Water Data in Time and Space

Prepared by David R. Maidment
Waterways Centre for Freshwater Research
University of Canterbury

Based in part on material from Brent Watson
Horizons Regional Council
Palmerston North

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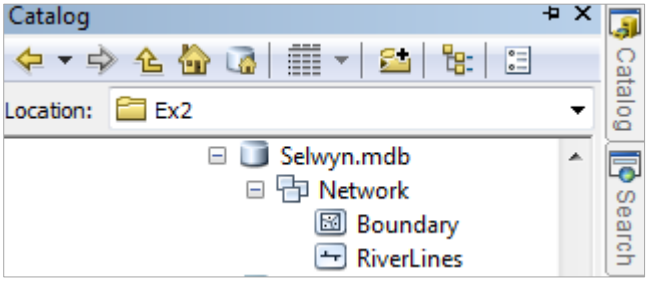
Goals of the Exercise

This exercise shows how hydrologic and water quality data are obtained using water data services, and how to create and work with a stream network for the Selwyn catchment.

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.

In the first part of this exercise using ArcGIS Desktop, you will be working with the following Geodatabase called **Selwyn**, which has a Feature Dataset within it called **Network**, and within that there are two feature classes **Boundary** and **RiverLines**, which are the Boundary of the Selwyn catchment and the River Environment Classification RiverLines for that area.



You can get these data from this zip file: http://www.caee.utexas.edu/prof/maidment/Canterbury/Ex3/Ex3Data.zip or from the UC Learn web site. You need to establish a working folder to do the exercise. This can be in any convenient location on the computer you are working on (e.g. …\Ex3\Ex3Data). After you have downloaded the zip file **Ex3Data.zip** double click on the file and you should see Winzip or other zip utility to open the file on your computer (if it doesn't open you'll have to unzip this file on a computer that has a zip utility installed).

Part One: Water Data in Time

When you are querying the LAWA web site for data or charts, what is actually happening behind the scenes is that queries are being made using a protocol called the Sensor Observations Service and the results are being returned in a language called WaterML2. These are standards of the Open Geospatial Consortium, whose protocols have been adopted by the Regional Councils and Crown Research Institutes in New Zealand to support open data sharing. We are hoping that the data services from these organizations will be opened up to all users but in the meantime, the following examples of water data services access from the Horizons Regional Council for data from the Mangatainoka River at Pahiatua Town Bridge are offered as examples.

Getting Flow Data from Mangatainoka River at Pahiatua Town Bridge

This example enables automated acquisition of daily mean flow or discharge data for the past two years. You will make a "Get Observation" request of the Sensor Observation Service (SOS) operated by the Horizons Regional Council, and you are using a service that has 4 parts:

- **Feature of Interest:** Mangatainoka at Pahiatua Town Bridge
- **Observed Property:** Flow Mean (1 Day) – this means the daily mean value of 5 minute observations
- **Procedure of Measurement:** [Water Level] – measurements of water level that have been converted to flow using a rating curve
- **Result:** Temporal Filter of P2Y which means the past 2 years backwards from the time that the request is made

Copy the text below, and launch the following web query from a web browser:

http://tsdata.horizons.govt.nz/contactrec.hts?Service=SOS&Request=GetObservation&FeatureOfInterest=Mangatainoka at Pahiatua Town Bridge&ObservedProperty=Flow Mean (1 Day)[Water Level]&TemporalFilter=om:phenomenonTime,P2Y

The result will emerge like this:

<?xml version="1.0"?>
<wml2:Collection xmlns:xlink="http://www.w3.org/1999/xlink" gml:id="wml2.collection.1"
xsi:schemaLocation="http://www.opengis.net/waterml/2.0 http://schemas.opengis.net/waterml/2.0/waterml2.xsd"
xmlns:wml2="http://www.opengis.net/waterml/2.0" xmlns:om="http://www.opengis.net/om/2.0"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
<wml2:metadata xlink:href="http://www.opengis.net/def/nil/OGC/0/missing"/>
<wml2:observationMember>
<om:OM_Observation gml:id="wml2.observationmember.1">
<om:phenomenonTime>
<gml:TimePeriod gml:id="om.phenomenontime.1">
<gml:beginPosition>2016-03-05T00:00:00+12:00</gml:beginPosition>
<gml:endPosition>2018-03-05T00:00:00+12:00</gml:endPosition>
</gml:TimePeriod>
</om:phenomenonTime>
<om:resultTime>
<gml:TimeInstant gml:id="om.resulttime.1">
<gml:timePosition>2018-03-06T15:52:41+12:00</gml:timePosition>
</gml:TimeInstant>
</om:resultTime>
<om:procedure xlink:title="Water Level" xlink:href="https://registry.scinfo.org.nz/lab/nems/def/procedure/Water Level"/>
<om:observedProperty xlink:title="Flow Mean (1 Day)[Water Level]"
xlink:href="https://registry.scinfo.org.nz/lab/nems/def/property/Flow Mean (1 Day)[Water Level]"/>
<om:featureOfInterest xlink:title="Mangatainoka at Pahiatua Town Bridge"
xlink:href="https://registry.scinfo.org.nz/lab/nems/def/"/>
<om:result>
<wml2:MeasurementTimeseries gml:id="wml2.measurementtimeseries.1">
<wml2:defaultPointMetadata>
<wml2:DefaultTVPMeasurementMetadata>
<wml2:uom code="l/s"/>
<wml2:interpolationType xlink:title="Average in preceding interval"
xlink:href="http://www.opengis.net/def/waterml/2.0/interpolationType/AveragePrec"/>
</wml2:DefaultTVPMeasurementMetadata>
</wml2:defaultPointMetadata>
<wml2:point>
<wml2:MeasurementTVP>
<wml2:time>2016-03-05T00:00:00+12:00</wml2:time>
<wml2:value>1240</wml2:value>
</wml2:MeasurementTVP>
</wml2:point>
<wml2:point>
<wml2:MeasurementTVP>
<wml2:time>2016-03-06T00:00:00+12:00</wml2:time>
<wml2:value>1200</wml2:value>
</wml2:MeasurementTVP>
</wml2:point>

To be turned in: A screen capture of the header of your WaterML response for flow along with the first couple of data values, as shown above. What is the time period of your data request (from date, to date)? What are the units of the flow data? What was the mean daily flow of the Mangatainoka River at Pahiatua Town Bridge on 5 March 2018?

Getting E. Coli Data from Mangatainoka River at Pahiatua Town Bridge

In a similar way as for the flow data, launch the query:

http://hilltopserver.horizons.govt.nz/cr_provisional.hts?Service=SOS&Request=GetObservation&FeatureOfInterest=Mangatainoka at Pahiatua Town Bridge&ObservedProperty=E. coli by MPN (HRC)[E. coli by MPN (HRC)]&TemporalFilter=om:phenomenonTime,P2Y

and the result appears as:

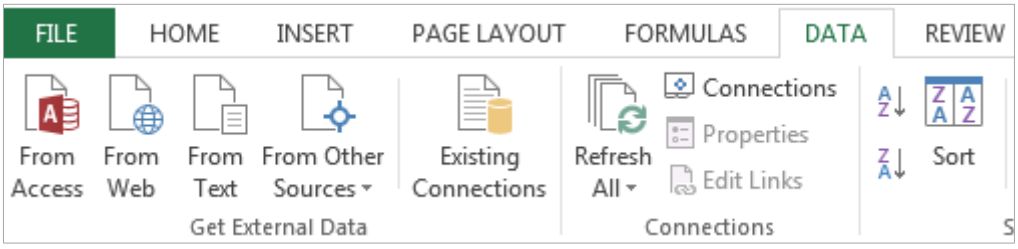
<?xml version="1.0"?>
<wml2:Collection gml:id="wml2.collection.1" xsi:schemaLocation="http://www.opengis.net/waterml/2.0 http://schemas.opengis.net/waterml/2.0/waterml2.xsd" xmlns:wml2="http://www.opengis.net/waterml/2.0" xmlns:om="http://www.opengis.net/om/2.0" xmlns:ogc="http://www.opengis.net/ogc" xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
<wml2:metadata xlink:href="http://www.opengis.net/def/nil/OGC/0/missing"/>
<wml2:observationMember>
<om:OM_Observation gml:id="wml2.observationmember.1">
<om:phenomenonTime>
<gml:TimePeriod gml:id="om.phenomenontime.1">
<gml:beginPosition>2016-11-30T09:22:00+12:00</gml:beginPosition>
<gml:endPosition>2018-02-27T09:00:00+12:00</gml:endPosition>
</gml:TimePeriod>
</om:phenomenonTime>
<om:resultTime>
<gml:TimeInstant gml:id="om.resulttime.1">
<gml:timePosition>2018-03-06T16:33:45+12:00</gml:timePosition>
</gml:TimeInstant>
</om:resultTime>
<om:procedure xlink:title="E. coli by MPN (HRC)" xlink:href="http://hilltopserver.horizons.govt.nz/def/procedure/E. coli by MPN (HRC)"/>
<om:observedProperty xlink:title="E. coli by MPN (HRC)[E. coli by MPN (HRC)]" xlink:href="http://hilltopserver.horizons.govt.nz/def/property/E. coli by MPN (HRC)[E. coli by MPN (HRC)]"/>
<om:featureOfInterest xlink:title="Mangatainoka at Pahiatua Town Bridge" xlink:href="http://hilltopserver.horizons.govt.nz/def/"/>
<om:result>
<wml2:MeasurementTimeseries gml:id="wml2.measurementtimeseries.1">
<wml2:defaultPointMetadata>
<wml2:DefaultTVPMeasurementMetadata>
<wml2:uom code="MPN/100mL"/>
<wml2:interpolationType xlink:title="Discontinuous" xlink:href="http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous"/>
</wml2:DefaultTVPMeasurementMetadata>
</wml2:defaultPointMetadata>
<wml2:point>
<wml2:MeasurementTVP>
<wml2:time>2016-11-30T09:22:00+12:00</wml2:time>
<wml2:value>650</wml2:value>
</wml2:MeasurementTVP>
</wml2:point>
<wml2:point>
<wml2:MeasurementTVP>
<wml2:time>2016-12-06T08:50:00+12:00</wml2:time>
<wml2:value>190</wml2:value>
</wml2:MeasurementTVP>
</wml2:point>

To be turned in: A screen capture of the header of your WaterML response for E. Coli along with the first couple of data values, as shown above. What is the Feature of Interest, Observed Property, Procedure of Measurement and Temporal Domain of the Result? What is the time period of your data request (from date, to date)? What are the units of the E. Coli data?

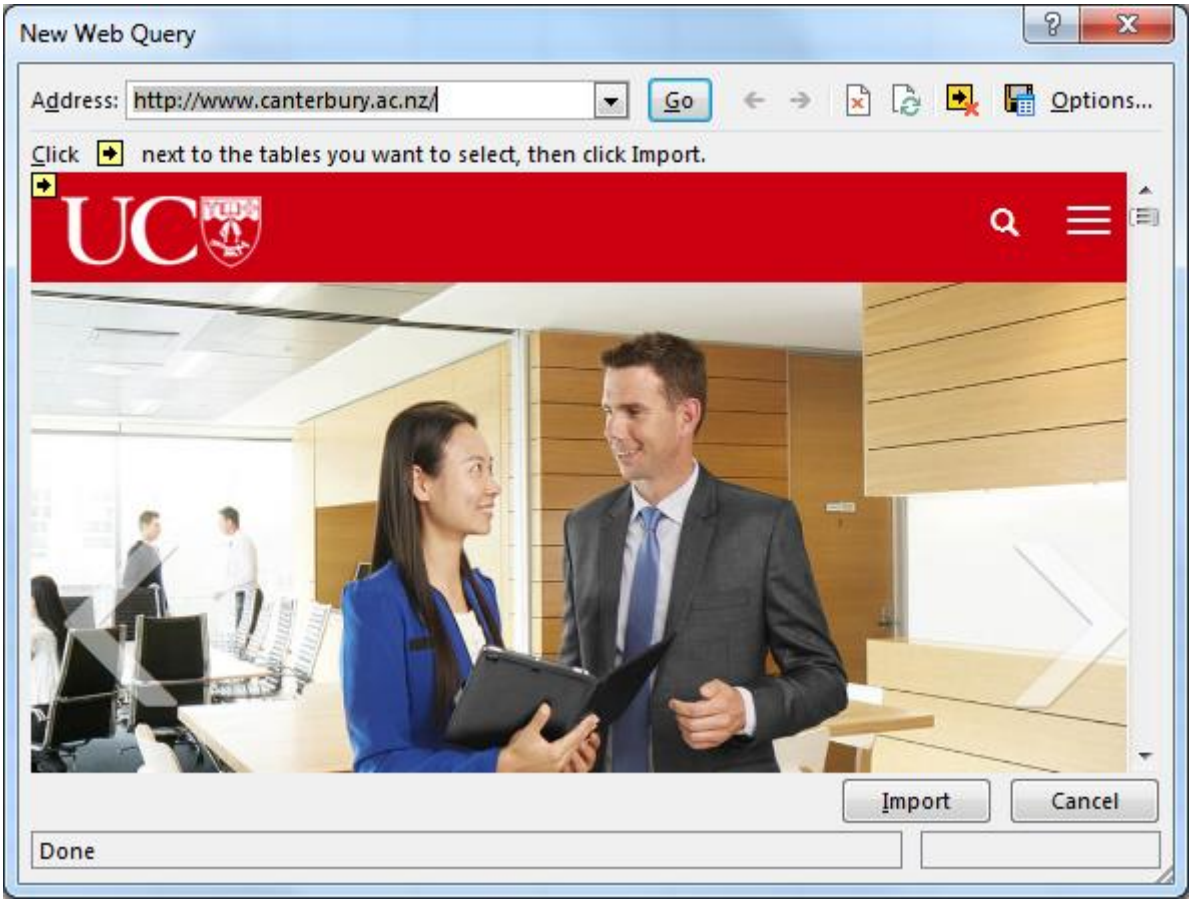
Using Water Data Services from Excel

As you would appreciate, web services are great for computers but not easy to interpret for hand computation. Excel knows how to read XML documents and to parse the information they contain into data fields.

Open Excel and within a blank worksheet, select the **Data** ribbon and **From Web** function within the **Get external Data** toolset.



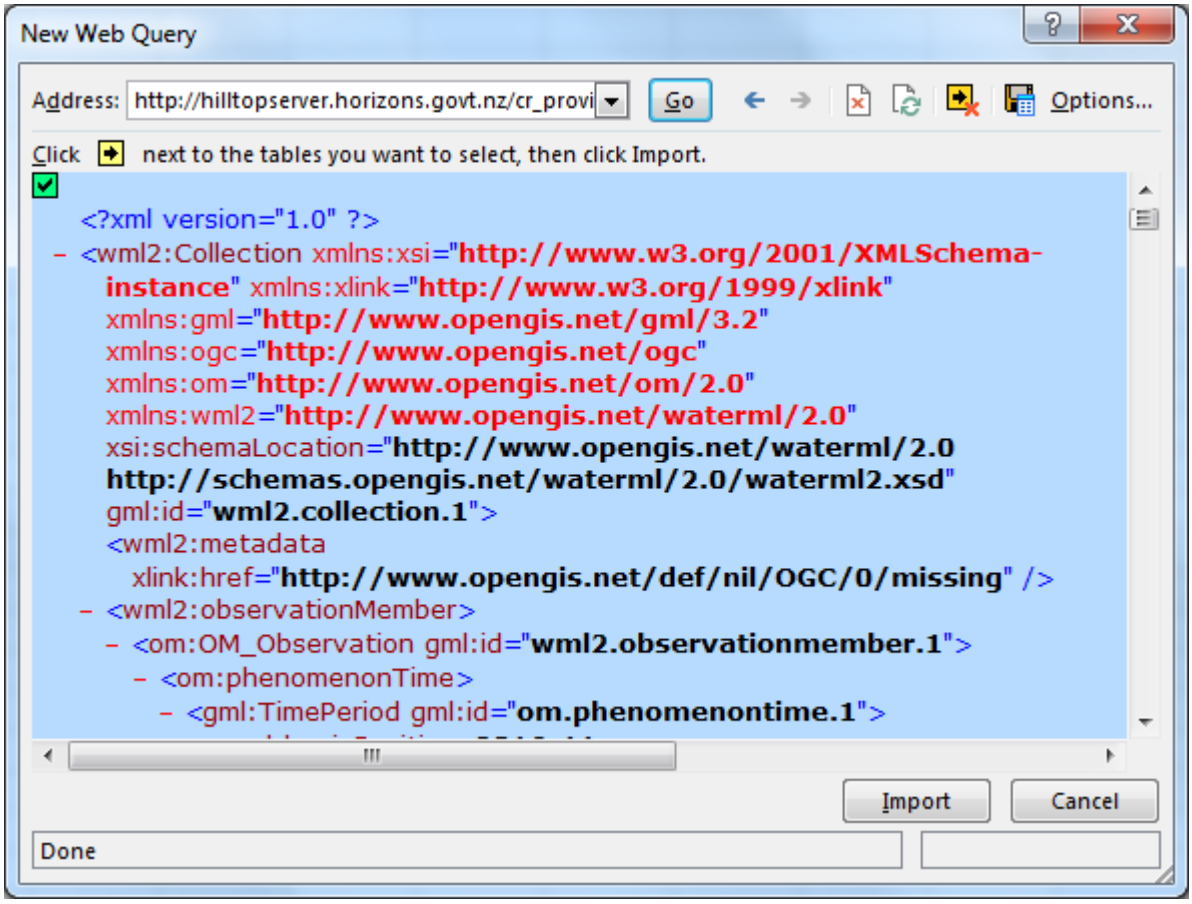
A popup web-query will default to your default webpage.



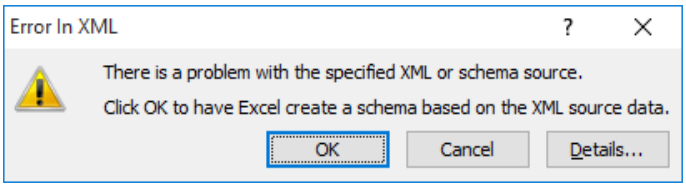
Copy and paste the same web query that we used for E Coli previously into the address bar where http://www.canterbury.ac.nz appears above. Here is the web query again:

http://hilltopserver.horizons.govt.nz/cr_provisional.hts?Service=SOS&Request=GetObservation&FeatureOfInterest=Mangatainoka at Pahiatua Town Bridge&ObservedProperty=E. coli by MPN (HRC)[E. coli by MPN (HRC)]&TemporalFilter=om:phenomenonTime,P2Y

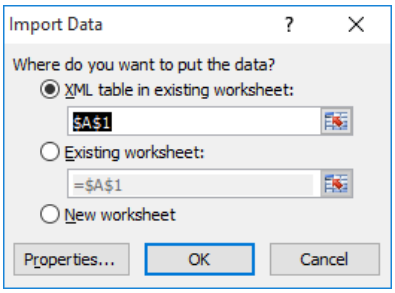
Hit **Go** and you'll see the same XML response that you saw before come up. Click on the little yellow arrow in the top left corner of display area so that it turns into a green check mark, as shown below, and hit **Import**.



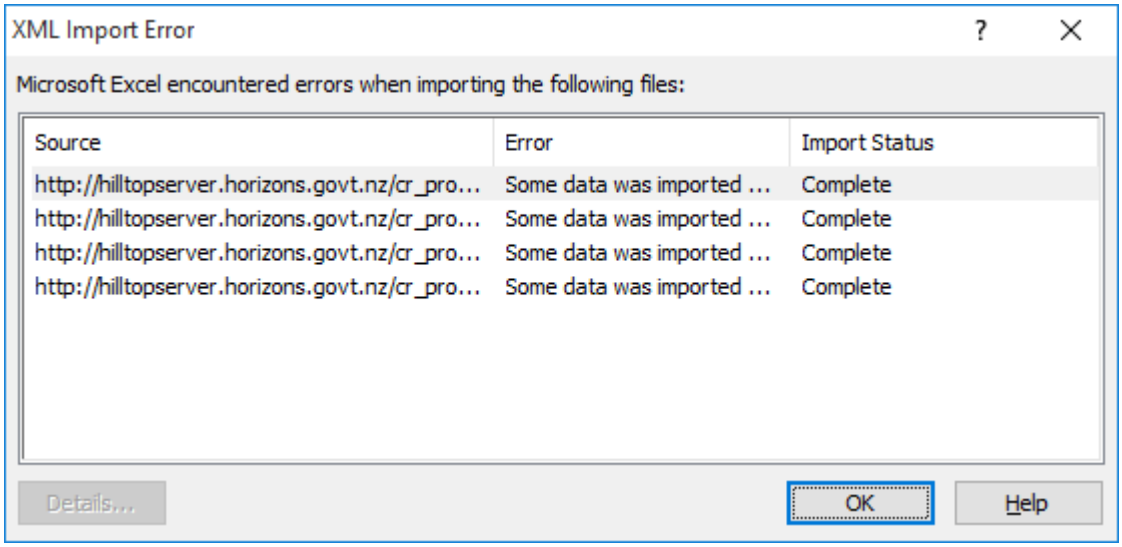
Excel doesn't know how to interpret all the header information in the WaterML2.0 Schema; however we are happy to allowing Excel to create a new schema from the (time, value) pairs of data in the repeated rows below the header. Select **OK** when you see the query below.



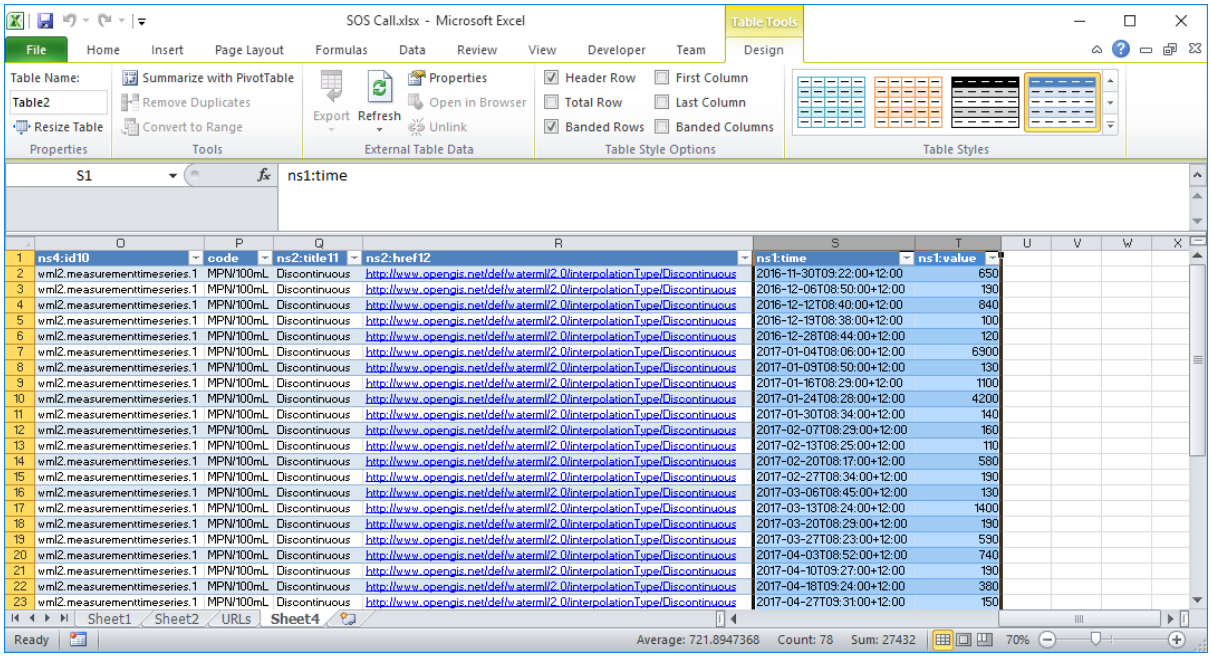
Select where in the workbook you want to place the data.



Excel will report at the importing steps and display any errors.



The final import contains a number of columns due to the complexity of the WaterML2.0 schema. Column S & T contains the (Time,Value) pairs.



note: the date &time is provided in Universal Time Coordinate system format.

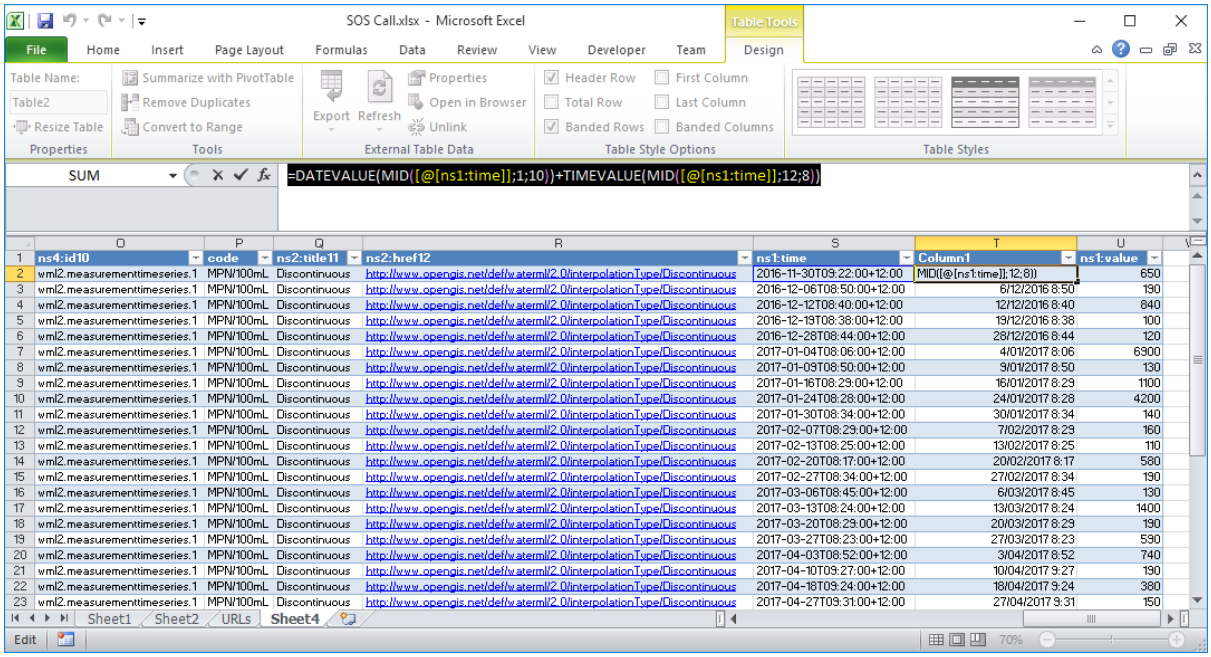
Converting UTC time.

If you require the UTC date time format to be converted to more common dd/mm/YYYY HH:MM:SS then you will need to decompose the UTC string. The following instruction is a basic solution that can be undertaken.

Insert a new column and type in the following formula.

=DATEVALUE(MID(*##Cell Reference##;*1;10))+TIMEVALUE(MID(*##Cell Reference##*;12;8))

=DATEVALUE(MID([@[ns1:time]];1;10))+TIMEVALUE(MID([@[ns1:time]];12;8))

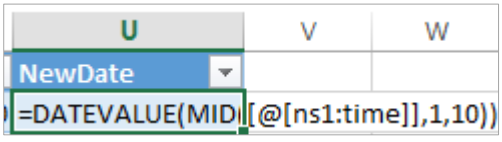


	O	P	Q	R	S	T	U
1	ns4:id10	code	ns2:title11	ns2:href12	ns1:time	Column1	ns1:value
2	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2016-11-30T09:22:00+12:00	MID([@[ns1:time]];12;8))	650
3	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2016-12-06T08:50:00+12:00	6/12/2016 8:50	190
4	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2016-12-12T08:40:00+12:00	12/12/2016 8:40	840
5	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2016-12-19T08:38:00+12:00	19/12/2016 8:38	100
6	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2016-12-28T08:44:00+12:00	28/12/2016 8:44	120
7	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-01-04T08:06:00+12:00	4/01/2017 8:06	6300
8	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-01-09T08:50:00+12:00	9/01/2017 8:50	130
9	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-01-16T08:29:00+12:00	16/01/2017 8:29	1100
10	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-01-24T08:28:00+12:00	24/01/2017 8:28	4200
11	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-01-30T08:34:00+12:00	30/01/2017 8:34	140
12	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-02-07T08:29:00+12:00	7/02/2017 8:29	160
13	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-02-13T08:25:00+12:00	13/02/2017 8:25	110
14	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-02-20T08:17:00+12:00	20/02/2017 8:17	580
15	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-02-27T08:34:00+12:00	27/02/2017 8:34	190
16	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-03-06T08:45:00+12:00	6/03/2017 8:45	130
17	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-03-13T08:24:00+12:00	13/03/2017 8:24	1400
18	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-03-20T08:29:00+12:00	20/03/2017 8:29	190
19	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-03-27T08:23:00+12:00	27/03/2017 8:23	530
20	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-04-03T08:52:00+12:00	3/04/2017 8:52	740
21	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-04-10T09:27:00+12:00	10/04/2017 9:27	190
22	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-04-18T09:24:00+12:00	18/04/2017 9:24	380
23	wml2.measurementtimeseries.1	MPN/100mL	Discontinuous	http://www.opengis.net/def/waterml/2.0/interpolationType/Discontinuous	2017-04-27T09:31:00+12:00	27/04/2017 9:31	150

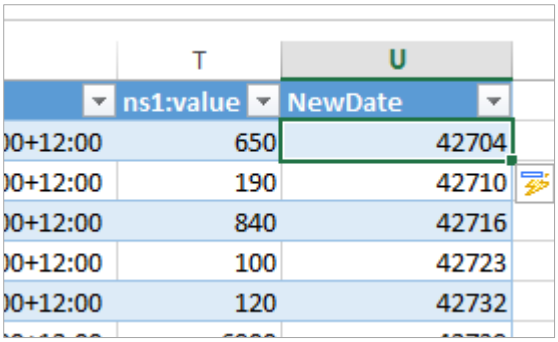
Now you have time series data. The time stamp in column S can be converted into a normal Excel date as follows. Create a new column called **NewDate** and set the resulting formula in the first row of this new column as:

=DATEVALUE(MID([@[ns1:time]],1,10))

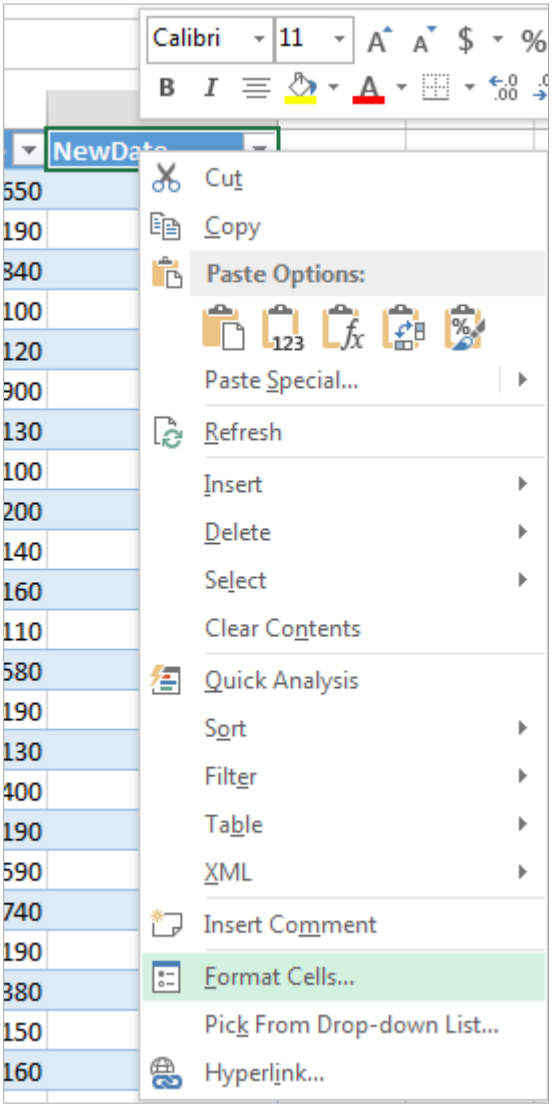
This query is using two Excel functions, DATEVALUE and MID, one inside the other. The MID function selects the text value from the column that it is pointing to (the time field), and isolates the first 10 characters in that field, 2016-11-30, and then the DATEVALUE function converts these into an Excel Date format.

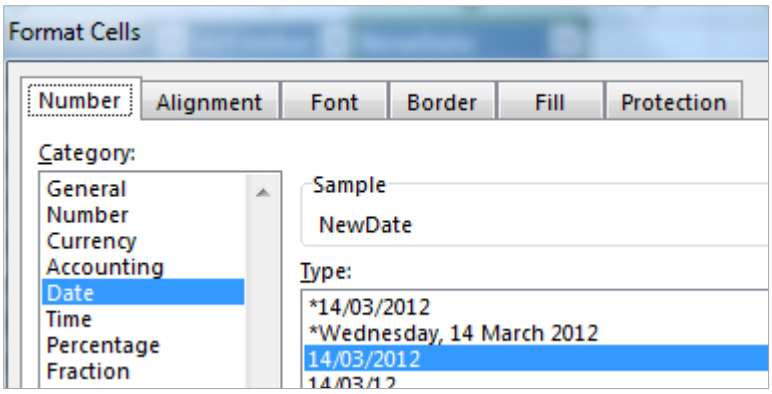


You'll see that Excel creates a column of integers that look incomprehensible. However, if you divide the first number, 42704 by 365.25 you'll get the result 116.9172, which means that this value is 116.91 years from January 1, 1900. This date is actually November 30, 2016 so you can see the connection.



Right click on this column and select **Format Cells**



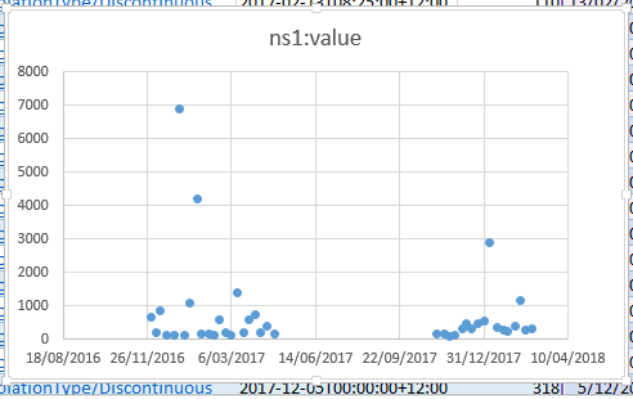


And you'll get a nicely formatted date field.

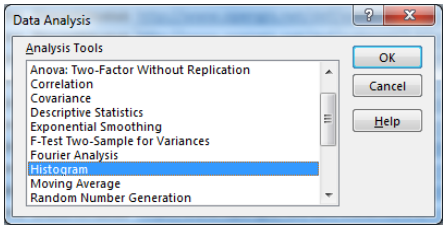
	T	U
	ns1:value	NewDate
12:00	650	30/11/2016
12:00	190	6/12/2016
12:00	840	12/12/2016
12:00	100	19/12/2016
12:00	120	28/12/2016
12:00	6900	4/01/2017
12:00	130	9/01/2017
12:00	1100	16/01/2017

Plot a nice time series chart of these data and find the critical percentile values of these data that correspond to the New Zealand coliform data standards.

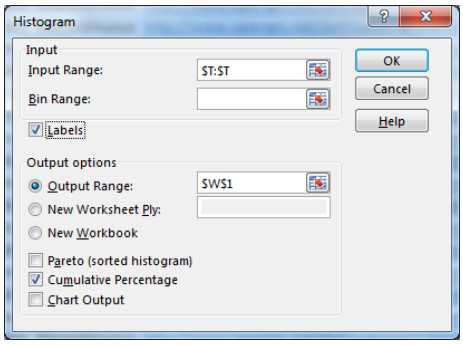
R	S	T	U	V	W
	ns1:time	ns1:value	NewDate	ns1:value	
/waterml/2.0/interpolationType/Discontinuous	2016-11-30T09:22:00+12:00	650	30/11/2016	650	
/waterml/2.0/interpolationType/Discontinuous	2016-12-06T08:50:00+12:00	190	6/12/2016	190	
/waterml/2.0/interpolationType/Discontinuous	2016-12-12T08:40:00+12:00	840	12/12/2016	840	
/waterml/2.0/interpolationType/Discontinuous	2016-12-19T08:38:00+12:00	100	19/12/2016	100	
/waterml/2.0/interpolationType/Discontinuous	2016-12-28T08:44:00+12:00	120	28/12/2016	120	
/waterml/2.0/interpolationType/Discontinuous	2017-01-04T08:06:00+12:00	6900	4/01/2017	6900	
/waterml/2.0/interpolationType/Discontinuous	2017-01-09T08:50:00+12:00	130	9/01/2017	130	
/waterml/2.0/interpolationType/Discontinuous	2017-01-16T08:29:00+12:00	1100	16/01/2017	1100	
/waterml/2.0/interpolationType/Discontinuous	2017-01-24T08:28:00+12:00	4200	24/01/2017	4200	
/waterml/2.0/interpolationType/Discontinuous	2017-01-30T08:34:00+12:00	140	30/01/2017	140	
/waterml/2.0/interpolationType/Discontinuous	2017-02-07T08:29:00+12:00	160	7/02/2017	160	
/waterml/2.0/interpolationType/Discontinuous	2017-02-13T08:25:00+12:00	110	13/02/2017	110	
/waterml/2.0/interpo			0	580	
/waterml/2.0/interpo			017	190	
/waterml/2.0/interpo			0	130	
/waterml/2.0/interpo			017	1400	
/waterml/2.0/interpo			0	190	
/waterml/2.0/interpo			017	590	
/waterml/2.0/interpo			017	740	
/waterml/2.0/interpo			017	190	
/waterml/2.0/interpo			017	380	
/waterml/2.0/interpo			017	150	
/waterml/2.0/interpo			017	160	
/waterml/2.0/interpo			017	145	
/waterml/2.0/interpo			017	86	
/waterml/2.0/interpo			017	121	
/waterml/2.0/interpolationType/Discontinuous	2017-12-05T00:00:00+12:00	318	5/12/2017	318	



You can construct a histogram of these data by using the Excel Analysis Toolpak option Histogram



Using the following options (be careful to click on Cumulative Percentage)



And you will get a cumulative frequency curve of the E. Coli data:

W	X	Y
Bin	*Frequency*	*umulative %*
86	1	2.56%
92.6608	0	2.56%
99.3216	0	2.56%
105.9824	1	5.13%
112.6432	1	7.69%
119.304	0	7.69%
125.9648	2	12.82%
132.6256	2	17.95%
139.2864	0	17.95%
145.9472	2	23.08%
152.608	1	25.64%

Below are the New Zealand human health standards for E. Coli. These are taken from p.39 of the **National Policy Statement for Freshwater Management, 2014**, which is posted on the course web page along with this assignment.

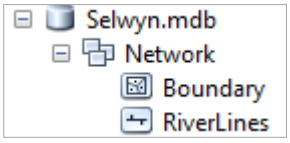
Value	Human health for recreation				
Freshwater Body Type	Lakes and rivers				
Attribute	*Escherichia coli (E. coli)*				
Attribute Unit	*E. coli*/100 mL (number of *E. coli* per hundred millilitres)				
Attribute State[1,2]	Numeric Attribute State				Narrative Attribute State
	% exceedances over 540 cfu/100 mL	% exceedences over 260 cfu/100 mL	Median concentration (cfu/100 mL)	95th percentile of *E. coli*/100 mL	Description of risk of Campylobacter infection (based on *E. coli* indicator)
A (Blue)	<5%	<20%	≤130	≤540	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk) The predicted average infection risk is 1%*
B (Green)	5-10%	20-30%	≤130	≤1000	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk) The predicted average infection risk is 2%*
C (Yellow)	10-20%	20-34%	≤130	≤1200	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk) The predicted average infection risk is 3%*
D (Orange)	20-30%	>34%	>130	>1200	20-30% of the time the estimated risk is ≥50 in 1000 (>5% risk) The predicted average infection risk is >3%*

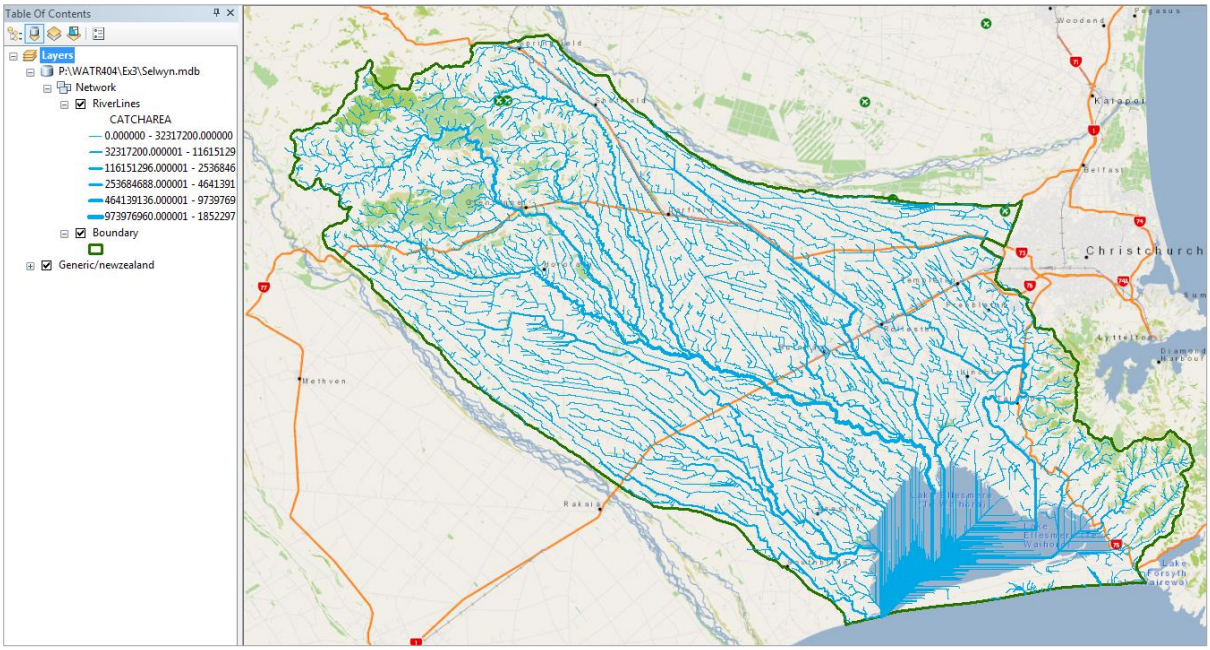
To be turned in: Plot a nice time series chart of these data and find the critical percentile values of these data that correspond to the New Zealand coliform data standards. What quality level do these data represent?

Part 2. Water Data in Space

River Network for the Selwyn Catchment

Open ArcMap, select a base map, open the data file **Ex3Data.zip** and from the **Selwyn** geodatabase, add the **Boundary** and **RiverLines** feature classes to the map display. Symbolize the river lines using the **CatchArea** attribute.





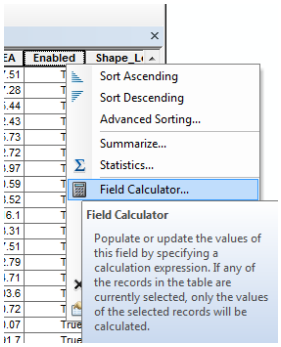
Open the Attribute Table for RiverLines and check if the **Enabled** field is set to **True**. If so, the geometric network cannot be formed with this feature class.

Table

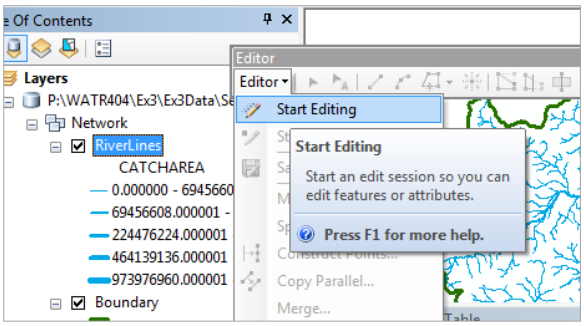
RiverLines

CSOFGL	CSOFGLNP	CSOFGLNPVL	SPRING	NZFNODE	NZTNODE	CATCHAREA	DISTSEA	Enabled	Shape_Length
CD/L/AI/P	CD/L/AI/P/LO	CD/L/AI/P/LO/MG	-	13039623	13039624	234000	75227.51	True	29.9911
CD/H/AI/P	CD/H/AI/P/LO	CD/H/AI/P/LO/LG	-	13039589	13039728	657900	93567.28	True	1121.225197
CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/LG	-	13039709	13039728	6057000	93035.44	True	589.53701
CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/MG	-	13039778	13039709	5432400	93932.43	True	896.730193
CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/LG	-	13039728	13039796	7089300	92445.73	True	1385.99865
CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/HG	-	13039875	13039709	297900	93672.72	True	637.104612
CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/LG	-	13039917	13039778	3579300	94693.97	True	761.33166
CD/H/AI/P	CD/H/AI/P/LO	CD/H/AI/P/LO/HG	-	13039938	13039796	993600	92920.59	True	1860.718912
CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/HG	-	13039952	13039778	1067400	95788.52	True	1855.585946
CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/HG	-	13039995	13039917	307800	95116.1	True	422.015345
CD/L/AI/P	CD/L/AI/P/LO	CD/L/AI/P/LO/LG	-	13040069	13039624	1348200	77613.31	True	2415.103329
CD/L/AI/P	CD/L/AI/P/LO	CD/L/AI/P/LO/LG	-	13039624	13040103	3733200	75197.51	True	3838.351979

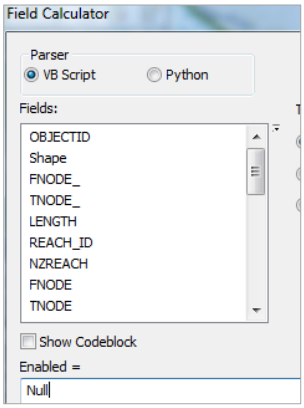
To avoid this problem, do a calculation that sets the Enabled field to **Null** and then you'll be good to go with these or other river lines that you want to make into a network.



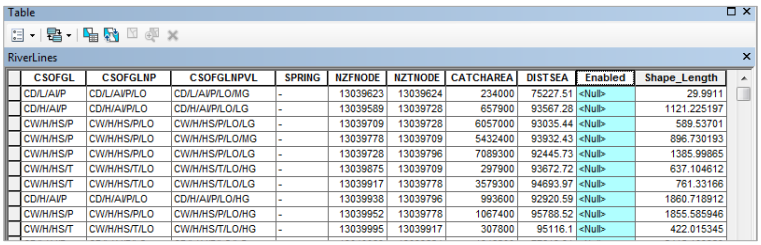
If the field calculator is greyed out, right click of on the right of the ArcMap ribbon, turn on the Editor tool and start editing the data



Here is how to set the calculation in the field calculator:

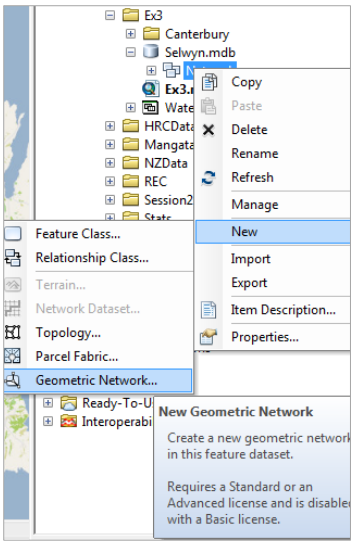


and you get this result, as needed.

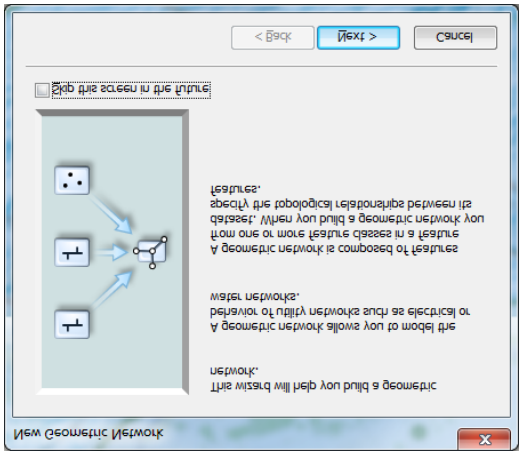


CSOFGL	CSOFGLNP	CSOFGLNPVL	SPRING	NZFNODE	NZTNODE	CATCHAREA	DISTSEA	Enabled	Shape_Length
CD/L/AI/P	CD/L/AI/P/LO	CD/L/AI/P/LO/MG	-	13039623	13039624	234000	75227.51	<Null>	29.9911
CD/H/AI/P	CD/H/AI/P/LO	CD/H/AI/P/LO/LG	-	13039589	13039728	657900	93567.28	<Null>	1121.225197
CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/LG	-	13039709	13039728	6057000	93035.44	<Null>	589.53701
CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/MG	-	13039778	13039709	5432400	93932.43	<Null>	896.730193
CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/LG	-	13039728	13039796	7089300	92445.73	<Null>	1385.99865
CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/HG	-	13039875	13039709	297900	93672.72	<Null>	637.104612
CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/LG	-	13039917	13039778	3579300	94693.97	<Null>	761.33166
CD/H/AI/P	CD/H/AI/P/LO	CD/H/AI/P/LO/HG	-	13039938	13039796	993600	92920.59	<Null>	1860.718912
CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/HG	-	13039952	13039778	1067400	95788.52	<Null>	1855.585946
CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/HG	-	13039995	13039917	307800	95116.1	<Null>	422.015345

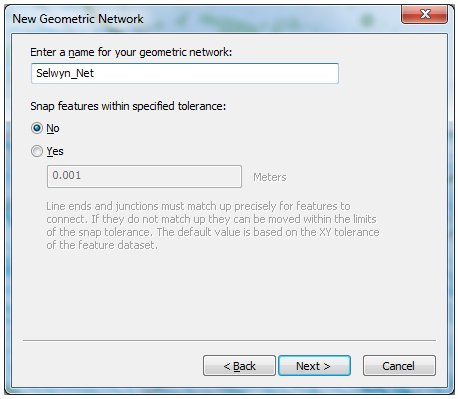
In ArcCatalog, Right click on the **Network Feature Dataset** and create a **New Geometric Network**



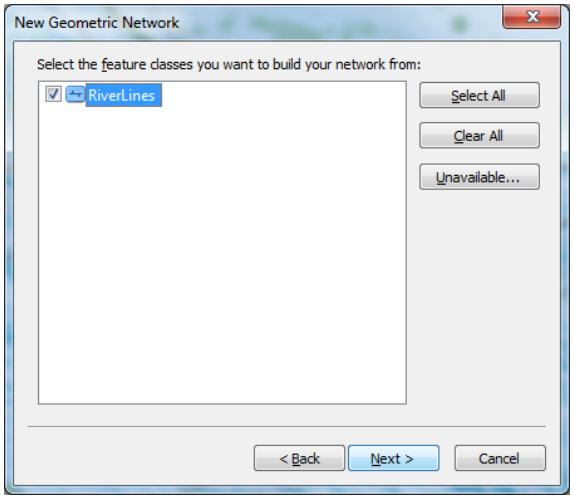
You'll see the following screen pop up, and hit **Next**



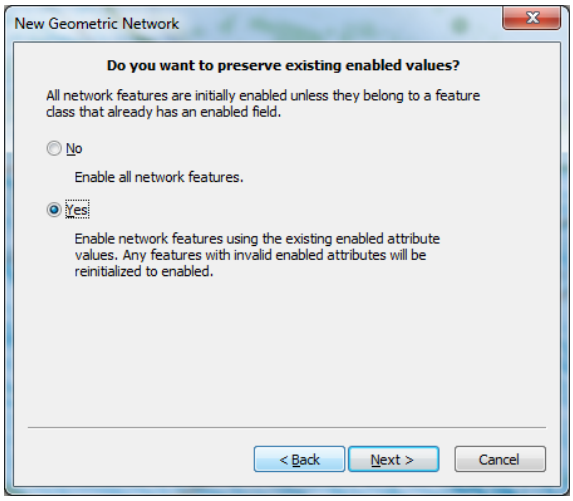
Name your network **Selwyn_Net** and hit **Next**



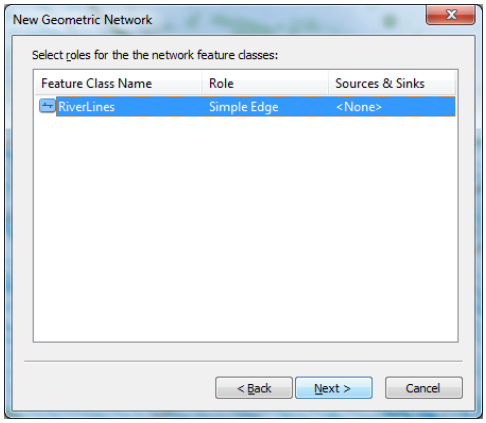
Select **RiverLines** to participate in the network and hit **Next**



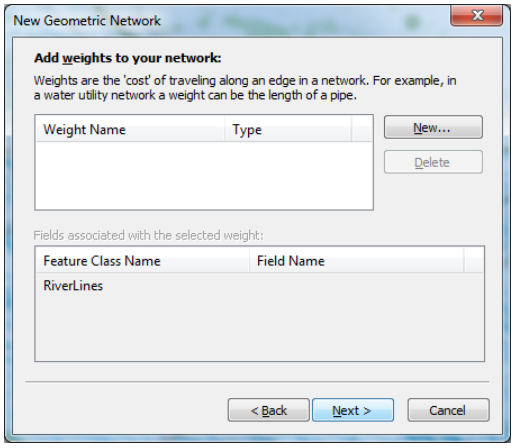
and hit **Next** again



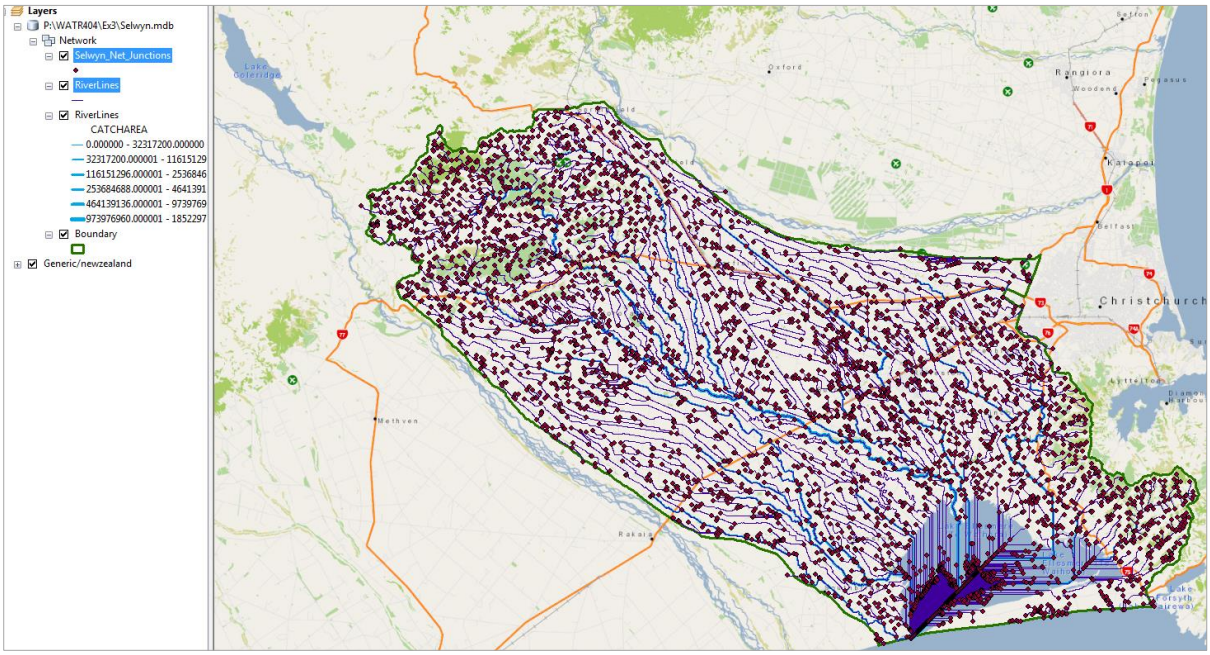
Select **RiverLines** to be your **SimpleEdge** feature class in the network



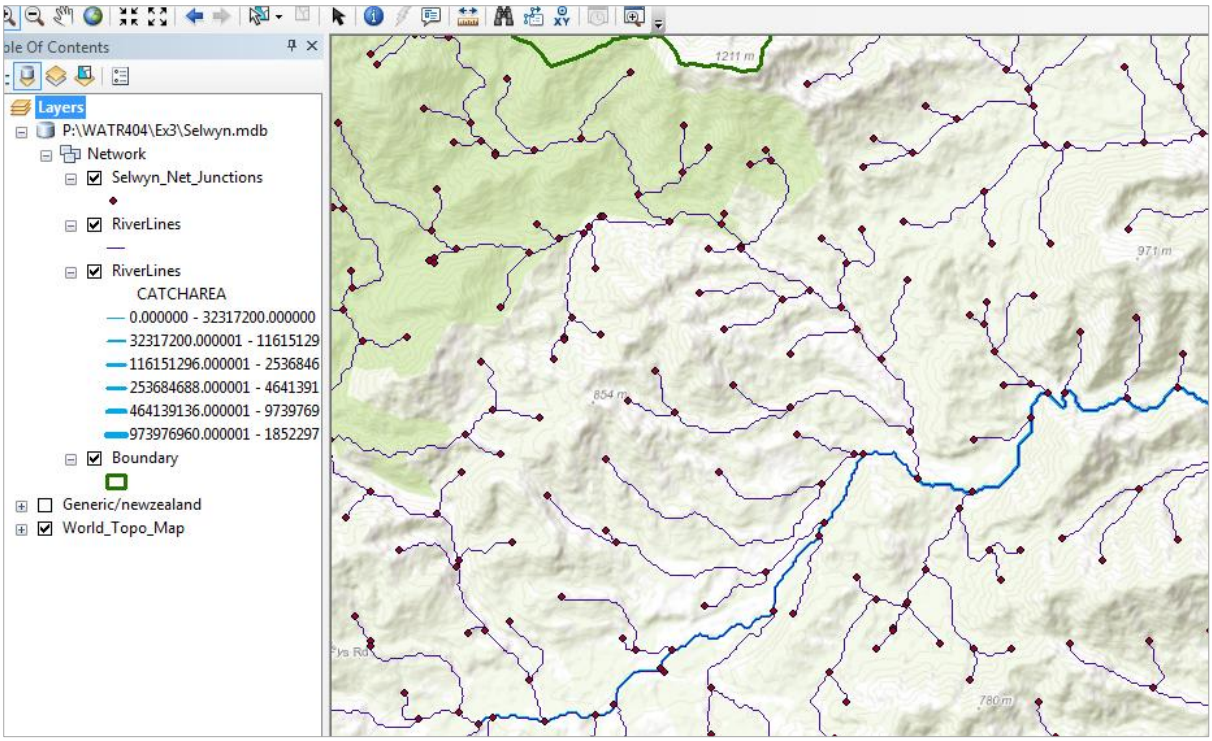
Hit **Next**



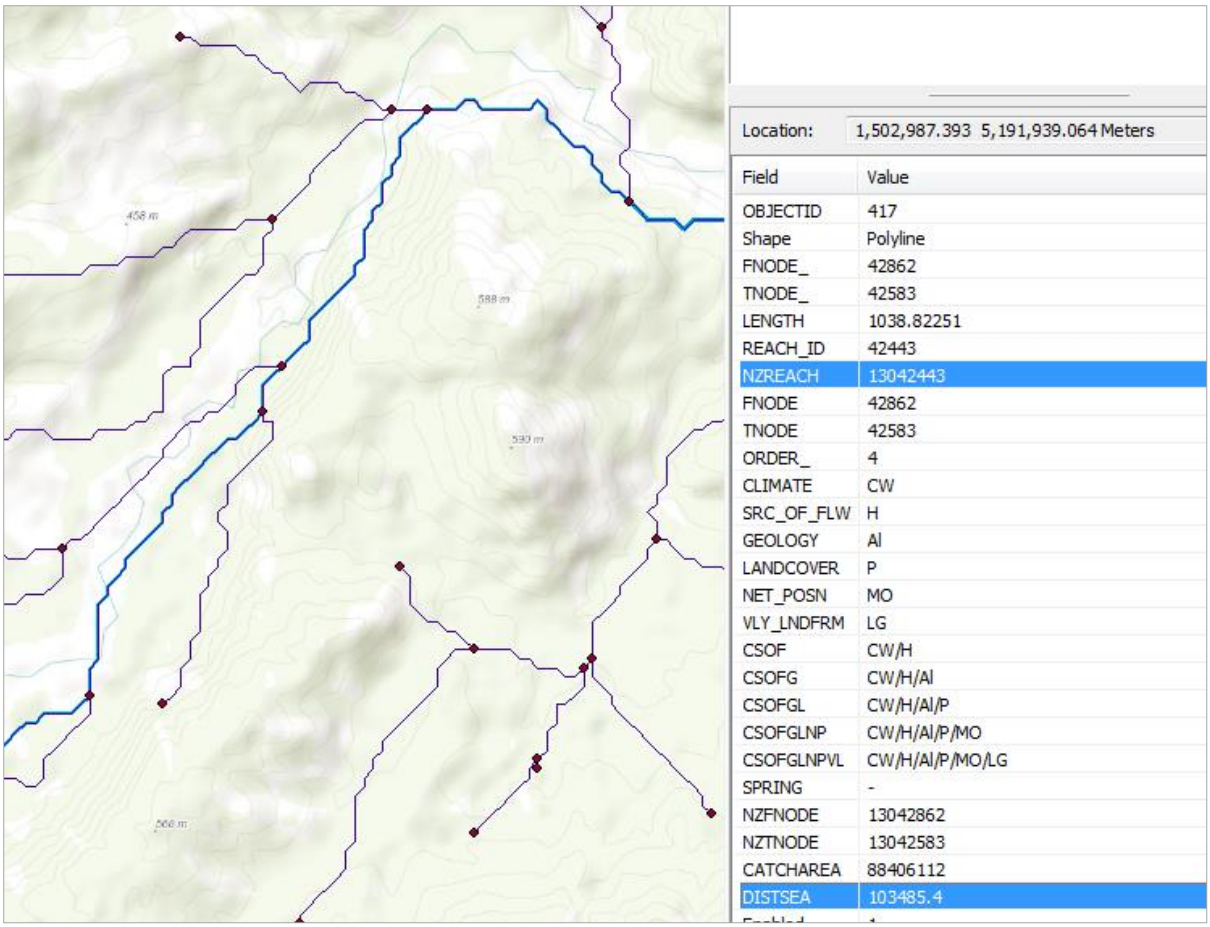
and lastly **Finish.** You'll see the computer think for a while and then come up with a new Geometric Network that has Junctions to connect every Edge. What has happened is that each RiverLine feature now knows what river lines it is connected to.



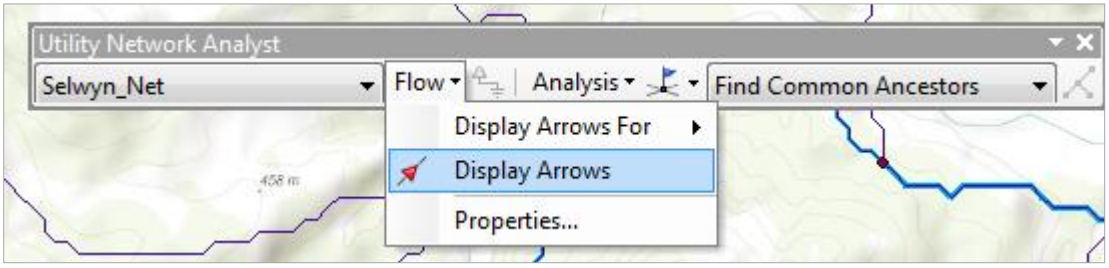
There seems to be a systematic displacement between the REC river lines and the river line images below in the **Generic New Zealand** base map we've been using, so let's use the **World Topo Map** basemap instead and zoom in to a particular area within the network.



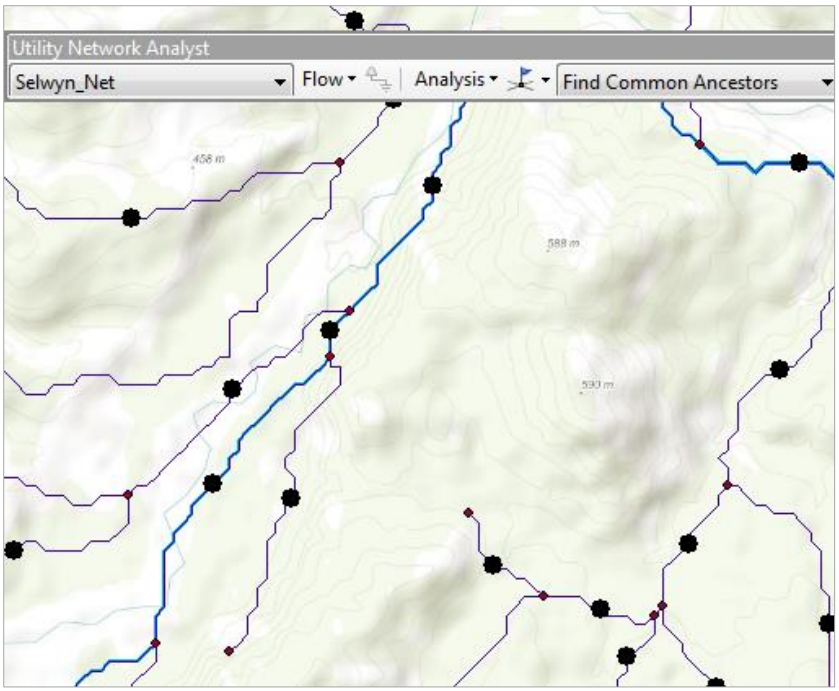
If we do a query using the tool, you'll see a set of attributes for each reach that includes its **NZREACH** number that is unique for all of the 600,000 reaches in New Zealand, and also **DISTSEA** which is the distance downstream from this reach that the water flow reaches the sea in meters. In the example shown this is 103485 meters or 103.485 km.



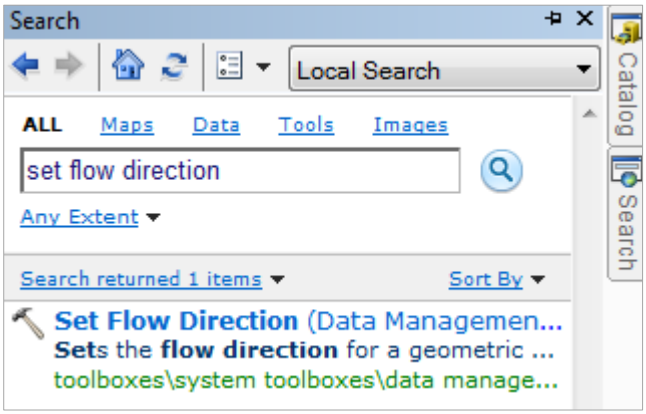
Right click on the grey area on the right hand side of the top ribbon in ArcMap and select **Utility Network Analyst**. Select **Flow/Display Arrows**



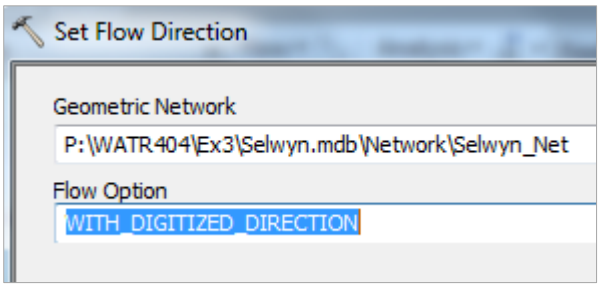
and you'll see lots of blobs appear. This means that the network edges don't know in what direction water flows on them.



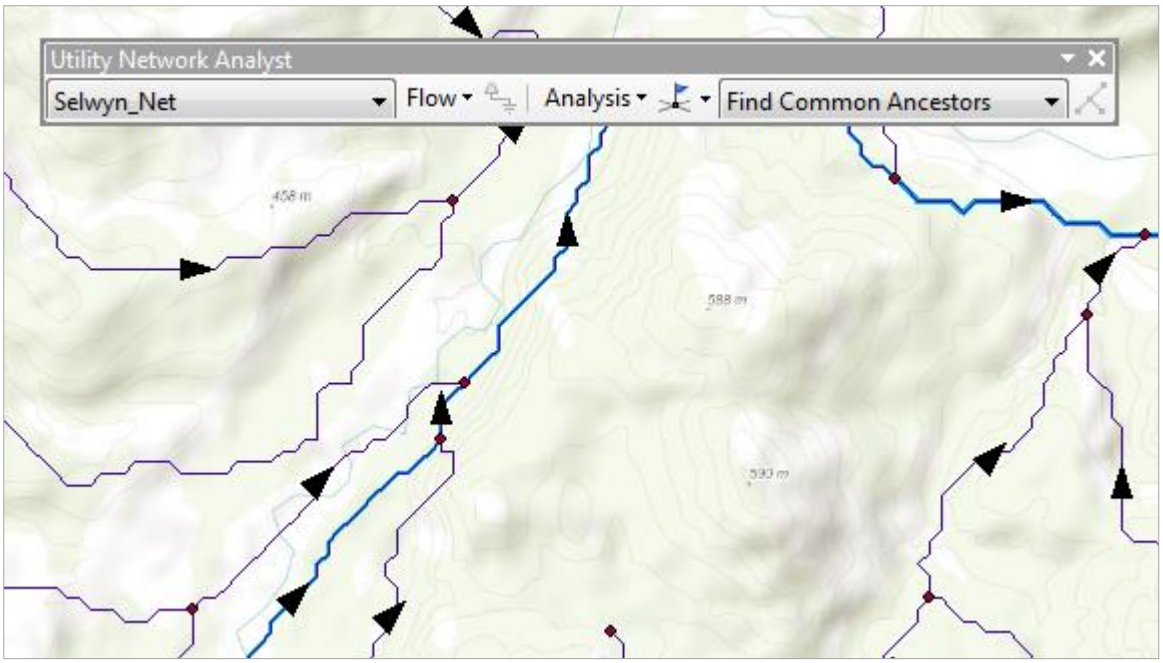
Use the Search Function to select the Set Flow Direction function



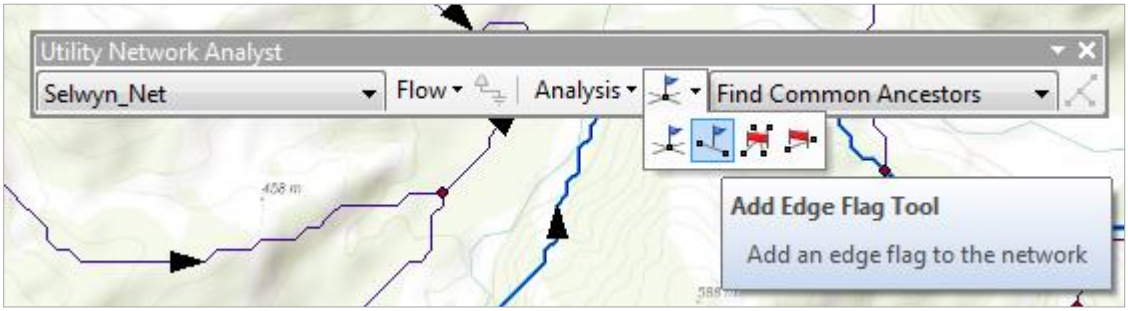
Select the **Selwyn_Net** for the Flow Direction and **WITH_DIGITIZED_DIRECTION** for the flow direction. This means that the flow will go in the direction of the nodes that make up the river lines and these are in a sequence that points downstream.

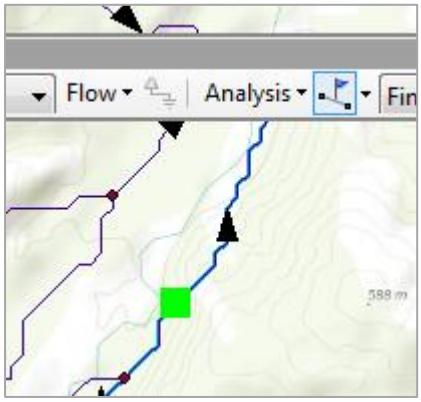


Now you can see that the network knows in what direction that the water flows. Pretty cool!!

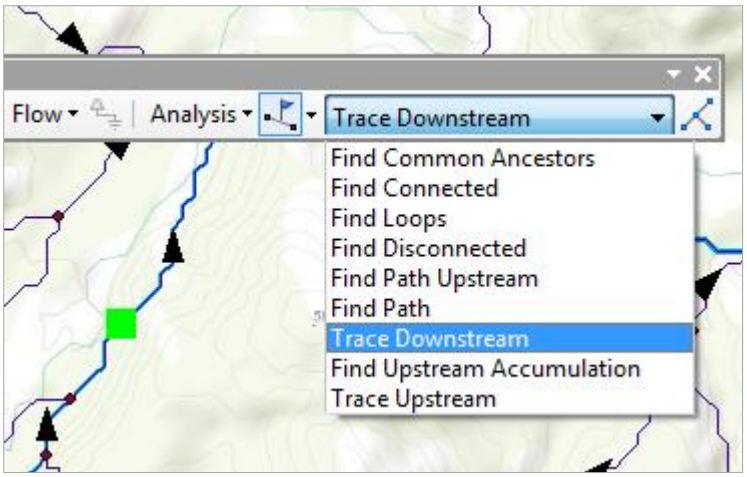


Now let's set an **Edge Flag** on a network edge.

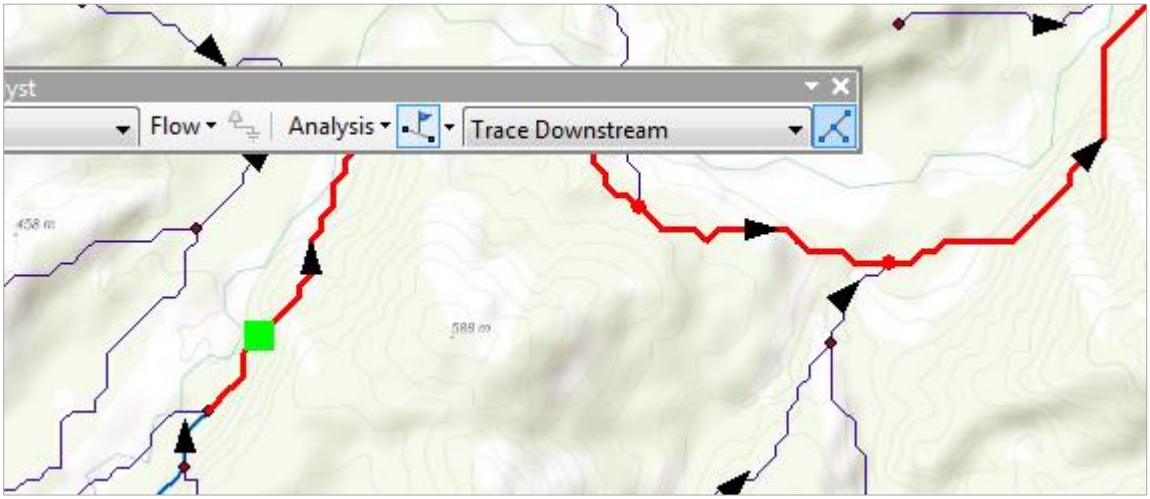




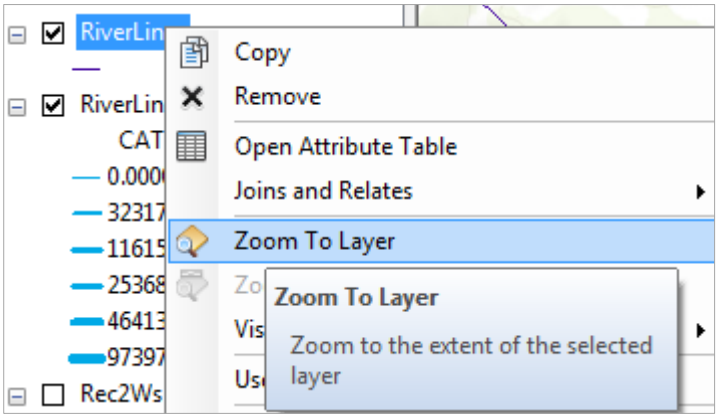
Now, let's do a Trace Downstream from this location



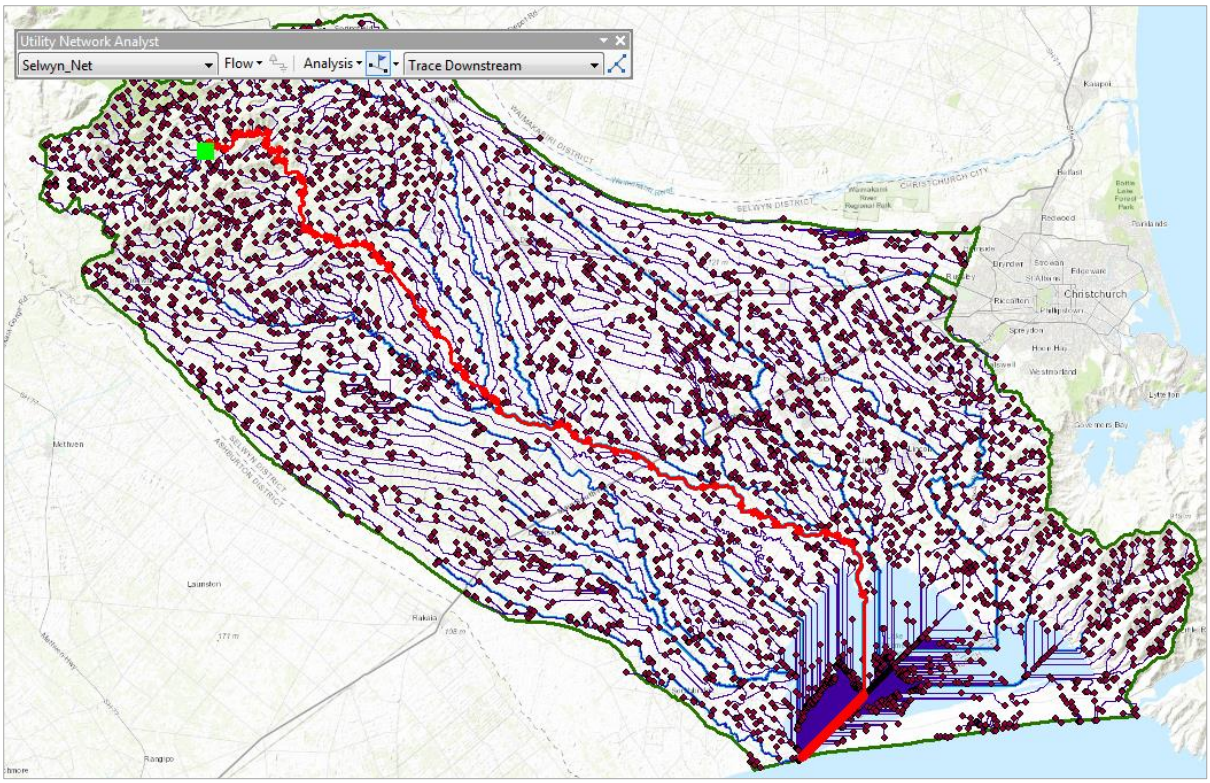
Click on the  and now you'll see a path showing how the flow goes downstream.



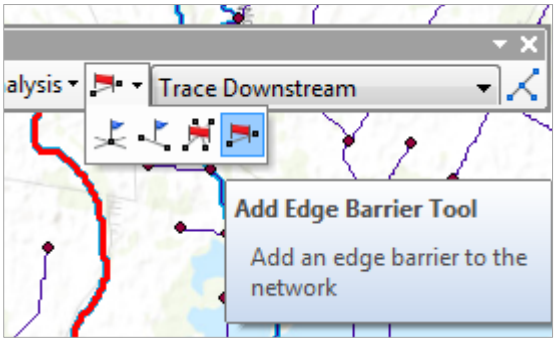
If you **Zoom to Layer** extent and turn off the Show Arrows option,



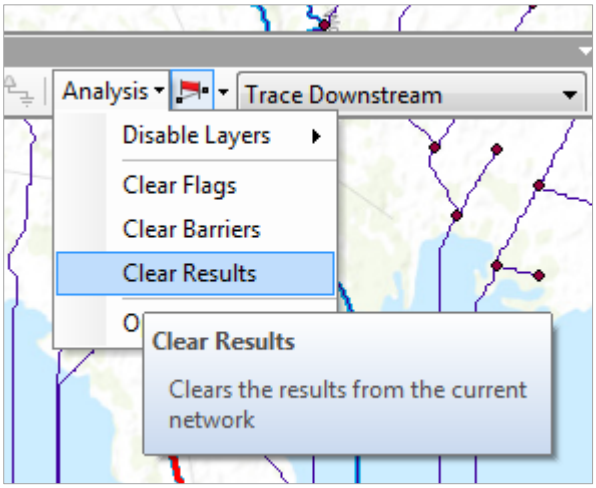
And you'll see a flow path all the way down to the sea.



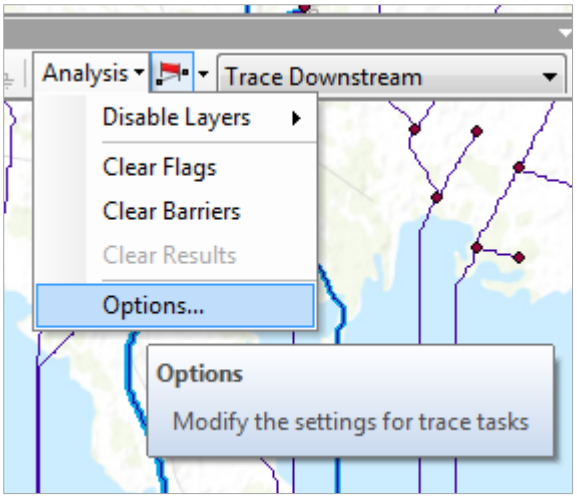
For assessment of the impact on Lake Ellesmere/Te Waihora, we don't want the distance all the way to the sea but rather to the shoreline of the lake, so let's zoom in there, and set a Barrier Barrier Tool, which is a red X that is a bit hard to see in this display.



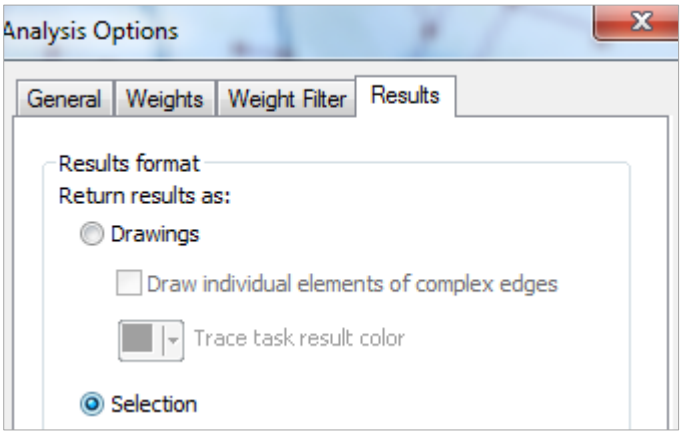
We select **Analysis/Clear Results** and it's a bit easier to see



Now, let's select **Analysis/Options** and

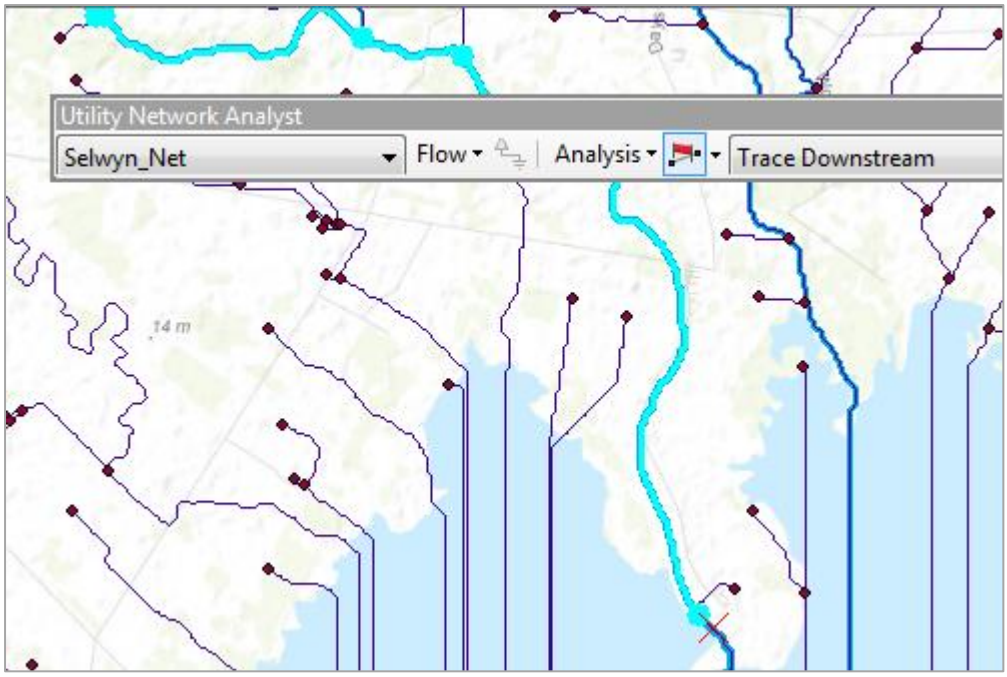


And return results as Selection rather than Drawings

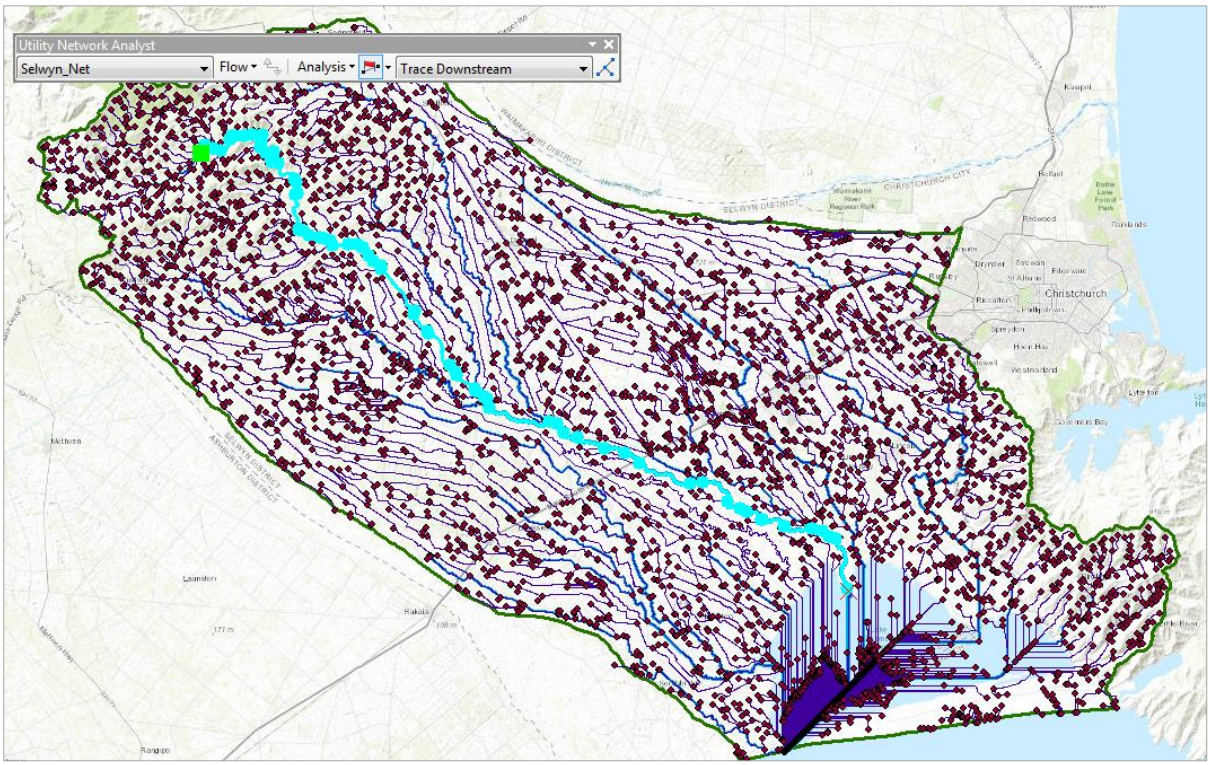


And now let's do our Trace Downstream again

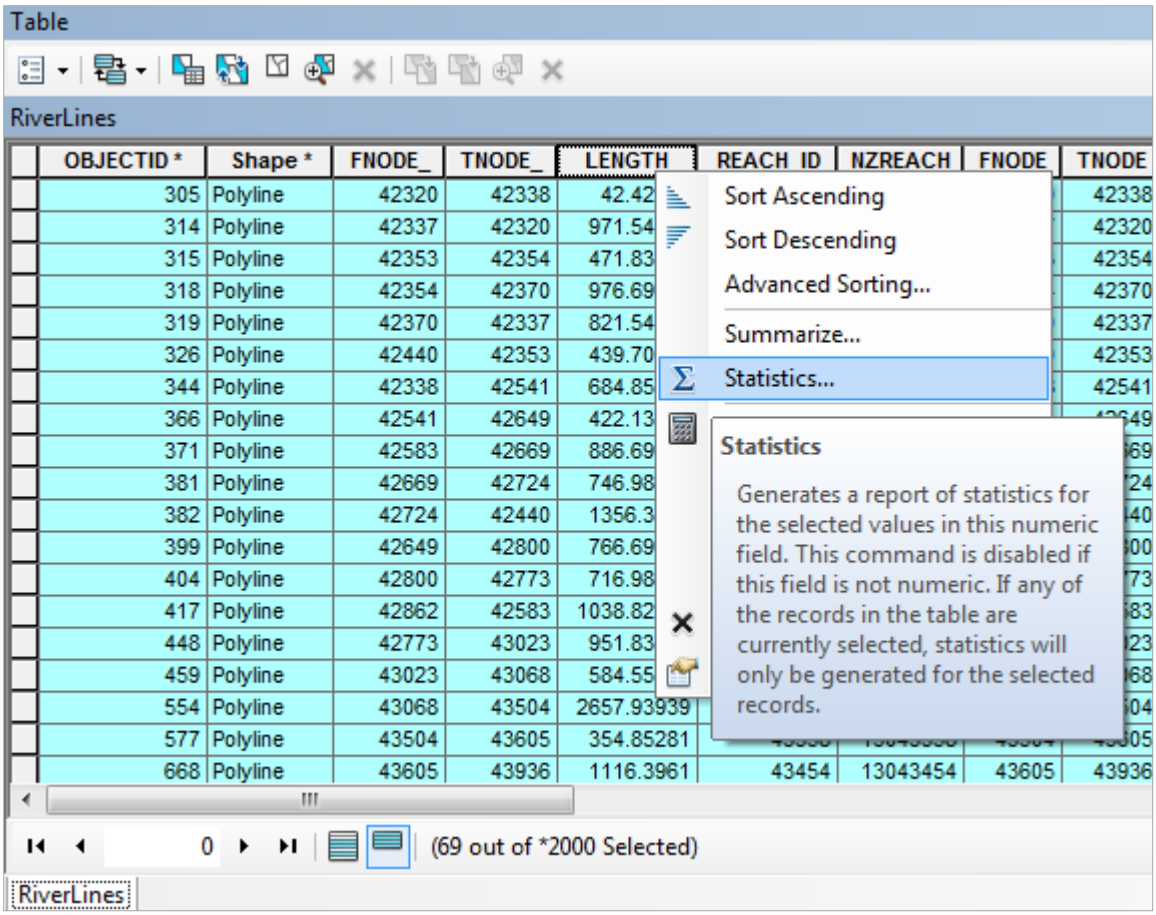
And you'll see that the riverlines are now selected in the display

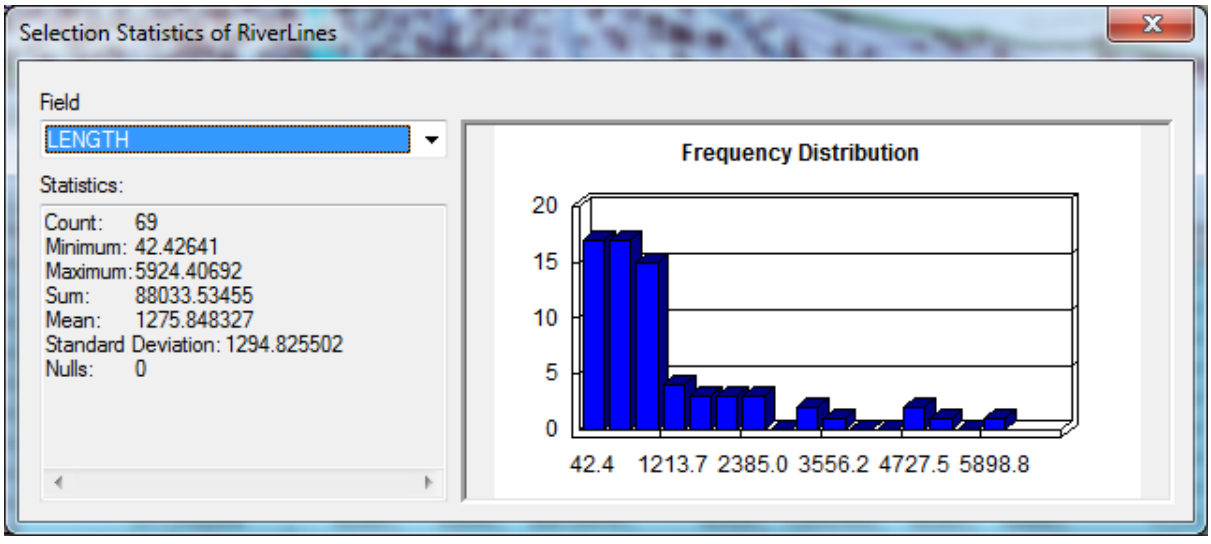


And if you Zoom to Layer again, you can see a very nice tracing of the flow path from our selected reach to Te Waihora.



If you open the Attribute Table, hit the Selected Record button at the bottom of the screen, and then calculate the Statistics on the Length attribute





In this the Sum value is 88033 meters or 88.033 Km. This means that water and contaminants flowing along this reach will have to travel about 88 Km to get to Te Waihora. As contaminants travel in water, they are transformed – the concentration of bacteria, for example, drops significantly with time (say 80% loss in 1 days travel time). So travel distance and time are important indicators of the likelihood of deleterious downstream impacts from upstream contamination.

To be turned in: Make a nice map of the Selwyn catchment with a pathway from one of the upstream reaches to Lake Ellesmere/Te Waihora shown as selected. What is the length of this flow path in Km?

Summary of Items to be Turned in:

(1) *A screen capture of the header of your WaterML response for flow along with the first couple of data values, as shown above. What is the time period of your data request (from date, to date)? What are the units of the flow data? What was the mean daily flow of the Mangatainoka River at Pahiatua Town Bridge on 5 March 2018?*

(2) *A screen capture of the header of your WaterML response for E. Coli along with the first couple of data values, as shown above. What is the Feature of Interest, Observed Property, Procedure of Measurement and Temporal Domain of the Result? What is the time period of your data request (from date, to date)? What are the units of the E. Coli data?*

(3) *Plot a nice time series chart of these data and find the critical percentile values of these data that correspond to the New Zealand coliform data standards. What quality level do these data represent?*

(4) *Make a nice map of the Selwyn catchment with a pathway from one of the upstream reaches to Lake Ellesmere/Te Waihora shown as selected. What is the length of this flow path in Km?*