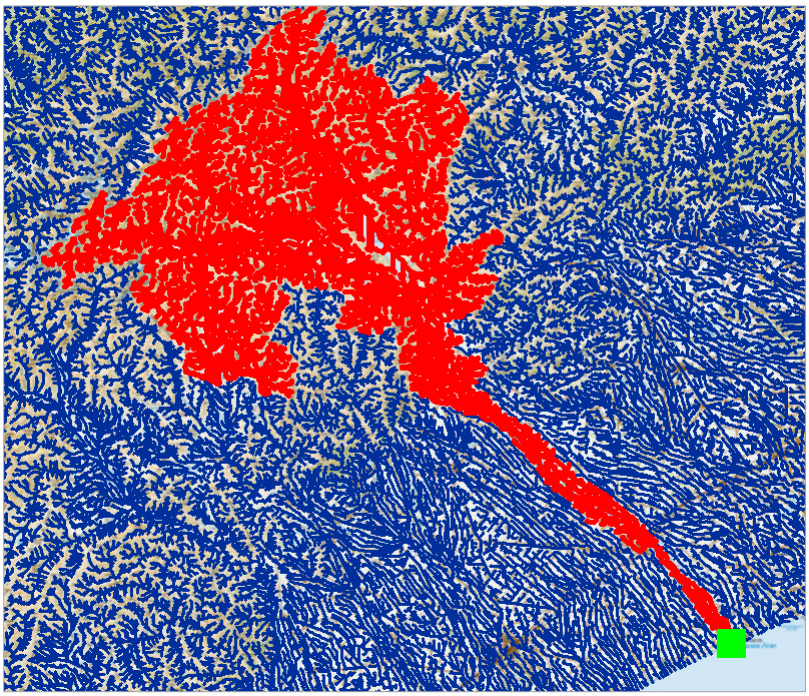
Let's zoom in to the mouth of the **Rakaia River** just south of Christchurch. Open the **Utility Network Analyst** toolbar and use the **Flow/Display Arrows** to show that the network has flow directions assigned on it.



Add an **Edge Flag** on a riverline at the mouth of the Rakaia River and select **Trace Upstream** from the Trace Tasks toolbar. Hit the little **Solve** button the right of the Trace Tasks toolbar and you'll get a nice upstream trace graphic in red for the Rakaia River drainage network.

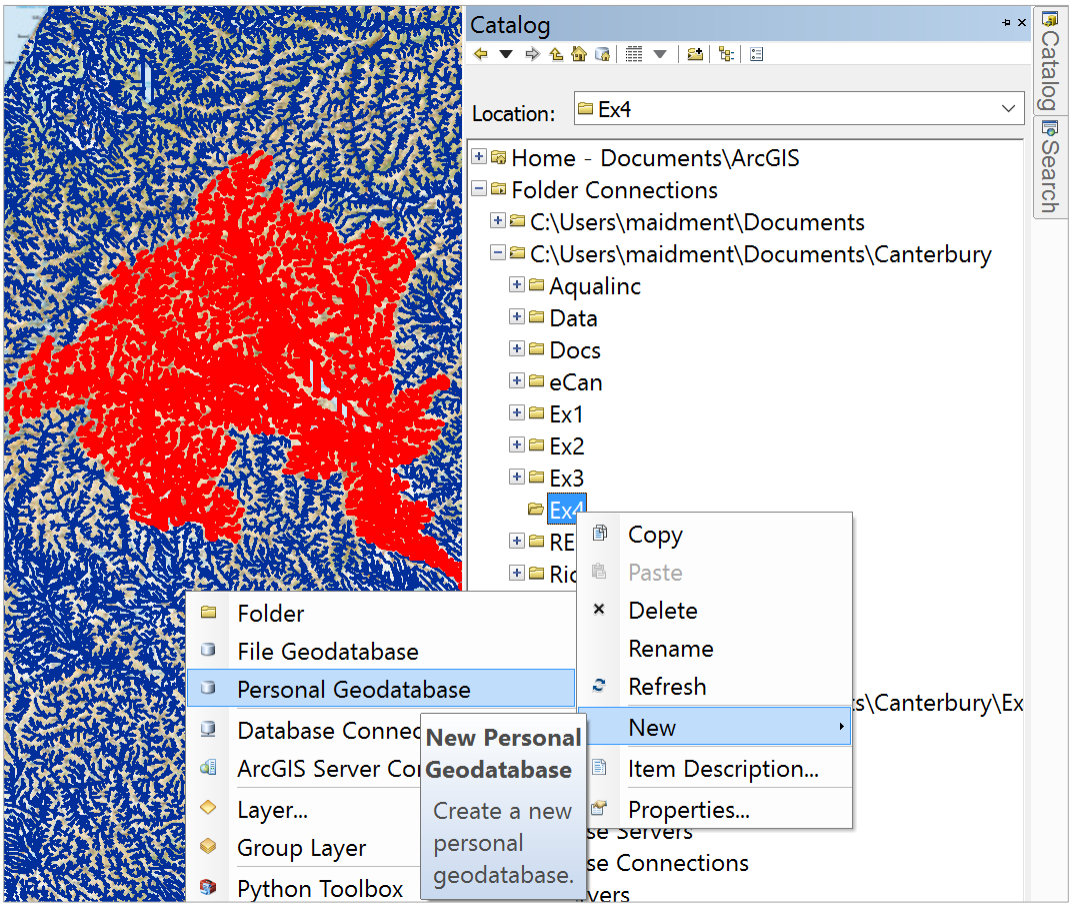


and if you zoom out, you'll see the upstream trace as a simple graphic.

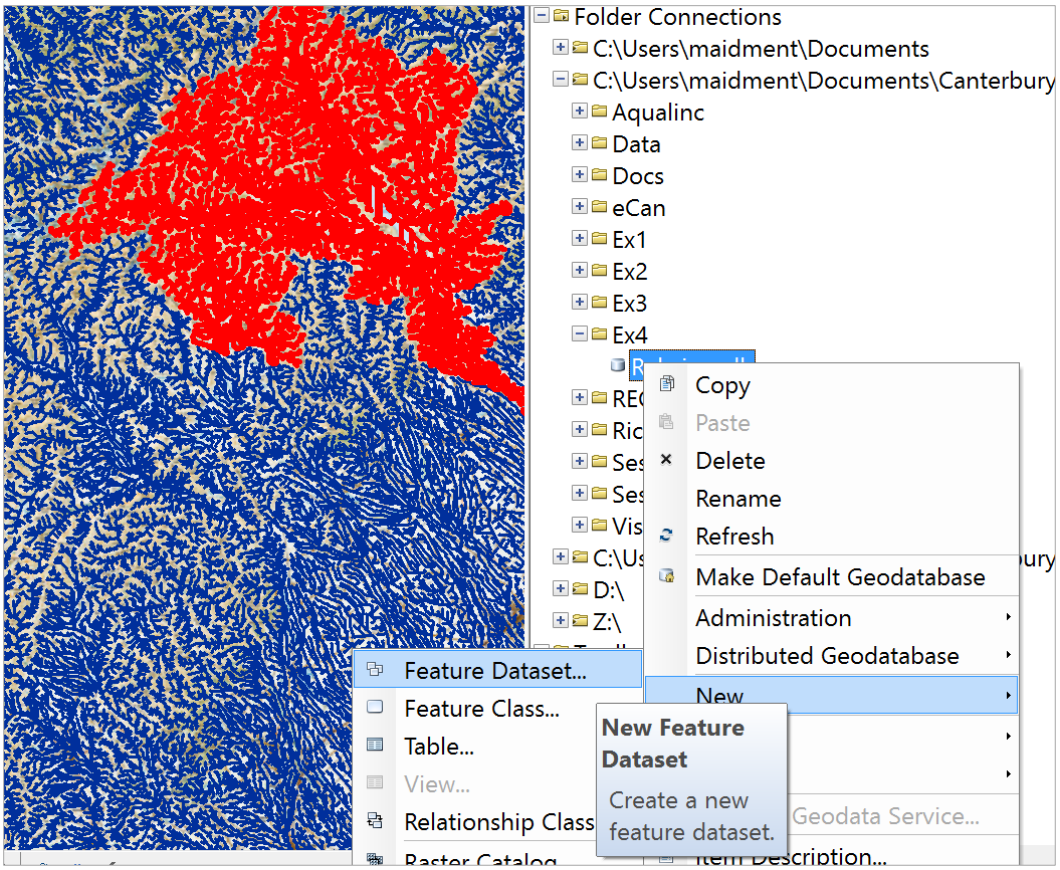


Now, let's establish a new geodatabase for the Rakaia River data.

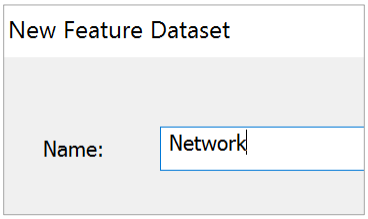
Click on the Catalog tab in the top right of the map display and in your folder for Exercise 4, create a **New Personal Geodatabase**.



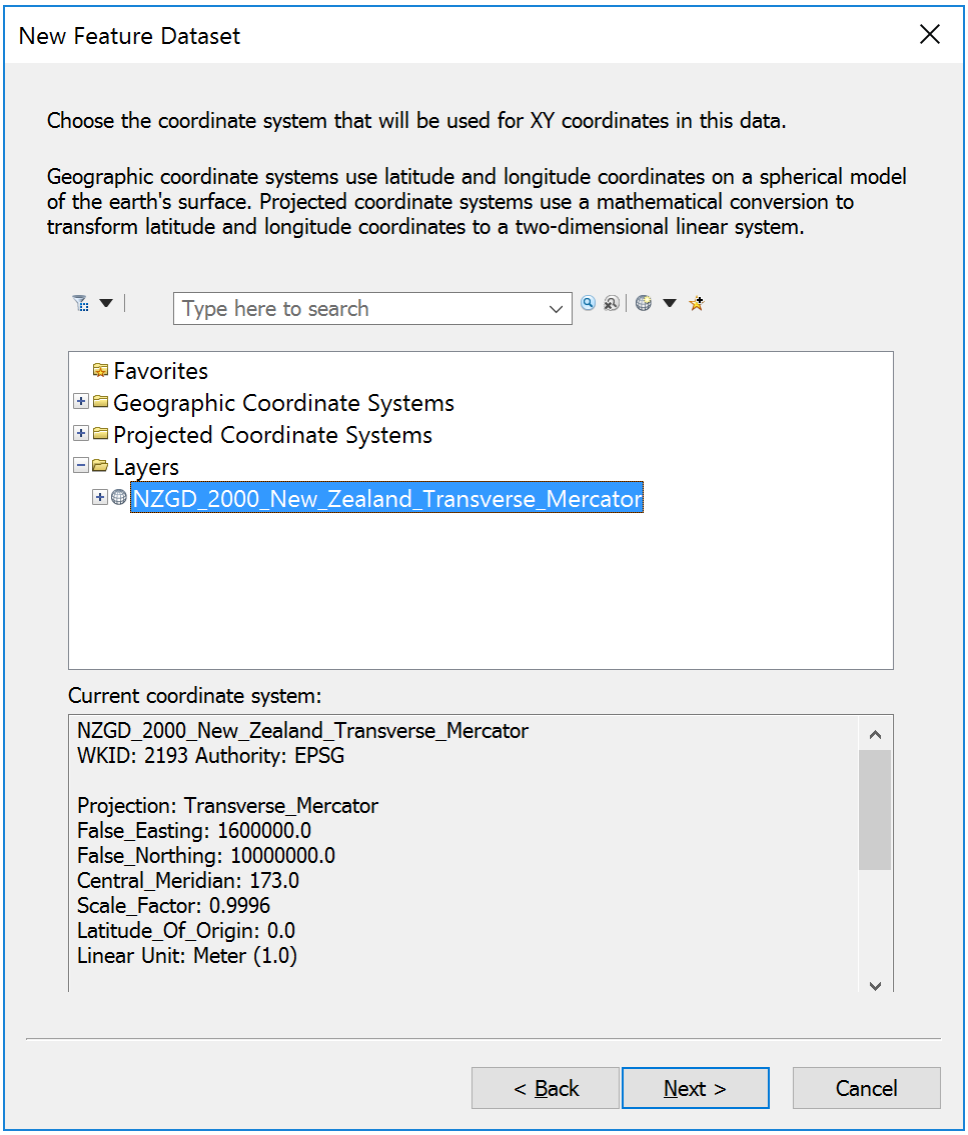
Let's call this **Rakaia**. Within this geodatabase, we'll create a new **Feature Dataset**.



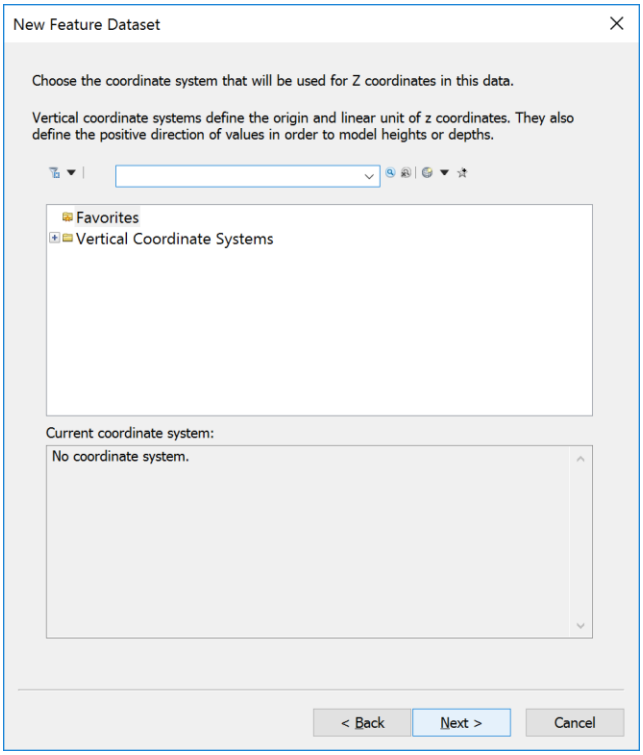
Let's call this **Network** (the specific name doesn't really matter)



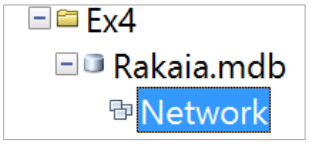
And hit **Next** to bring up a screen that defines the coordinate system to be used for this Feature Dataset. We'll use the standard **New Zealand Transverse Mercator** map projection which is used to define the Riverlines layer that we brought in from the REC:



And hit **Next** again to choose a Vertical Coordinate System, which we'll ignore in this exercise,

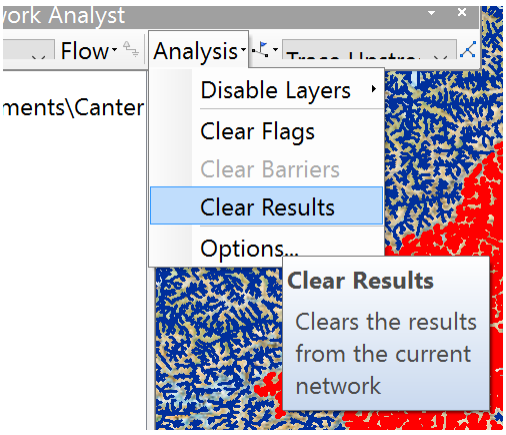


And in the following screen hit **Finish** and your Network Feature Dataset will be created.

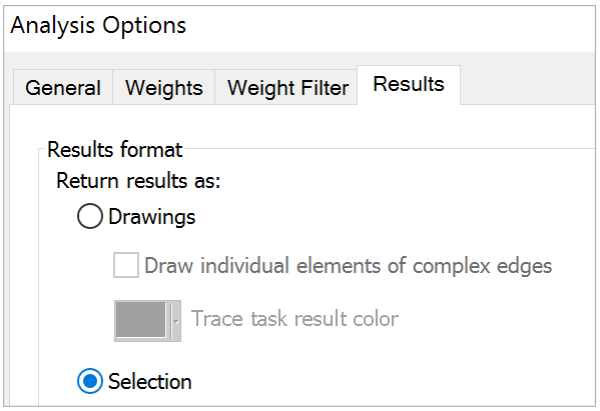


This is a container to put the feature classes in for the Rakaia catchment. Now let's get some data to put in this Feature Dataset.

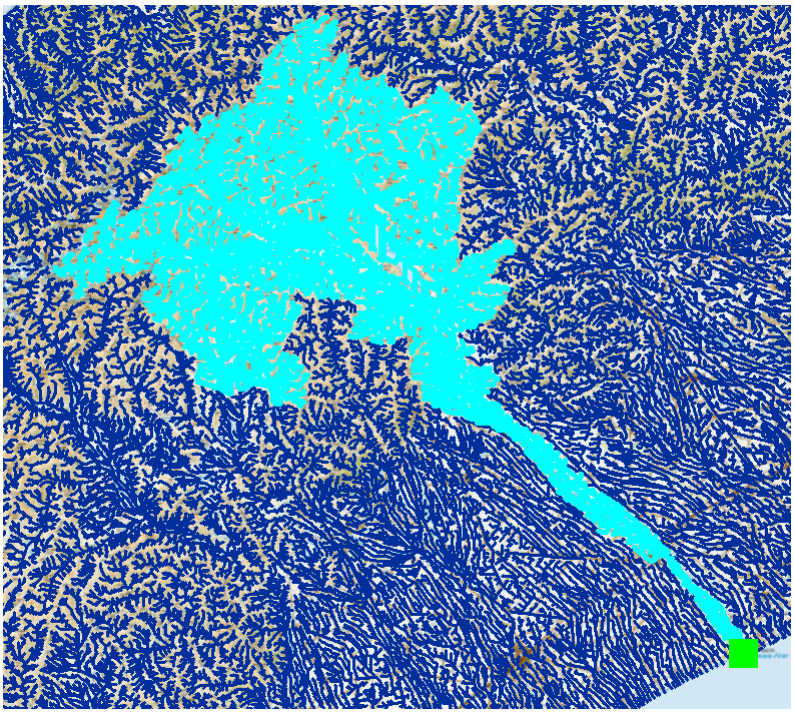
In the **Utility Network Analyst** toolbar, select **Analysis/Clear Results**



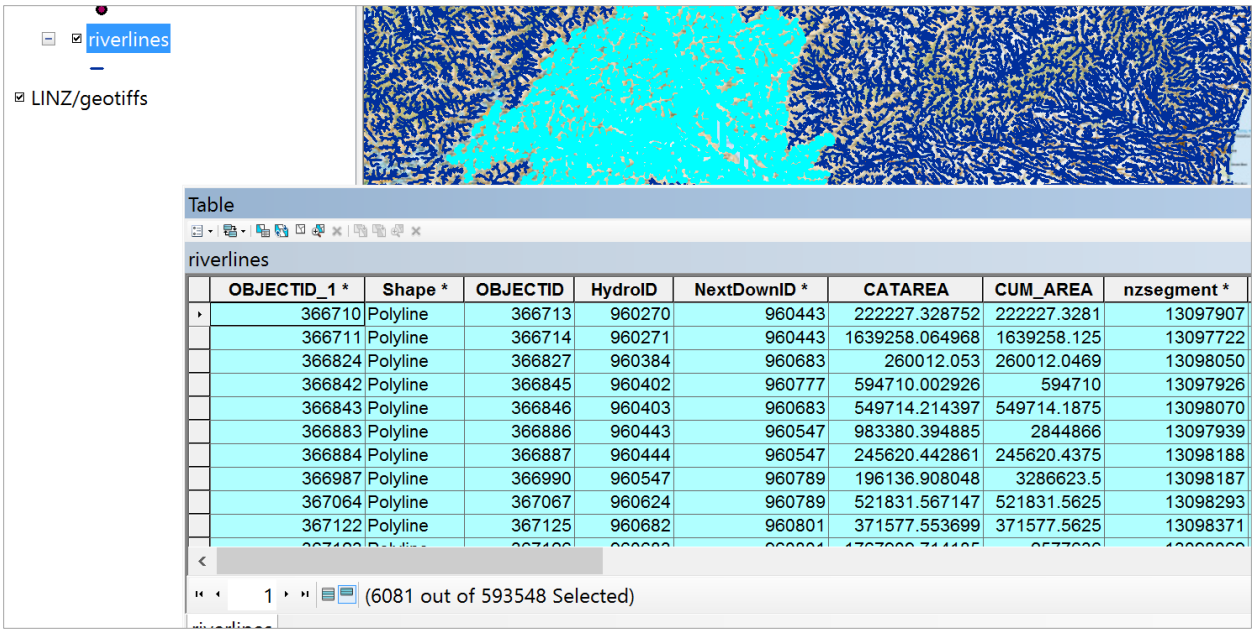
And then in **Analysis/Options/Results** choose **Selection**.



And let's execute the **Trace Upstream** task in the **Utility Network Analyst** toobar again, and we'll get a set of selected RiverLines.

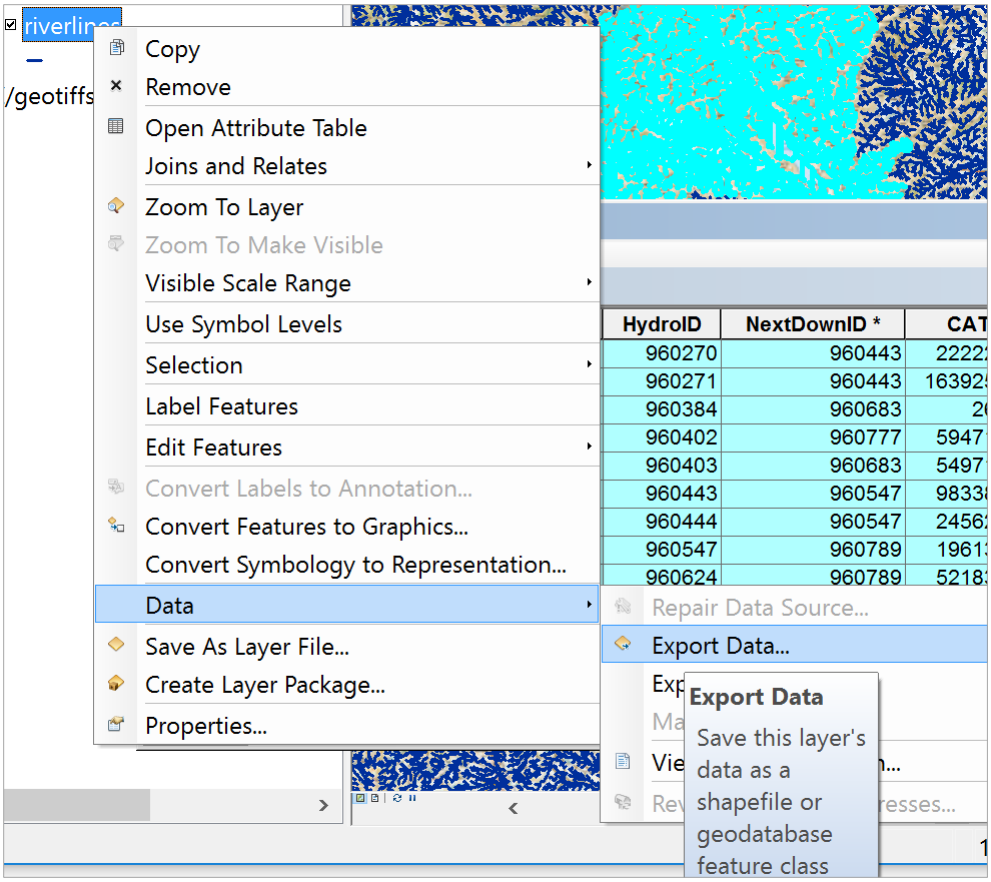


If you open the **Attribute Table** of the **Riverlines** feature class, you'll see the selected reaches and hit the  selection button at the bottom of the table, you'll see that we've selected 6081 reaches.

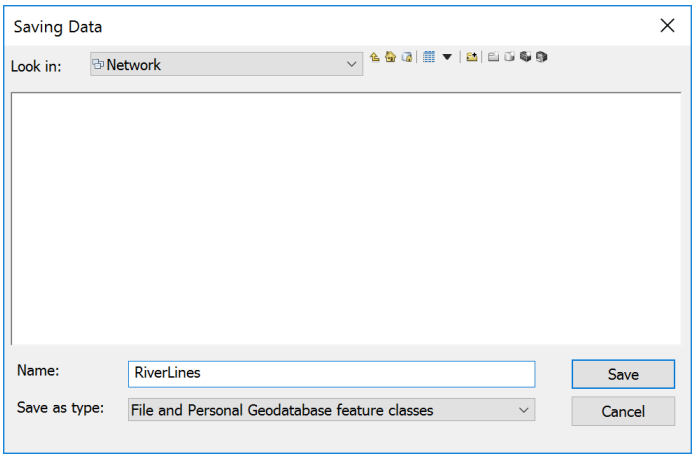


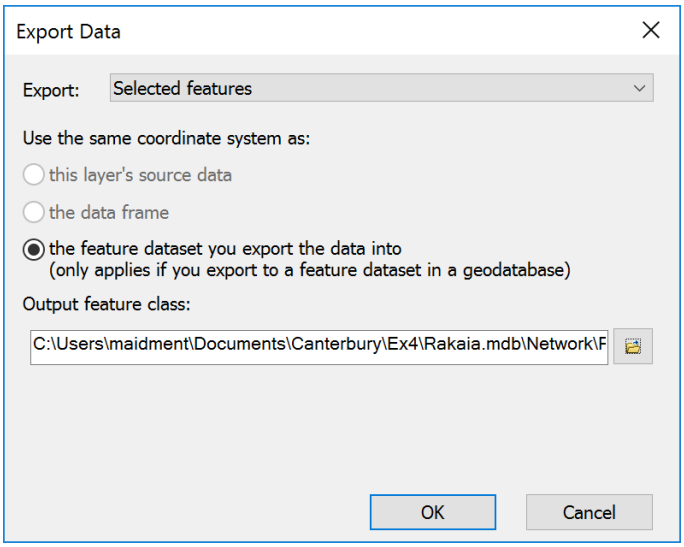
OBJECTID_1 *	Shape *	OBJECTID	HydroID	NextDownID *	CATAREA	CUM_AREA	nzsegment *
366710	Polyline	366713	960270	960443	222227.328752	222227.3281	13097907
366711	Polyline	366714	960271	960443	1639258.064968	1639258.125	13097722
366824	Polyline	366827	960384	960683	260012.053	260012.0469	13098050
366842	Polyline	366845	960402	960777	594710.002926	594710	13097926
366843	Polyline	366846	960403	960683	549714.214397	549714.1875	13098070
366883	Polyline	366886	960443	960547	983380.394885	2844866	13097939
366884	Polyline	366887	960444	960547	245620.442861	245620.4375	13098188
366987	Polyline	366990	960547	960789	196136.908048	3286623.5	13098187
367064	Polyline	367067	960624	960789	521831.567147	521831.5625	13098293
367122	Polyline	367125	960682	960801	371577.553699	371577.5625	13098371

Now let's export these Riverlines to our Rakaia geodatabase. Right click on the **Riverlines** feature class and select **Data/Export Data**

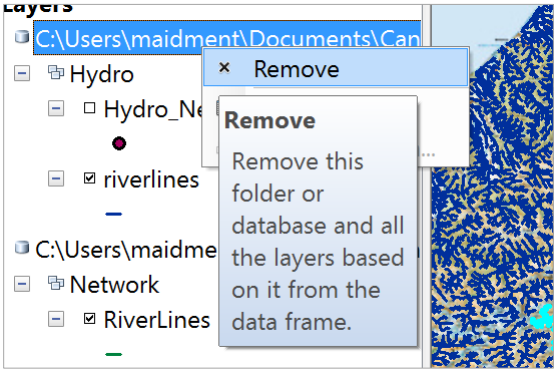


And navigate to the **Network** Feature Dataset, and save the selected features as a new **RiverLines** feature class.

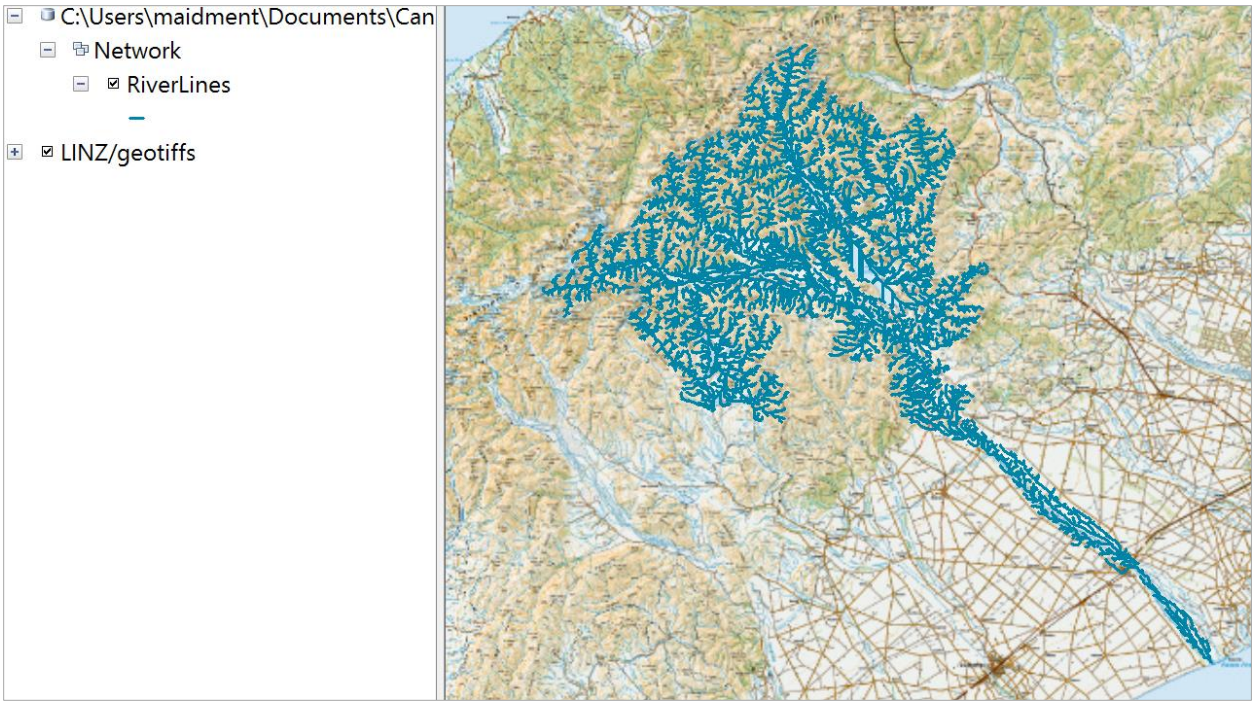




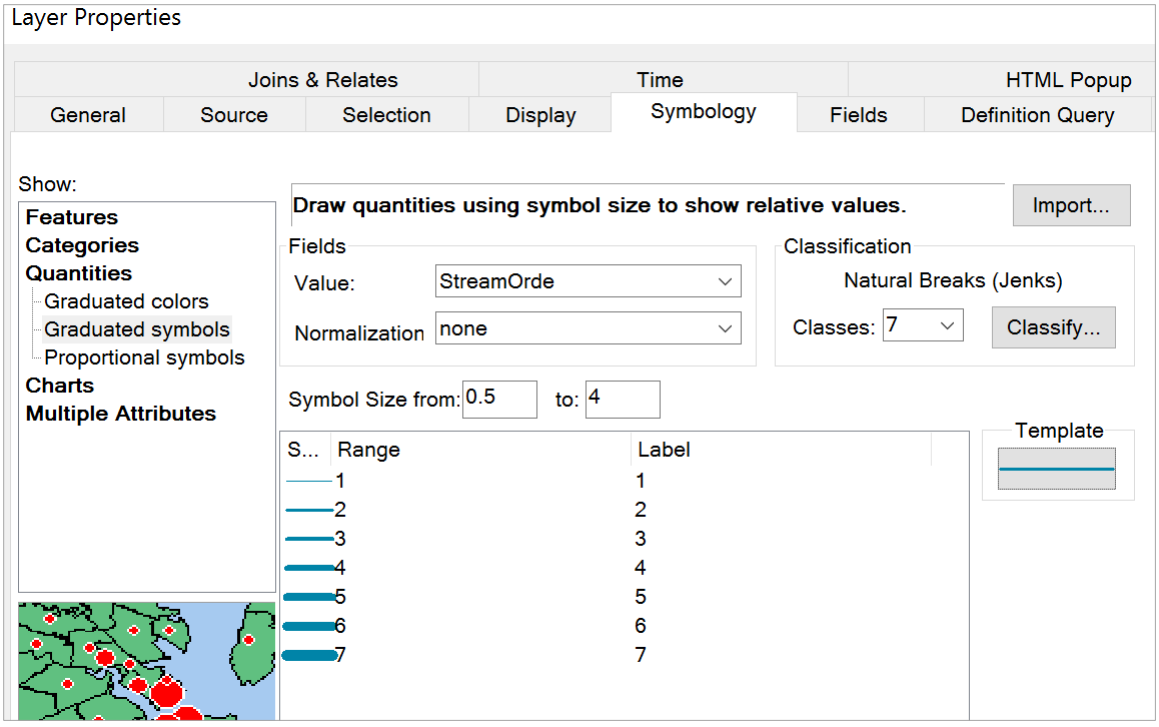
then add the resulting dataset to the map display. Remove the original REC network from the map display



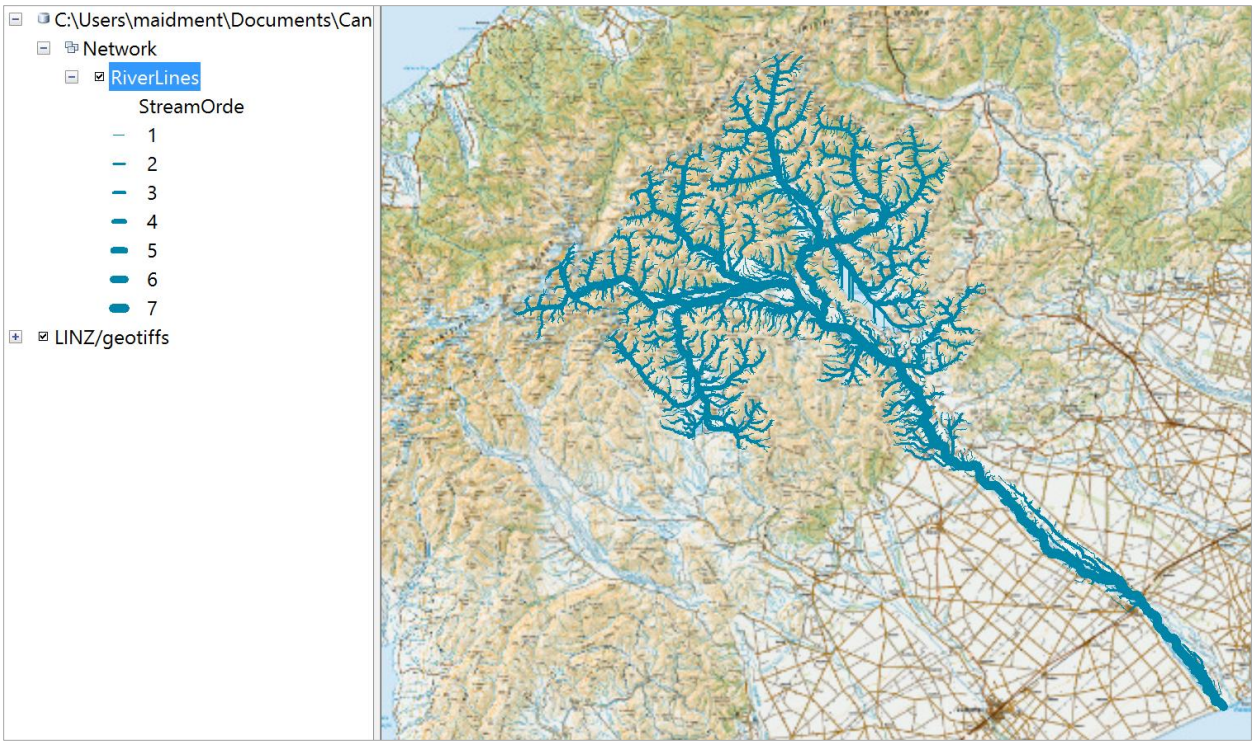
And color the resulting RiverLines in blue. Pretty cool!



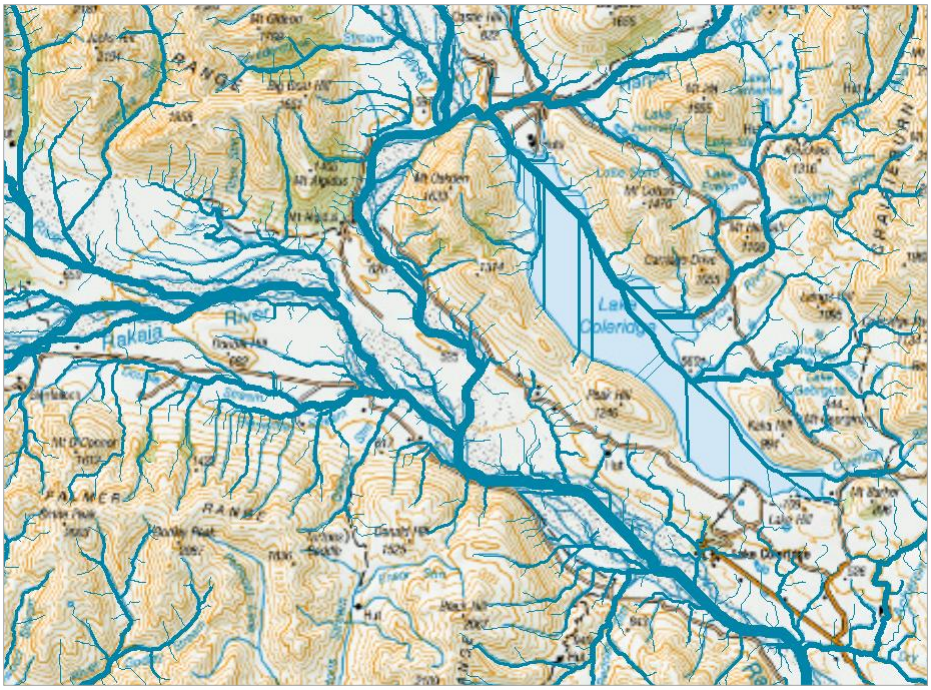
Now let's symbolize the RiverLines with **Graduated Symbols** using **StreamOrde** as the Value Field with **7** Classes and a **Blue** Template color



And you'll end up with a rather beautiful river map.



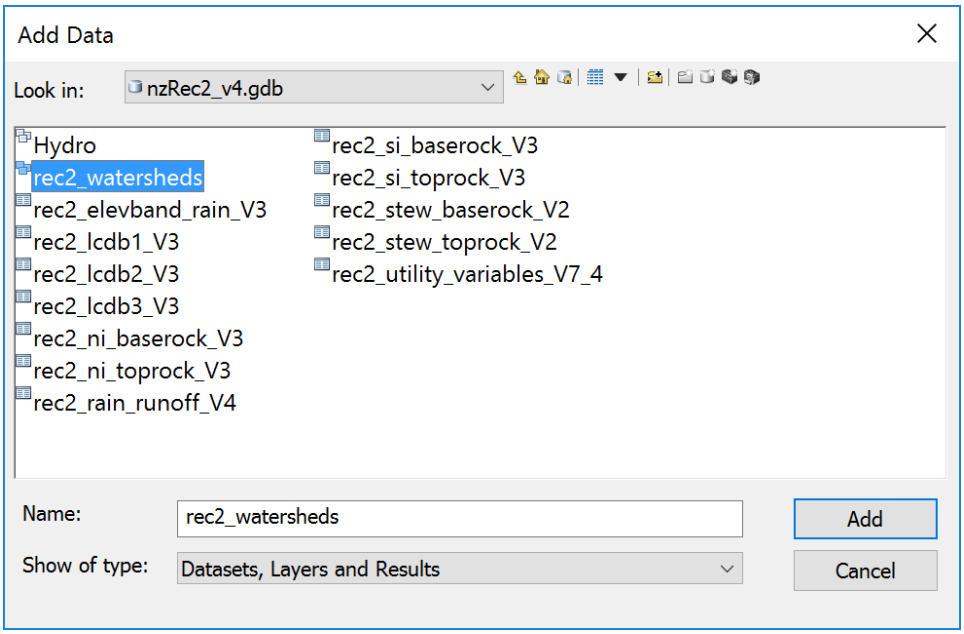
If you zoom in to the upper part of the catchment, you'll see a nice map of the headwaters of the Rakaia River, including Lake Coleridge.



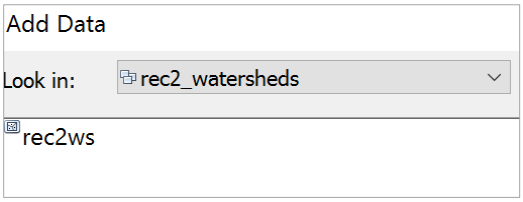
Save your map display using **File/Save As** in ArcMap as **Ex4.mxd**

To be Turned In: A map of the riverlines in the Rakaia Catchment. How many RiverLines do we have in the map? What is their total length (Km)? What is their average length (Km)?

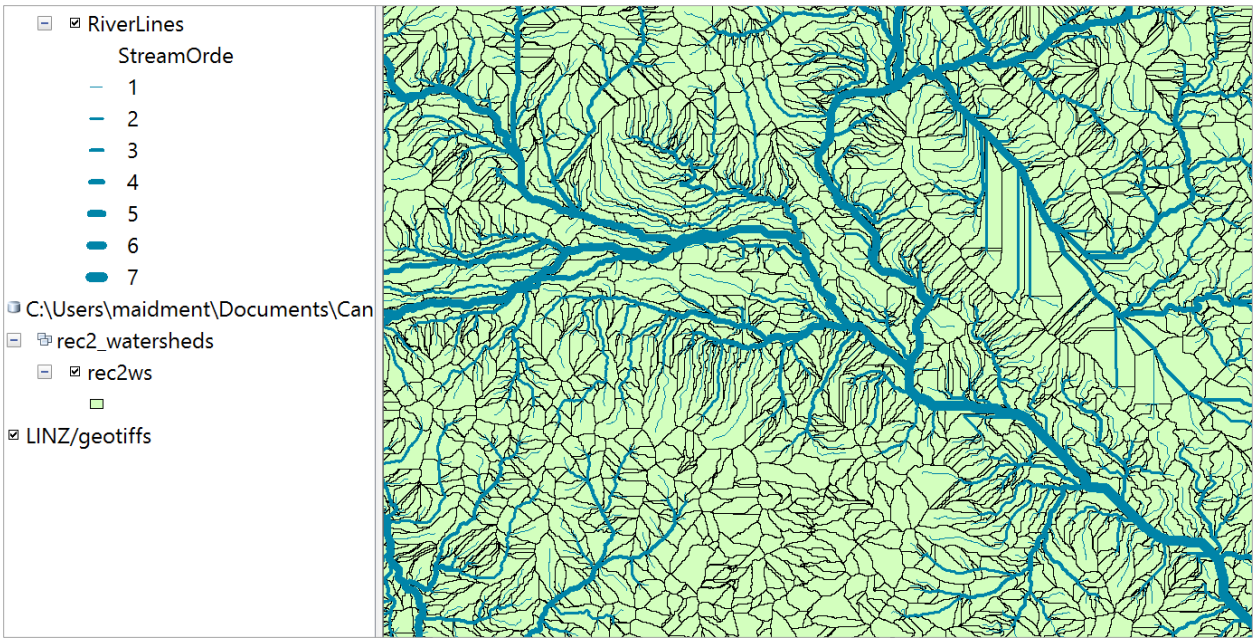
Now let's get some drainage areas to go along with these stream lines. Go back to the REC geodatabase that we started with and add the **rec2_watersheds** feature dataset,



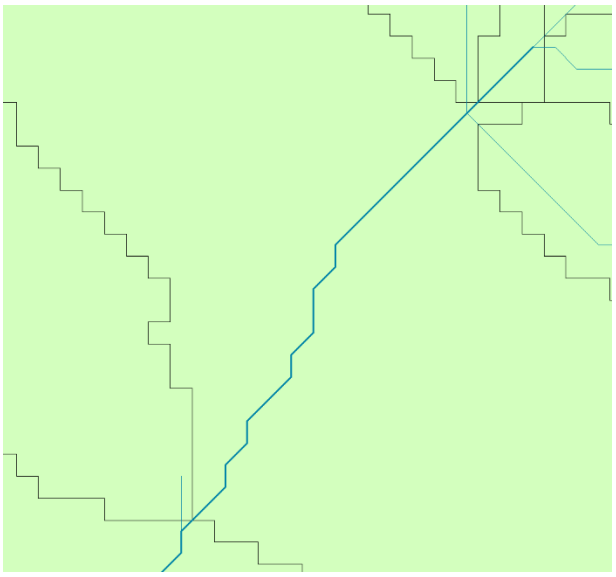
that has only the **rec2ws** feature class within it.



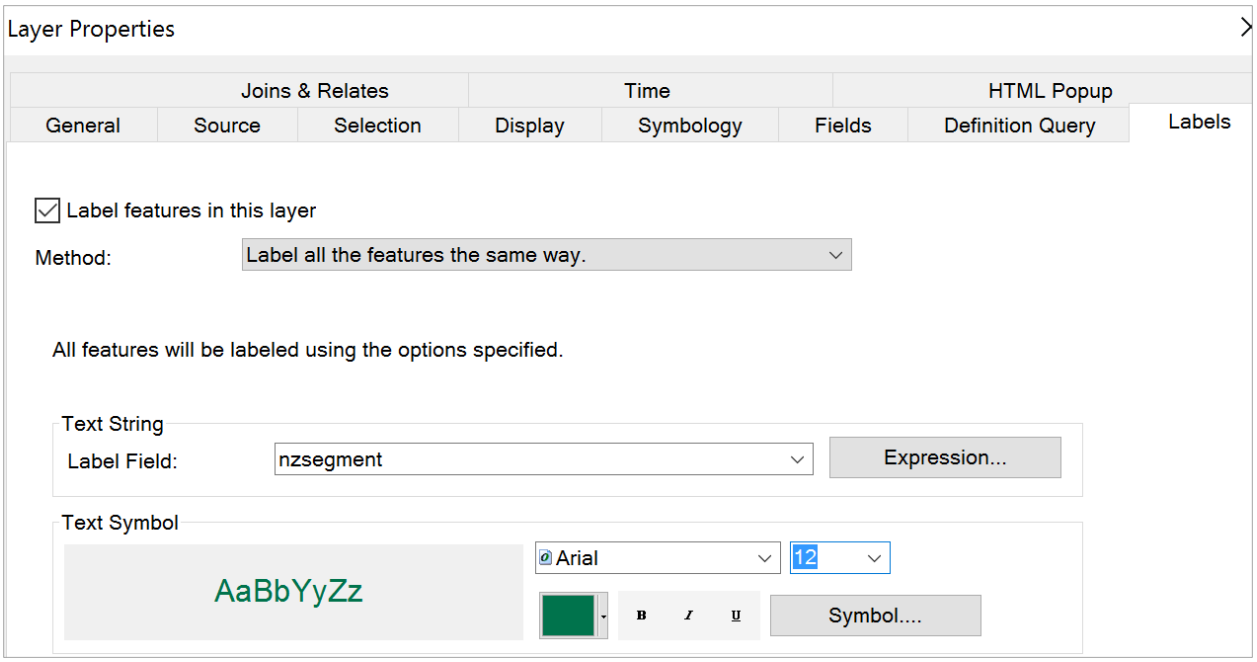
And if you color this in a nice green color, you'll see an intricate pattern of local drainage areas associated with each reach.



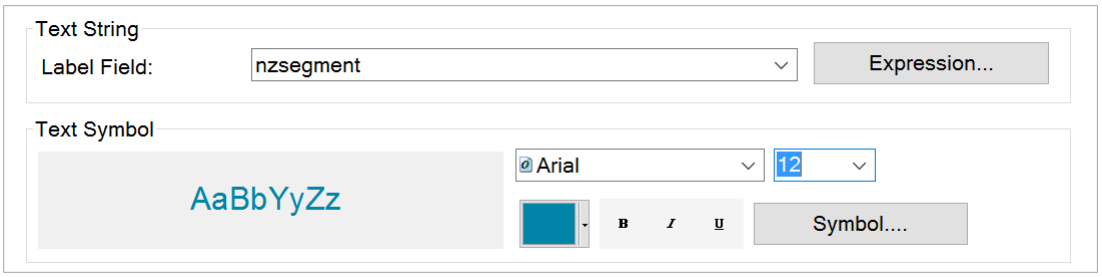
Here is a zoom in to a local area



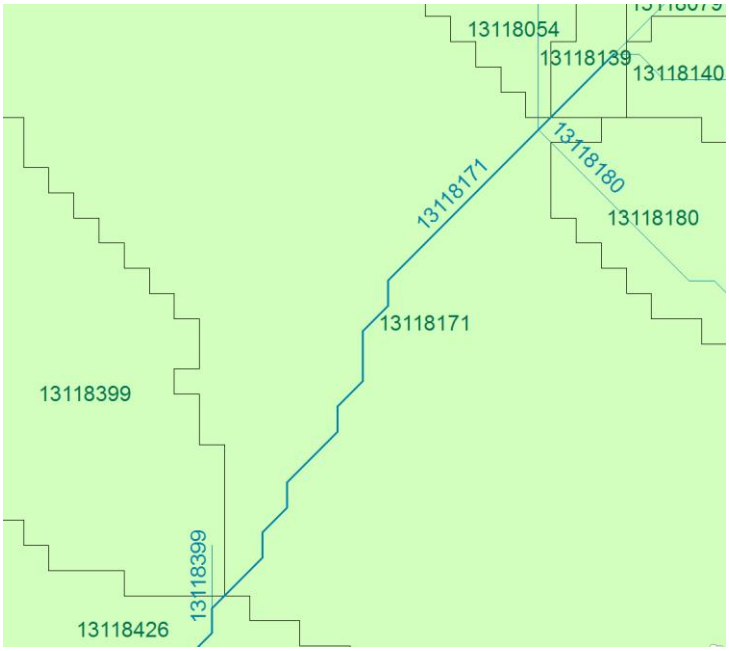
Let's set the **Label** properties for the **rec2_ws** feature class with Label Field **nzsegment** and **green** color with Arial **12** symbol size.



And similarly label the **RiverLines** with Label Field **nzsegment** and a **blue** color with text size **12.**



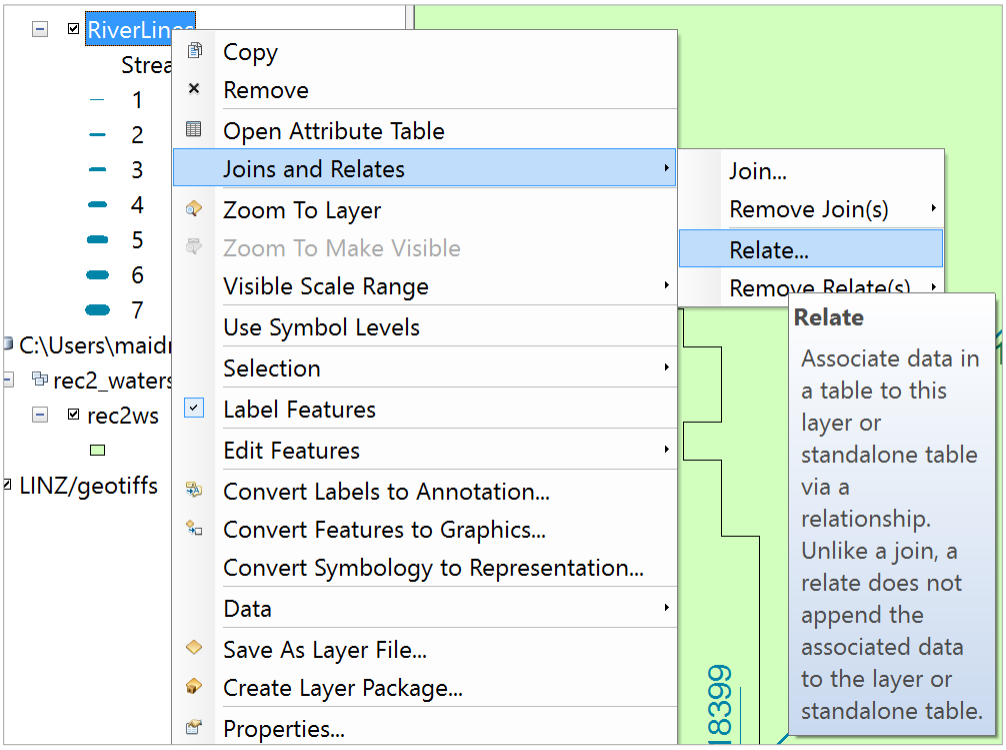
And you'll see that each RiverLine has an associated local drainage area with the same nzsegment ID number. Pretty cool!



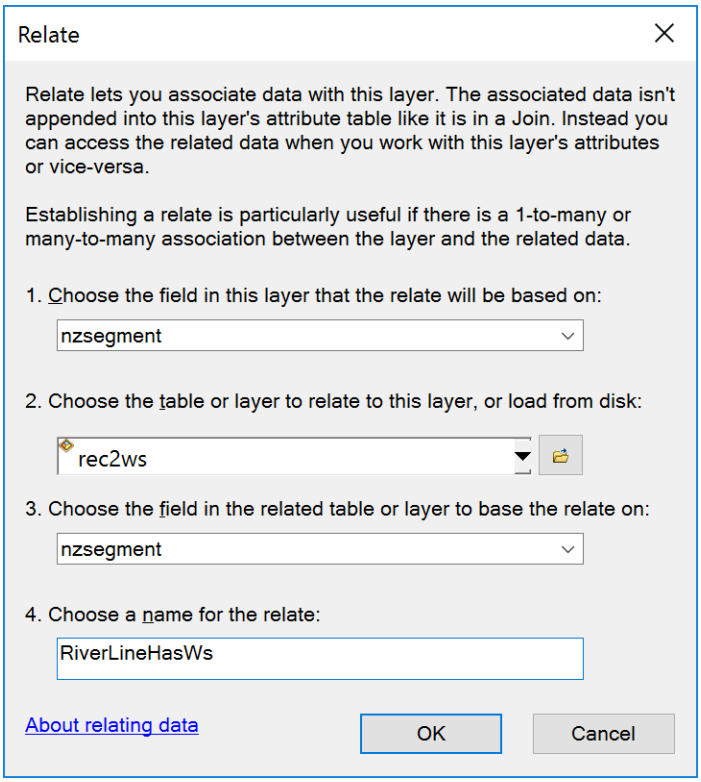
Let's use this association to choose the rec2_ws features that encompaass the Rakaia drainage basin.

Turn off the **display of Labels** on the RiverLine and Rec2_ws feature classes.

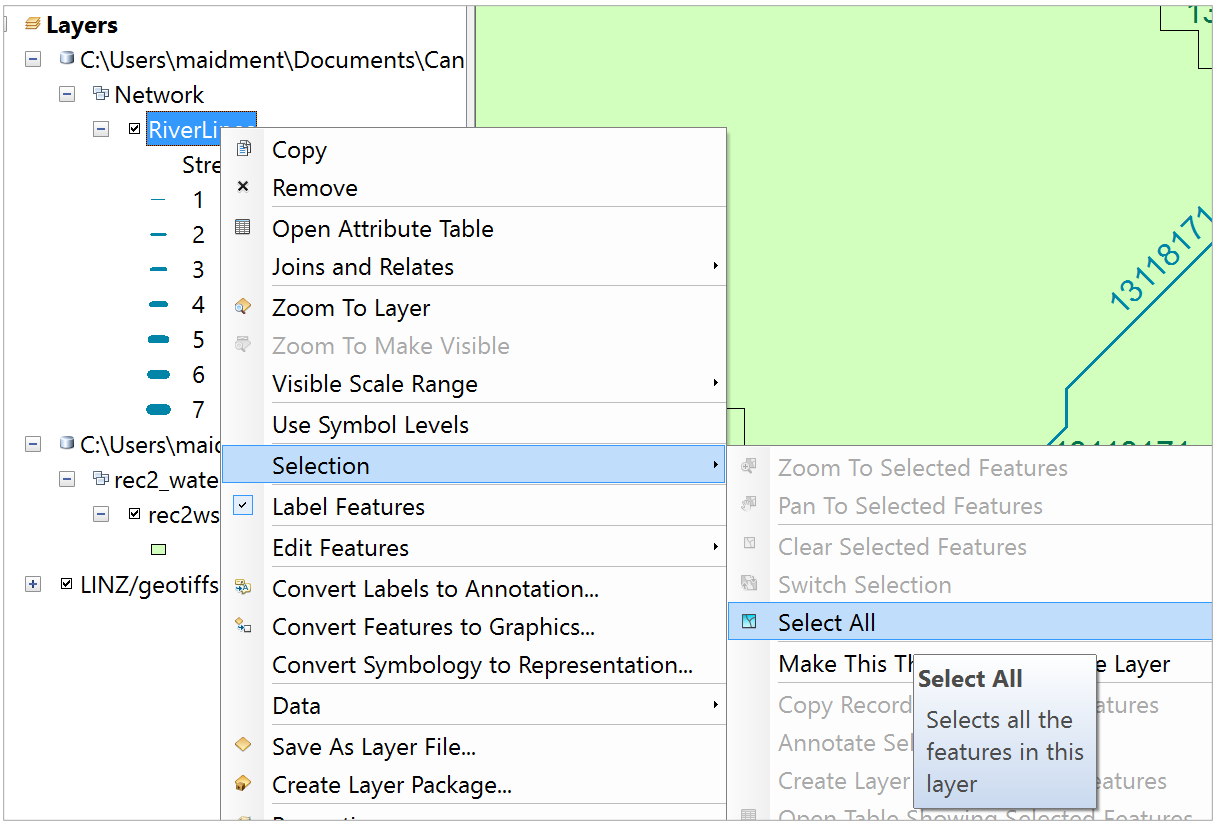
Right Click on the **RiverLine** feature class and select **Joins and Relates/Relate**



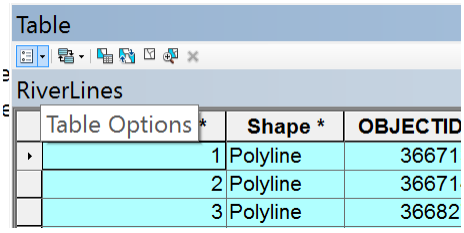
And in the resulting table, select **nzsegment** as the field that the relate will be based on and **rec2_ws** as the related layer. I have named this relate **RiverLineHasWs** to signify the connection between the two feature classes but any name will do.



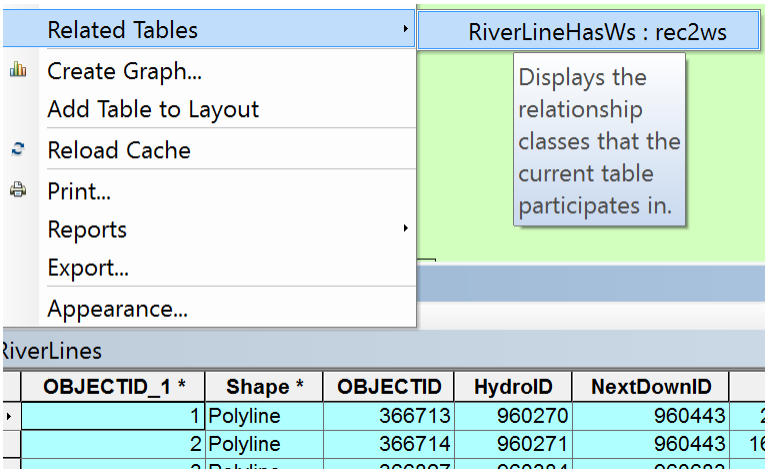
Now let's **Select** all the **RiverLines**



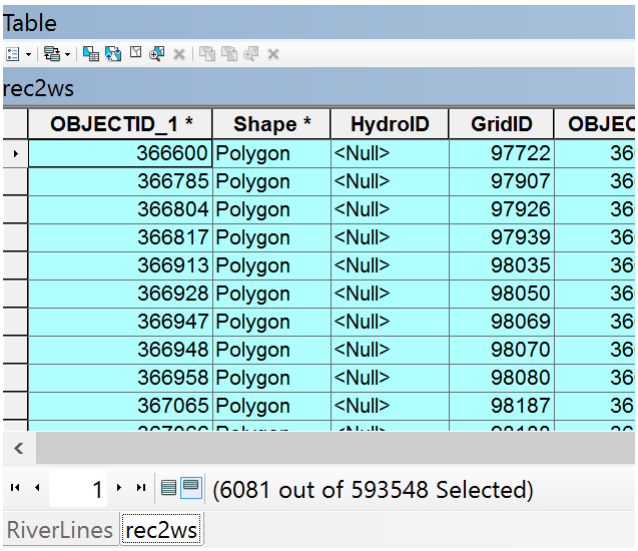
Open the Riverline feature class Attribute Table and select the Table Options in the top left corner of the Table



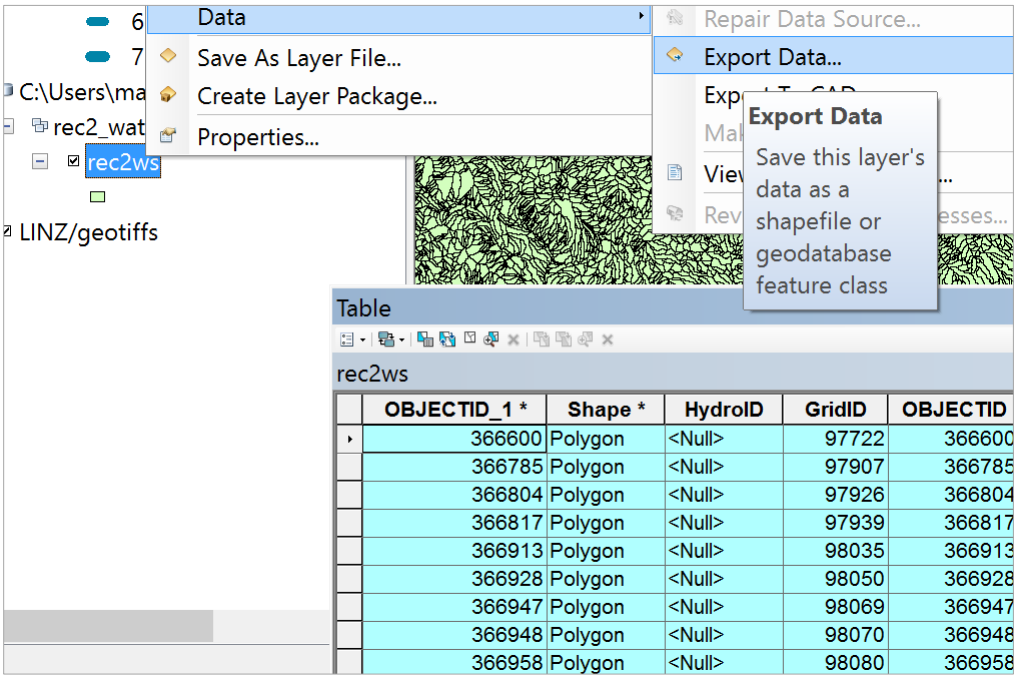
And select the **Related Tables/RiverLineHasWS:rec2ws**



And you'll see the Attribute Table of the RiverLines feature class pops up with 6081 features selected

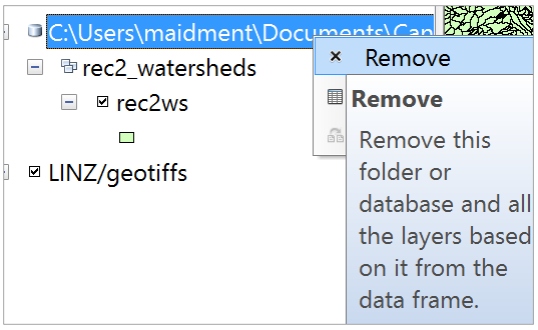


Now right click on the re2ws feature class and select Data/Export Data to export the selected catchment areas for the Rakaia basin

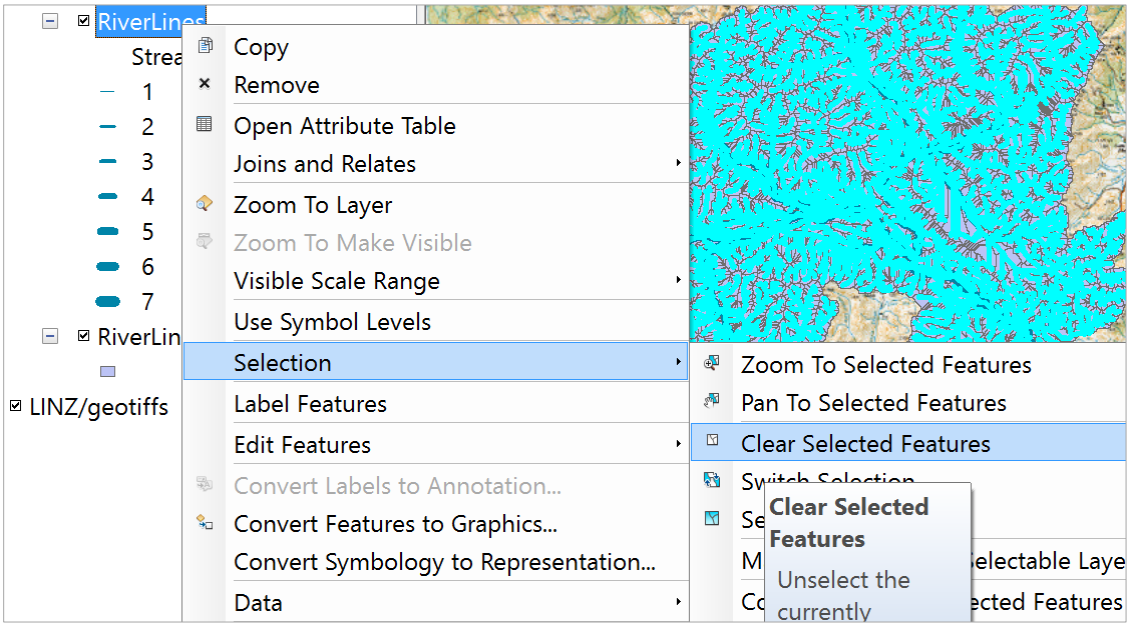


Save the data in the **Network** feature dataset as before, and call the feature class **RiverLineCatchment**

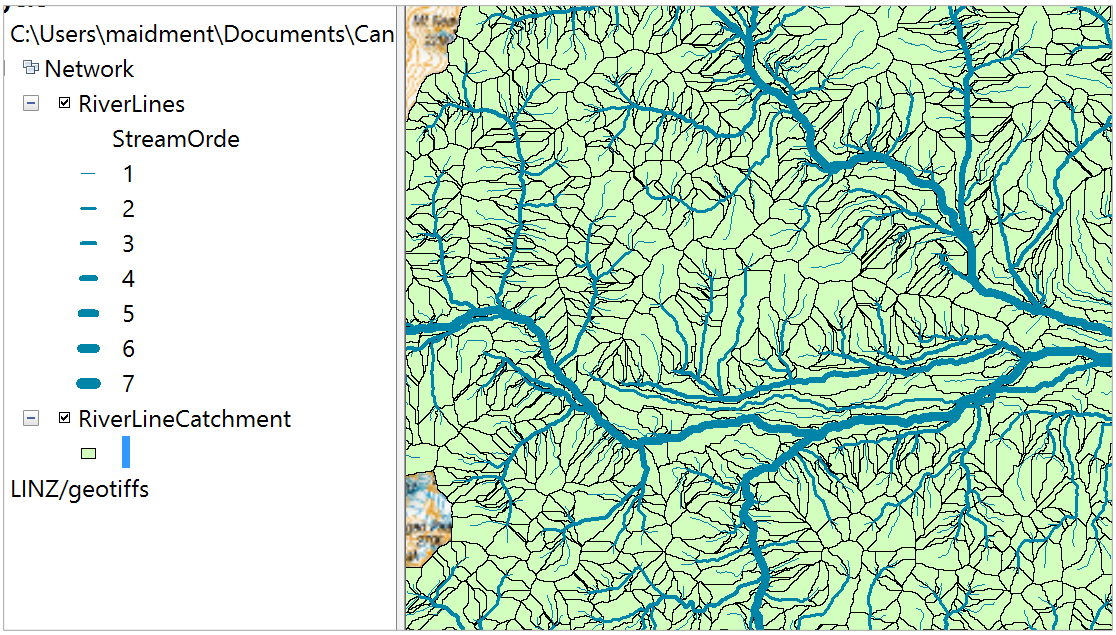
Remove the display of the national rec2ws features



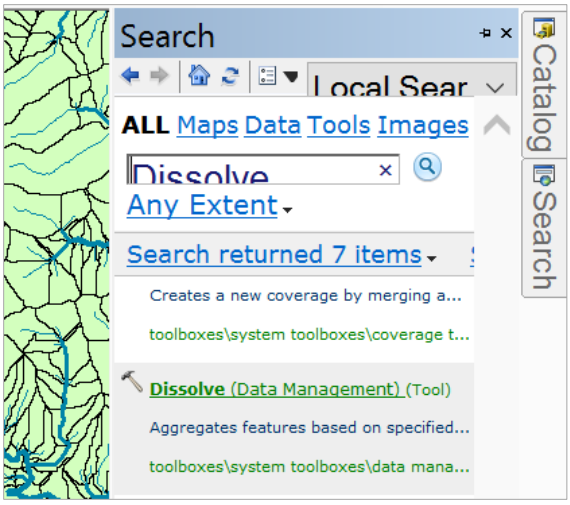
Clear the selected RiverLine features



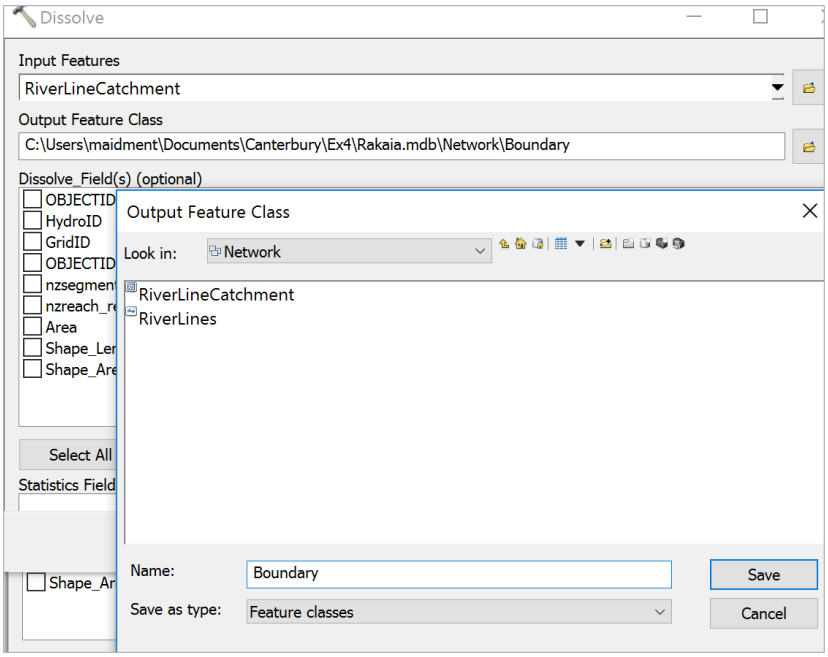
And now you'll have just the features we want. Let's color the RiverLineCatchments green and zoom in to check out what we've got and you'll see we have a complete coverage of the land area that drains to these river features! Wow. That is really cool! This is a beautifully constructed geospatial dataset.



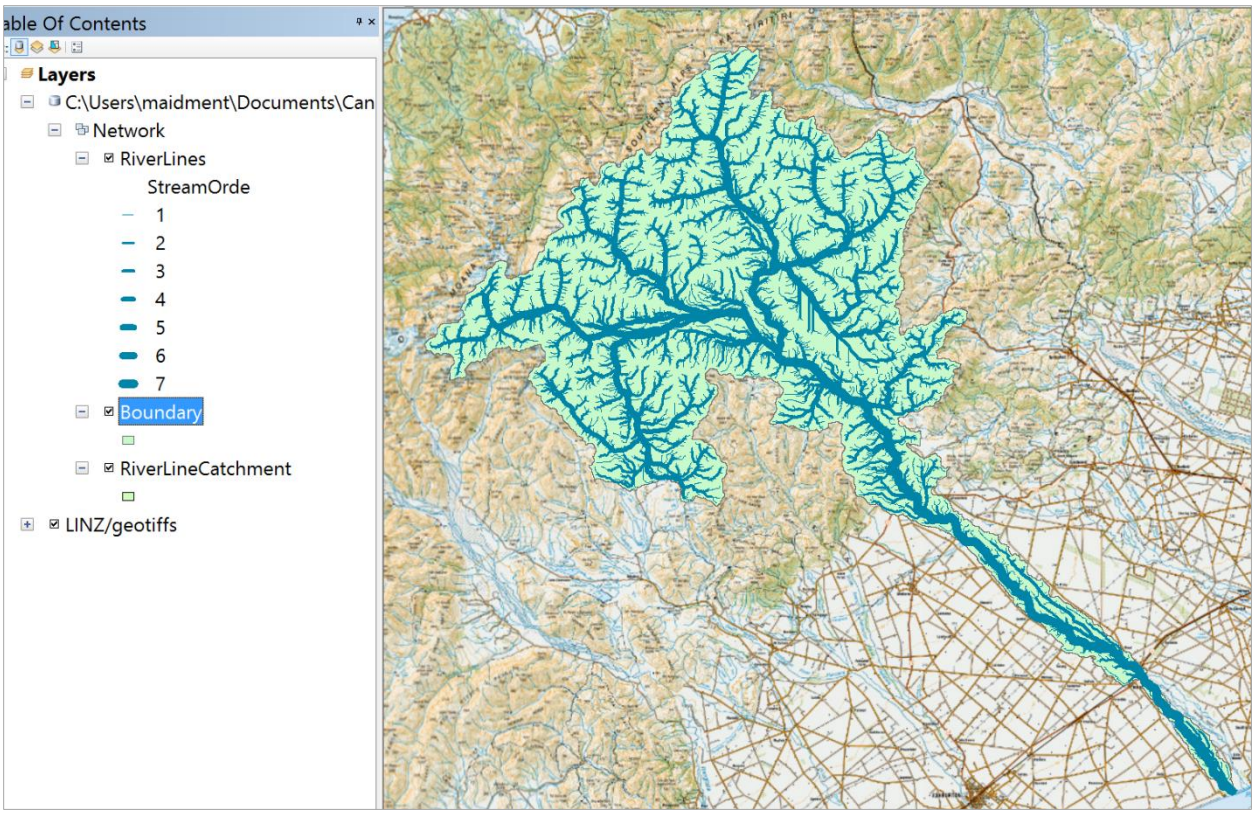
Let's make a single polygon that is the whole Rakaia catchment boundary. In the **Search** box in the upper right hand corner of ArcMap, select **Dissolve (Data Management).**



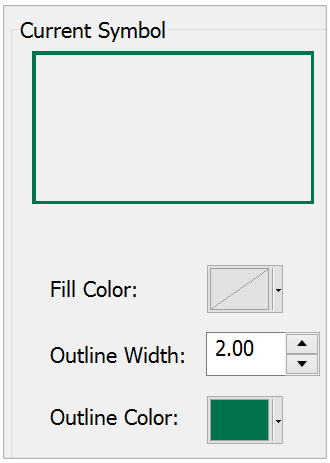
Select the **Input Features** as **RiverLineCatchment** and the **Output Features** as a new feature class called **Boundary** in the **Network** feature dataset.



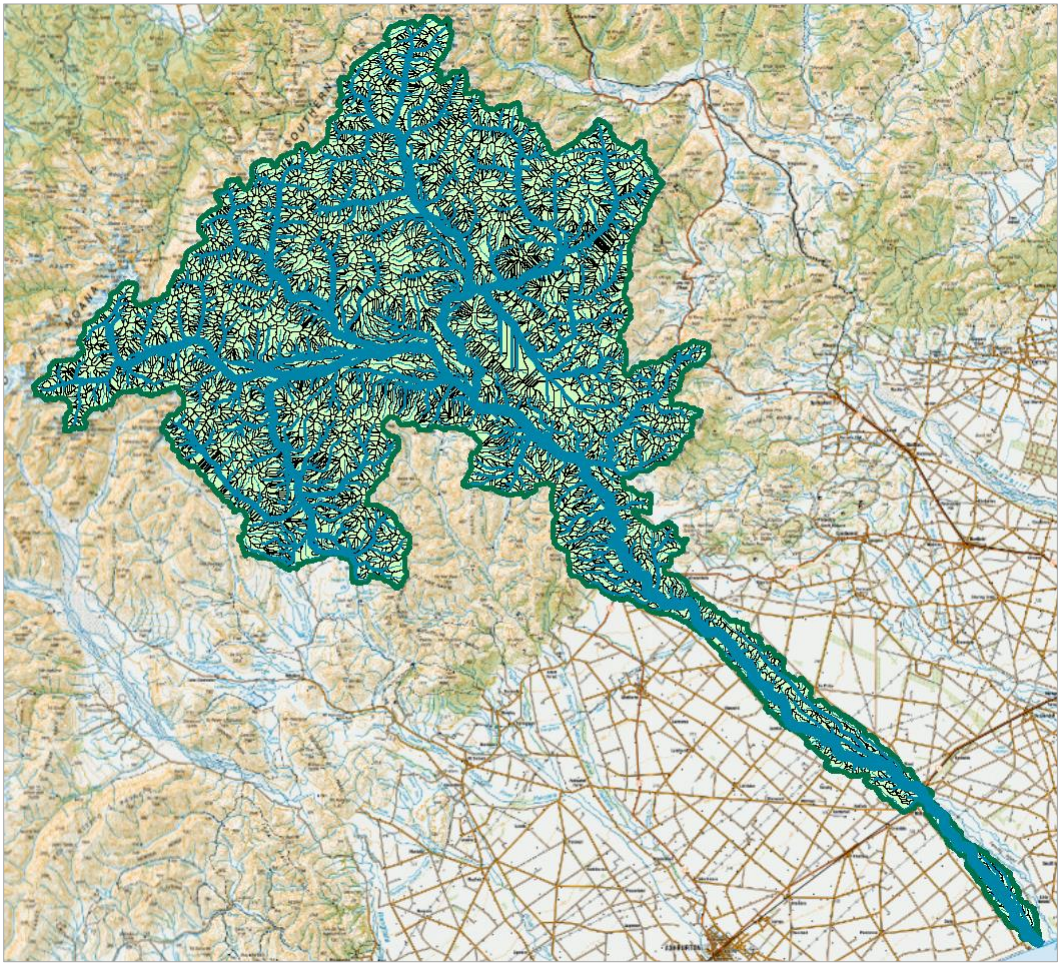
It looks like nothing is going on but then after a little while the screen display shakes a bit and you'll see a new boundary polygon appears



Lets symbolize the **Boundary** feature class as **Hollow**, with a **Green** outline width of **2**



And now you've got a pretty nice hydrologic basemap for a study of the Rakaia River Catchment



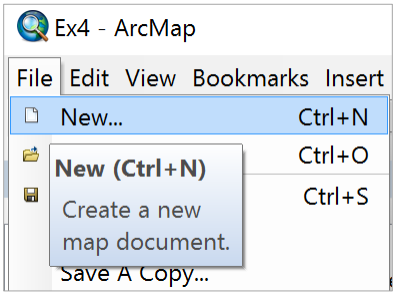
Save the **Ex4.mxd** project file

To be Turned in: A Basemap of the Rakaia River Catchment. What is the drainage area (Sq Km) of this catchment?

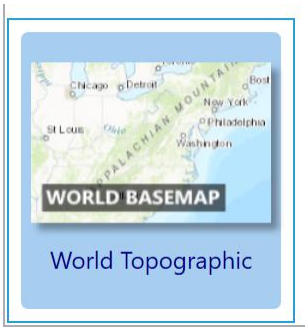
Part Two: Basemap using ArcGIS Online Hydro Services

Now let's suppose we are not in a country like New Zealand that has a Digital River Network dataset. We are going to construct a Basemap for the Purari River in Papua New Guinea using ArcGIS Online Hydro Services.

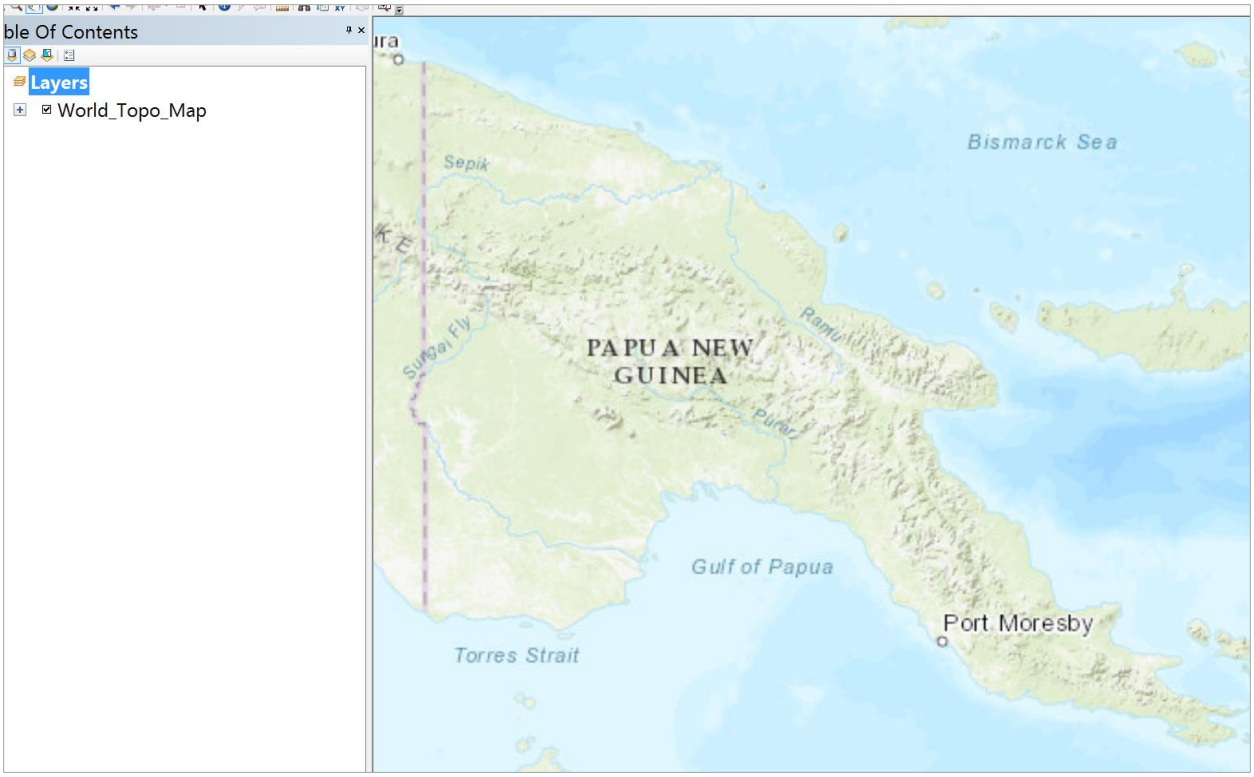
Make sure you've saved the **Ex4.mxd** project file from the first part of this exercise. Let's open a new ArcMap document



Add the World Topographic Basemap

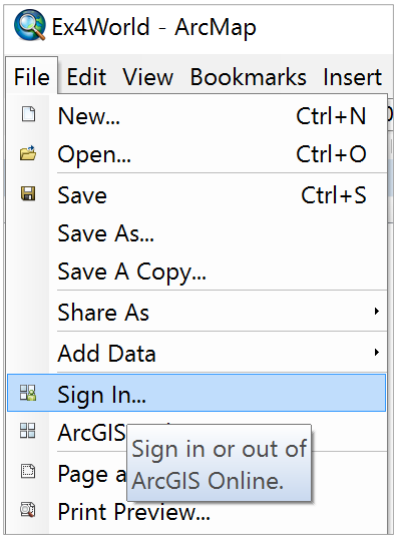


And lets zoom into Papua New Guinea

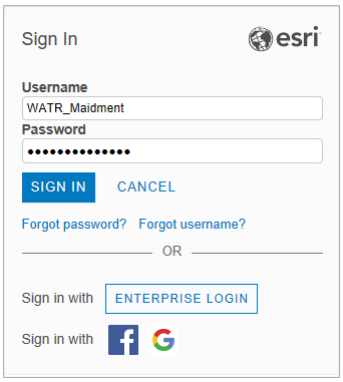


Let's save this Map Document as **Ex4World.mxd**

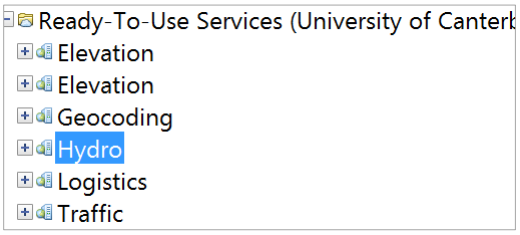
Now we are going to use Geospatial services that ESRI has mounted in the cloud. **File/Sign In** to ArcGIS Online using your University of Canterbury Organizational Account login



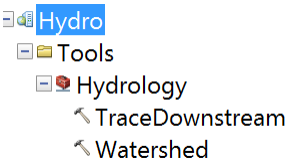
Your Username is **WATR_Surname**, whatever your surname is, and the password is whatever you established as when you responded to the request from the UC Organizational account request you received recently.



In the **Catalog** tab at the top right of ArcMap if you look right down on the bottom, you'll see **Ready to Use Services (University of Canterbury)** which are services you now have access to by virtue of belonging to the ArcGIS Online Organizational Account at UC. One of these categories of services is for **Hydro**

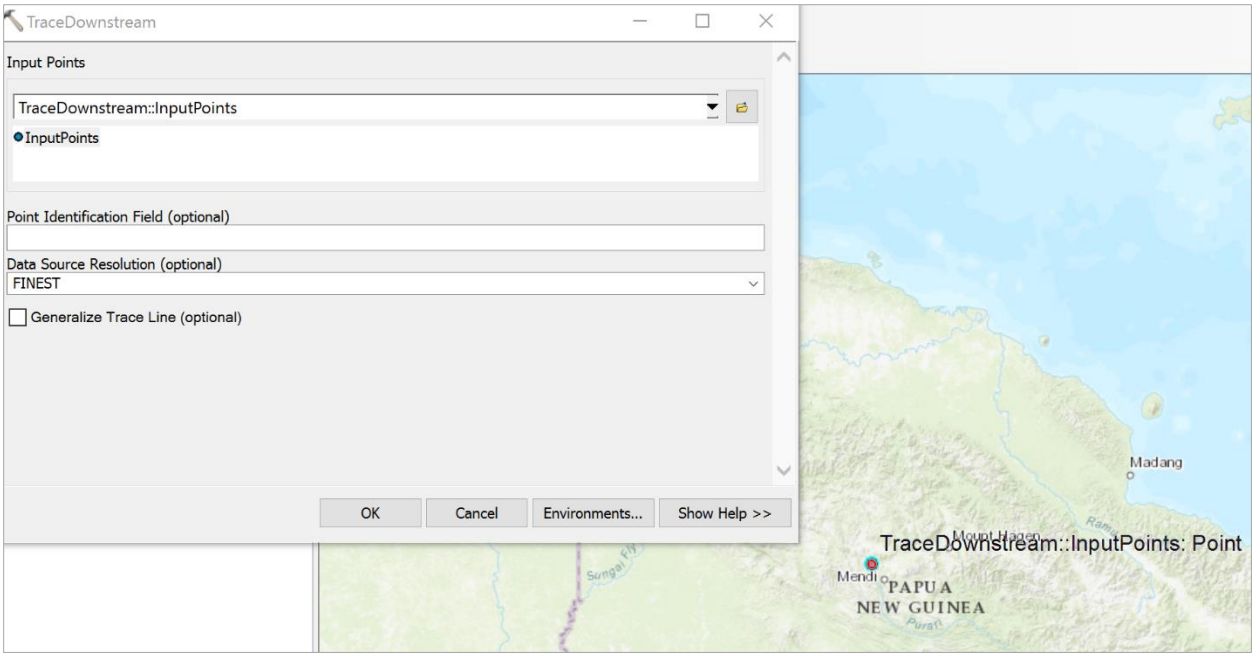


And if you expand this out, you'll see that there are **Trace Downstream** and **Watershed** tools that are like those we've been using with the New Zealand Digital River Network, except that these tools apply anywhere in the world and they operate from remote land surface terrain datasets in the cloud that you don't have to download to use.



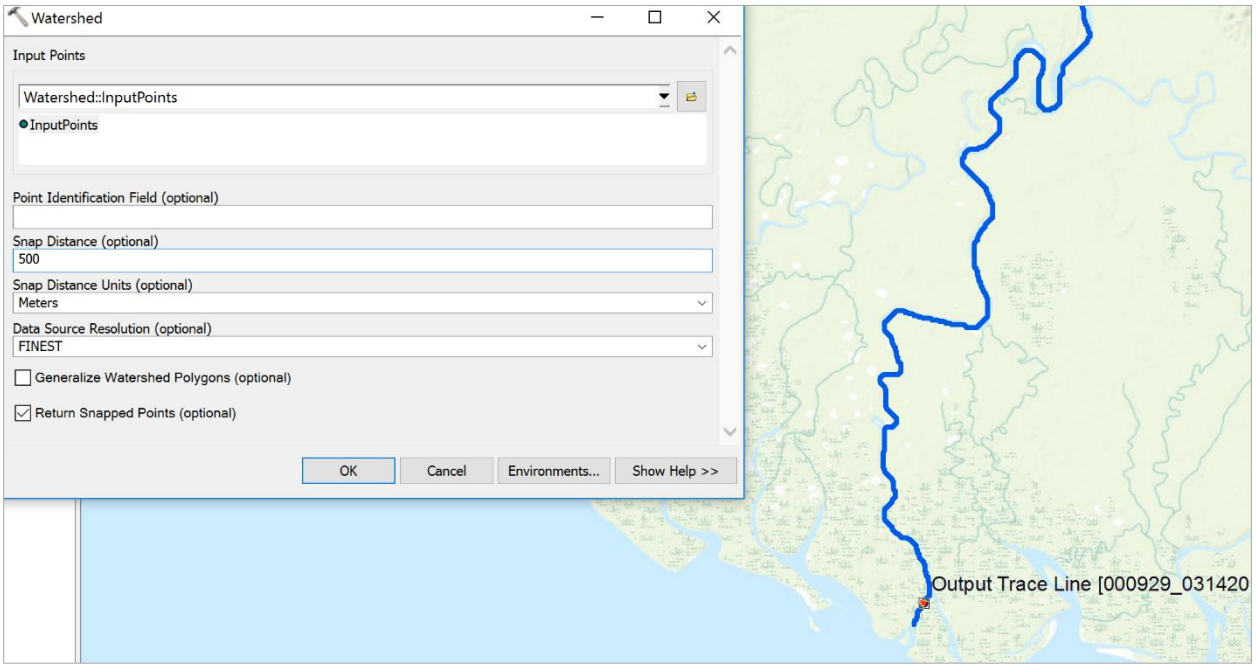
In the center of Papua-New Guinea, there is a rather large river called the Purari which flows near the town of Mendi.

Click on **Trace Downstream** and in the resulting box, select the **FINEST** dataset to work with and move the cursor to a point near Mendi and click a point location to begin your trace from.

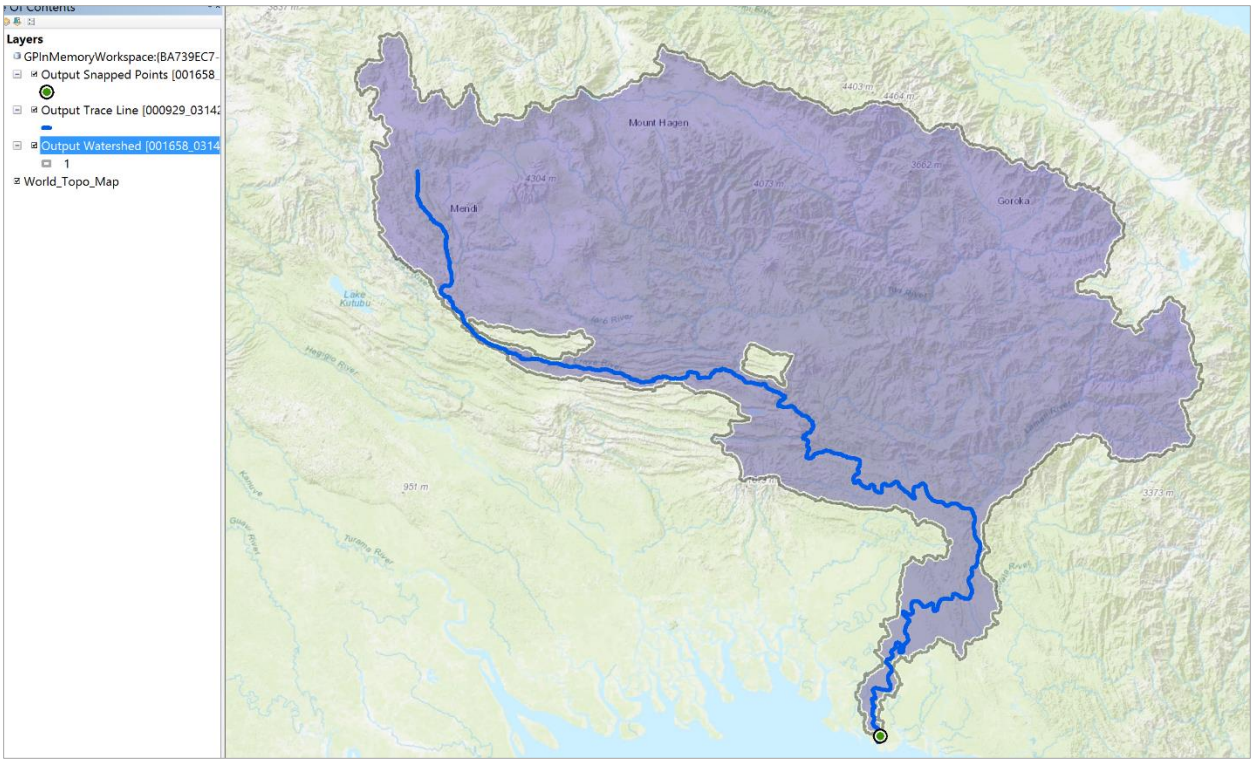


And now you'll see a nice Trace Downstream river line from Mendi to the coast

Now let's zoom in near the coast and click on the **Watershed** tool. Make the snap distance **500** meters, and Data Source Resolution **FINEST** and click on a point on the Purari River trace near the outlet at the coast.

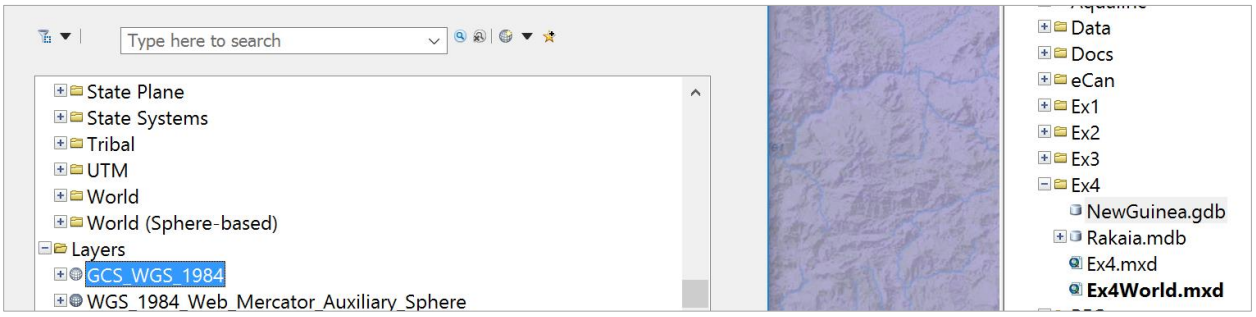


And you'll get a new point in your map display and a drainage area polygon (after a bit of waiting)

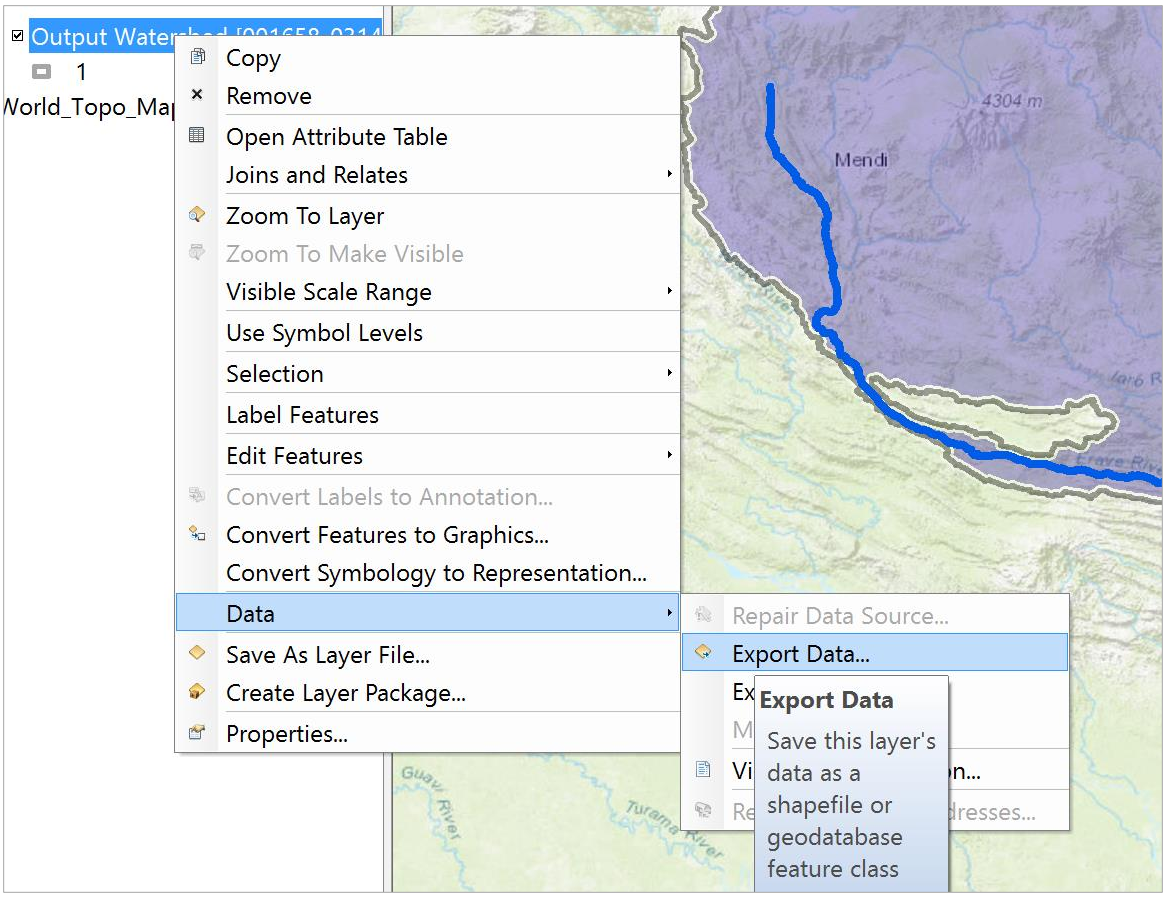


You'll see a couple of holes in this drainage area, which are regions that those who developed the dataset considered to be areas of internal drainage in the drainage basin.

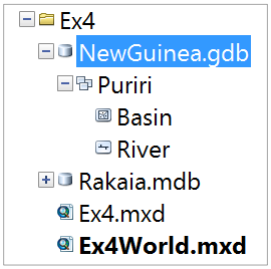
Lets build a new geodatabase called **NewGuinea** with a feature dataset called **Purari** and use the **GCS_WGS_1984** coordinate system.

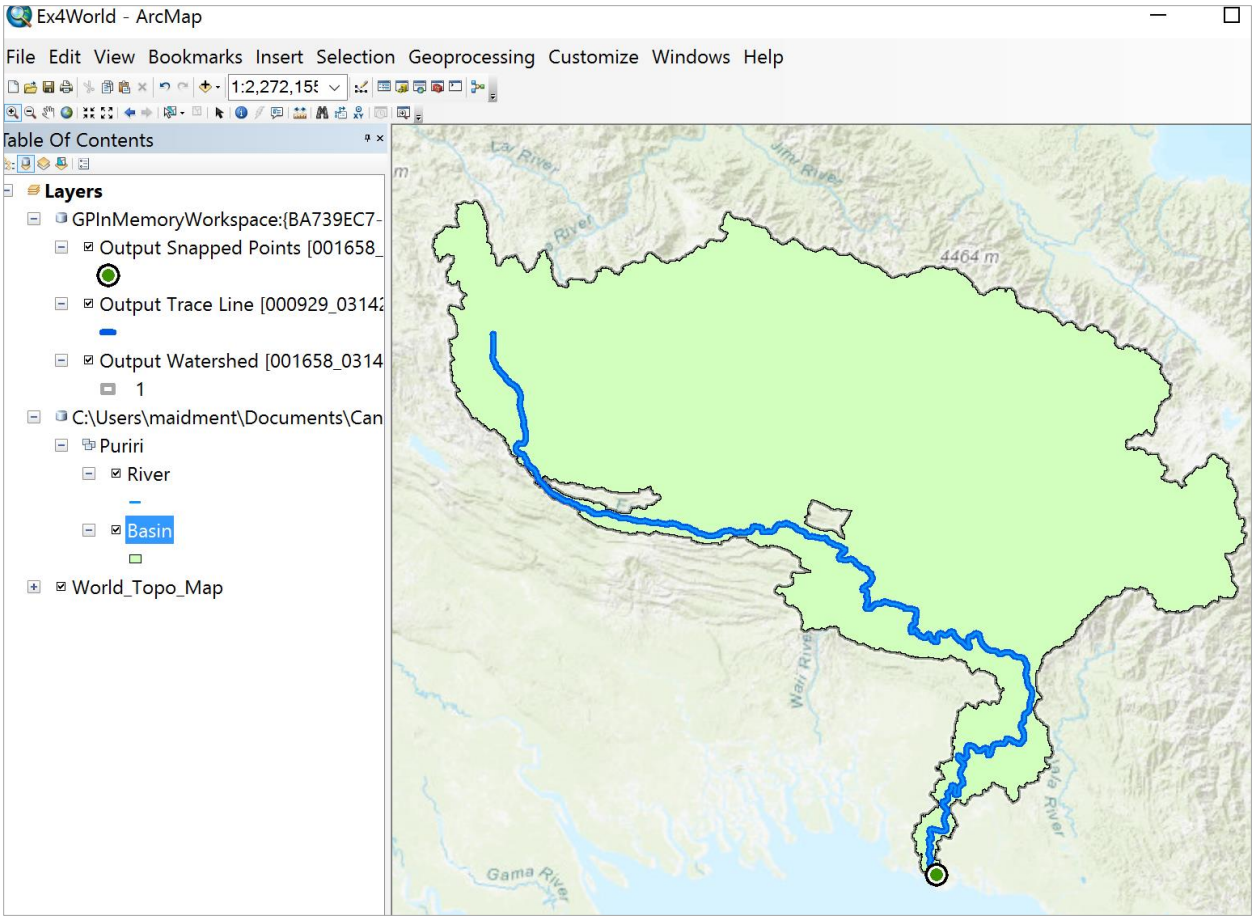


Now let's export the watershed boundary to a new feature class called **Basin**



And similarly export the Trace Downstream line as a new feature class called River and you'll find you've got a nice new geodatabase with two feature classes in it, Basin and River, that can serve as the Basemap for a study of the Purari river basin in Papua-New Guinea.





To be Turned In: A basemap of the Purari River basin in Papua-New Guinea.

Now that you've got the idea of how to create a new geodatabase and a basemap for a drainage area, I'd like you to create a comparable basemap for your Term Project study area, or if you are studying an abstract subject that doesn't have a drainage area associated with it, create a base map for a study area in some region of New Zealand or the world that interests you.

To be turned in: A basemap of a drainage area of your term project or of another drainage area that interests you. ***The Geodatabase containing this basemap should be zipped up and submitted through Learn*** *along with your pdf document that summarizes your response to the items requested in this exercise.*

Summary of Items to be Turned In:

(1) A map of the riverlines in the Rakaia Catchment. How many RiverLines do we have in the map? What is their total length (Km)? What is their average length (Km)?
(2) A Basemap of the Rakaia River Catchment. What is the drainage area (Sq Km) of this catchment?
(3) A basemap of the Purari River basin in Papua-New Guinea.
(4) A basemap of a drainage area of your term project or of another drainage area that interests you. ***The Geodatabase containing this basemap should be zipped up and***

submitted through Learn *along with your pdf document that summarizes your response to the items requested in this exercise.*