GIS Project: Soil and Water Storage Properties of Molalla-Pudding Watershed

CE 413

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Introduction:

My senior design project is a culvert replacement and a road realignment on a farm right outside of Scotts Mills Oregon, to allow for logging traffic on the road and fish passage in the creek. To be able to design for this project, it would be essential to find general soil and stream information. Information that will be important to find for the project will be soil groups, the available water storage, the drainage density, and the flow rate of the area near where the fish passage structure. To find this information I will be essentially following Exercise Two from earlier in the term, but skipping the section dealing with aquifers because there is no major aquifer data in this area.

Site Description:

The location of interest is on a farm in Scotts Mills Oregon, laying in both Marion and Clackamas counties. The creek of interest is called Marquam Creek. This location is within the Molalla-Pudding Sub-basin, which has an area of about 875 square miles. The location has a HUC8 of 170900090. This area has a temperate Mediterranean climate and roughly around 40 to 60 inches of precipitation a year. The topography seems to be fairly flat compared to surrounding areas, and the elevation at the point of interest is around 500 feet from mean sea level. Figure 1 shows the Molalla-Pudding sub-basin that the project will be focusing on.

Figure 1: Molalla-Pudding Sub-basin Location

Data:

Table 1: Data Set Information

Data Set	Description	Vector or Raster	Source	Map Projection	Resolution of Raster Data
NHDSnapshot	Contains hydrography data, including NHD points, NHD flowlines, and NHD Waterbodies	Vector	NHD Website	N/A	N/A
NHDPlusAttributes	Contains tables, including cumulative area, headwater node area, plus flow, and elevslope	Vector	NHD Website	N/A	N/A
WBDSnapshot	Contains WBD Watershed dara	Vector	NHD Website	N/A	N/A
SSURGO Soil Data	Contains soil data and information	Vector	SSURGO Data Downloader	N/A	N/A
USGS Stream Gage Data	Contains the location and data from USGS stream gages	Vector	USGS Website	N/A	N/A

The table above shows all of the data used and information of what the data was. Everything got projected into the NAD_1983_2011_Oregon_Statewide_Lambert_Ft_Intl coordinate system, which has a Lambert Conformal Conic projection.

GIS Methods:

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┌──────────┐   ┌────────────────────┐              ┌──────────┐
│  Map 1   │   │ Create and export  │              │  Map 2   │
│          │   │ USGS data excel table│            │          │
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      │   │              │                                │
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┌──────────┐   ┌─────────────┐              ┌──────────────────┐
│ Create   │   │  Add data   │              │ Download SSURGO  │
│Geodatabase│  │             │              │   soil data      │
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  │   NHD Data   │         │  USGS Data   │    └──────────────┘
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┌──────────────┐ ▼               │          │   Redisplay      │
│WDB_Subwatershed│┌──────────────┐│          │ symbology using  │
└──────────────┘ │ NHD_Flowlines││          │  properties      │
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│Select desired│ ┌──────────────┐ ┌──────────────┐
│ HUC 8 values │ │Select by     │ │Display XY Data│
└──────────────┘ │ location     │ └──────────────┘
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│Export data into│┌──────────────┐│Export into   │
│ geodatabase  │ │Export data into││geodatabase   │
└──────────────┘ │ geodatabase  │ └──────────────┘
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│Dissolve │ │Redisplay │┌───────────────┐│Redisplay    │
└─────────┘ │symbology ││Add Field and  ││symbology using│
            │using     ││name mean      ││properties    │
            │properties││annual flow    │└──────────────┘
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                     ┌──────────────┐    │Label gages   │
                     │Join EROM_010001│  │through        │
                     └──────────────┘    │properties     │
                              │          └──────────────┘
                              ▼
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                     │Field calculator│
                     │on new field and│
                     │connect to     │
                     │EROM 010001    │
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                              │
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                     │Remove Joins  │
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                     ┌──────────────┐
                     │Redisplay     │
                     │symbology using│
                     │properties    │
                     └──────────────┘
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Figure 2: Methods Flowchart

As Figure 2 shows. A map was made in ArcMap and a geodatabase was made to hold all base data for the map. Then the NHD data [1] was imported. The WBD_Subwatershed attribute table was opened and I selected by attributes for a HUC8 value of 170900090 to only have the Molalla-Pudding basin. This data then got exported into the geodatabase so I can make a map with only this basin. The symbology was then changed in the layer's properties to display the watersheds and subwatersheds. Then dissolve was used on the whole basin to create a nice border around the basin. Then using the attribute table I found the numbers of watersheds and subwatersheds and area values.

This map was closed and a new one was opened. The soil data [2] was imported into the new map and was clipped to create a soil feature class for the Molalla-Pudding basin. Then I opened the properties and redisplayed the map symology through classify. I made maps for the available water storage 0-100 cm and again with hydrologic soil groups. Professional maps were created for these two properties. Then the attribute table was used to find information about the average available water storage, the total amount of water that the basin can store, and the areas of each hydrologic soil group.

The original map was then reopened. The flowline layer was turned on and I selected flowlines within the basin by select by location. This data was exported and saved within our geodatabase. All layers not within the basin was removed to clean up the map. The watershed were resymbolized to be hollow so that the flowlines could be seen better. The attribute table was opened to gain information about the stream lengths within the basin, to find the drainage density of the Molalla-Pudding basin.

Then the attribute table was opened again for the flowlines and a field was created and named Mean Annual Flow. We then joined the EROM_010001 table to the flowlines layer based on COMID. Then used field calculator and made the Mean Annual Flow field equal to the Mean Annual Flow field in the EROM_010001 table. The join was then removed to make the attribute table less cluttered. Then the symbology of the flowlines was changed in properties to make the lines get bigger or smaller based on that stream's mean annual flow. The attribute table was then opened again to fine the high and low mean annual flow values for the basin.

The USGS gage data [3] was imported in an excel spreadsheet and the latitude and longitude values were converted from degree minutes seconds to decimal degrees. There were about 125 stream gages within the Molalla-Pudding Basin so I chose 6 to use in my map, 3 in Clackamas county and 3 in Marion county. The table was then imported

into arc map. Then use Display XY data with X being Longitude and Y being Latitude. Export into the geodatabase as a shapefile. Then change the dot symbol to something more noticeable and then label each with their location name. A professional map was made out of this layout.

Results:

Figure 3, shows the sub-basin and the HUC10 watershed and HUC12 subwatersheds.
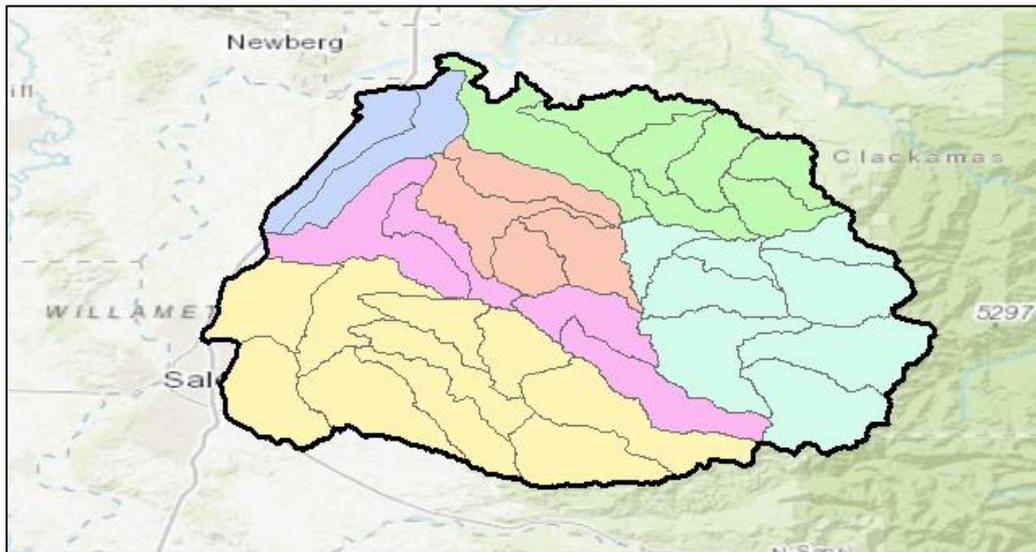
Figure 3: Molalla-Pudding Basin Watersheds and Sub-watersheds

Within the Molalla-Pudding Basin there are 6 watersheds with an average area of 145 square miles, and 35 sub-watersheds with an average area of 25 square miles.
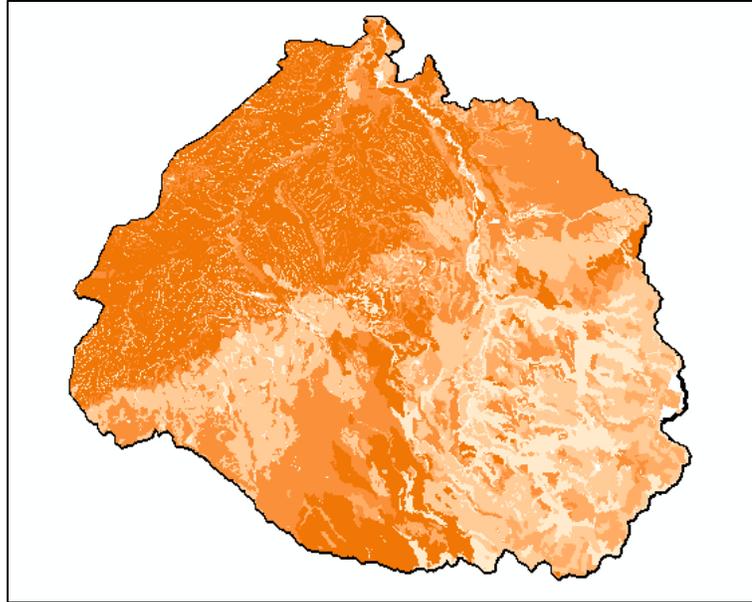
Figure 4: Annual Water Storage 0-100 cm for Molalla-Pudding Basin

Next the annual water storage properties were found, shown in figure 4. The average mean annual water storage in the Molalla-Pudding basin is around 16.5 cm. The volume of water that could potentially be store on the top 1 m of soil in this basin if the soil was fully saturated with water would be around 3267 km^3 or around 784 mi^3. A professional map was made for this layout.
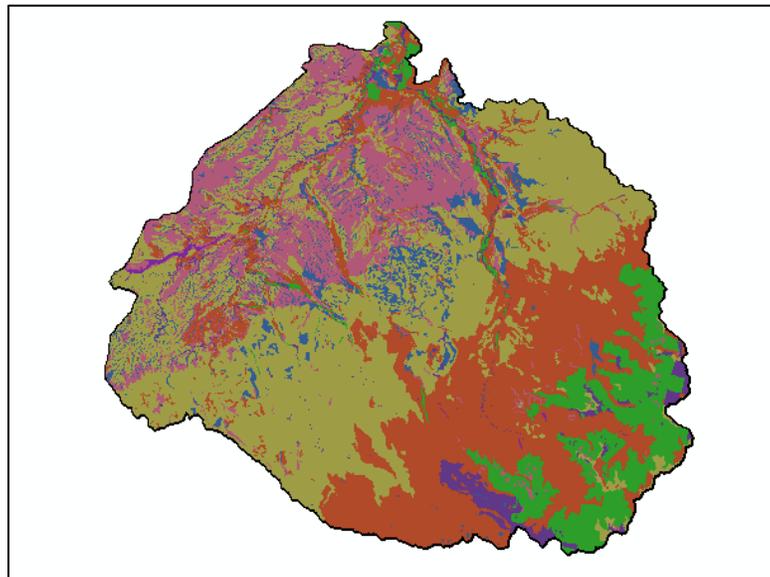
Figure 5: Hydrologic Soil Groups for Molalla-Pudding Basin

The hydrologic soil groups for the basin were found, shown in figure 5. The areas for each hydrologic group in square miles are shown below in Table 2.

Table 2: Areas of the Hydrologic Groups for Molalla Pudding Basin

Hydrologic Group	Area in mi^2
A	79
B	247
B/C	3
C	348
C/D	126
D	44
Null	28

A professional map was made to show the hydrologic soil groups.
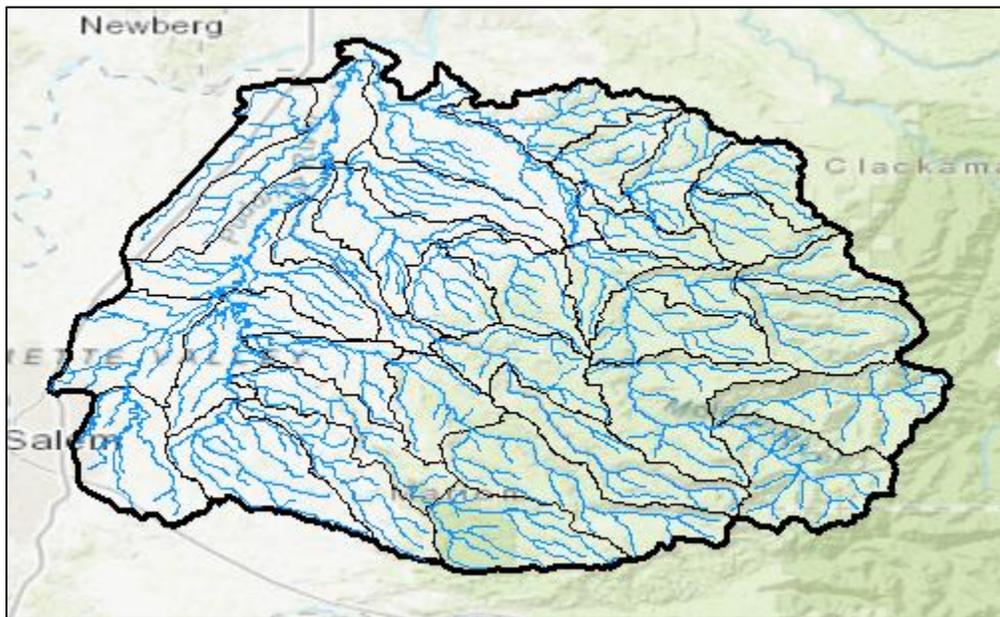
Figure 6: Flowlines of streams in the Molalla-Pudding Basin

Figure 6 shows all of the streams that lie within the basin. The sum of all of the lengths of the streams is around 1064 miles. That makes a drainage density for the basin to be around 1.21 miles^{-1}.
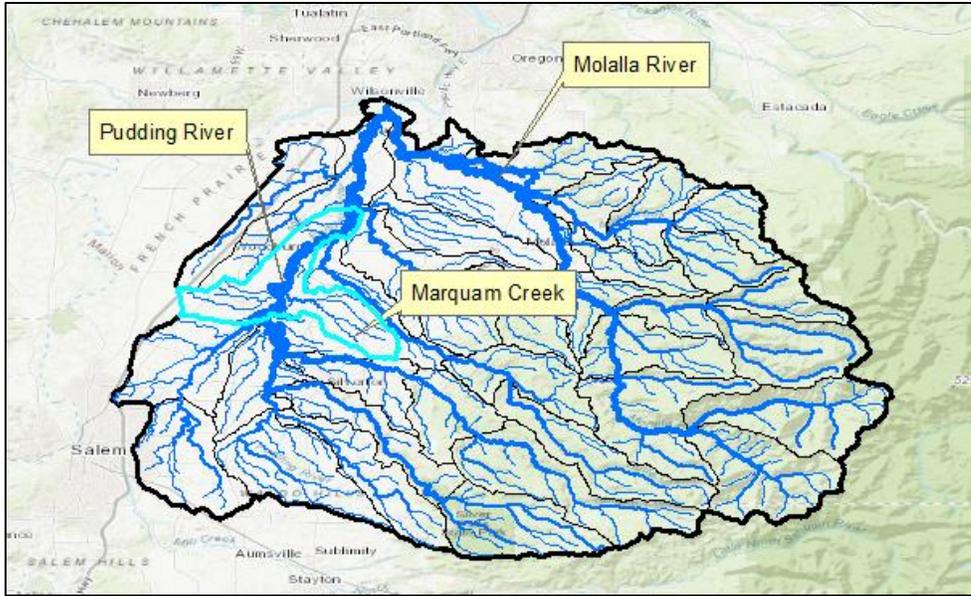
Figure 7: Mean Annual Flows of Streams within the Molalla-Pudding Basin

Figure 7 shows the mean annual flow of the streams in the basin. The highest mean annual flow in this basin is around 4243 cfs and the lowest is around 0 cfs. The average mean annual flow in the basin is around 275 cfs. A professional map of this layout was created.

Table 3: Stream Gage Information

ID	Name	Latd	Latm	Lats	Longd	Longm	Longs	LatDD	LongDD	DASqmile	MAFlow
1	Mollala River near Molalla, OR	45	7	10	-122	32	0	45.11944	-121.467	201	3285
2	Pudding River at Aurora, OR	45	14	0	-122	44	56	45.23333	-121.251	479	20721
3	Bull Creek near Wilhoit, OR	44	57	39.24	-122	23	6	44.9609	-121.615	0.78	9481
4	Drift Creek near Silverton, OR	44	58	36.5	-122	49	48.4	44.97681	-121.17	25	1232
5	Pudding River near Mount Angel, OR	45	3	47	-122	49	45	45.06306	-121.171	203	9679
6	Pudding River near Woodburn, OR	45	9	5	-122	48	11	45.15139	-121.197	314	7836

The information from Table 3 was imported into ArcMap to create Figure 8.
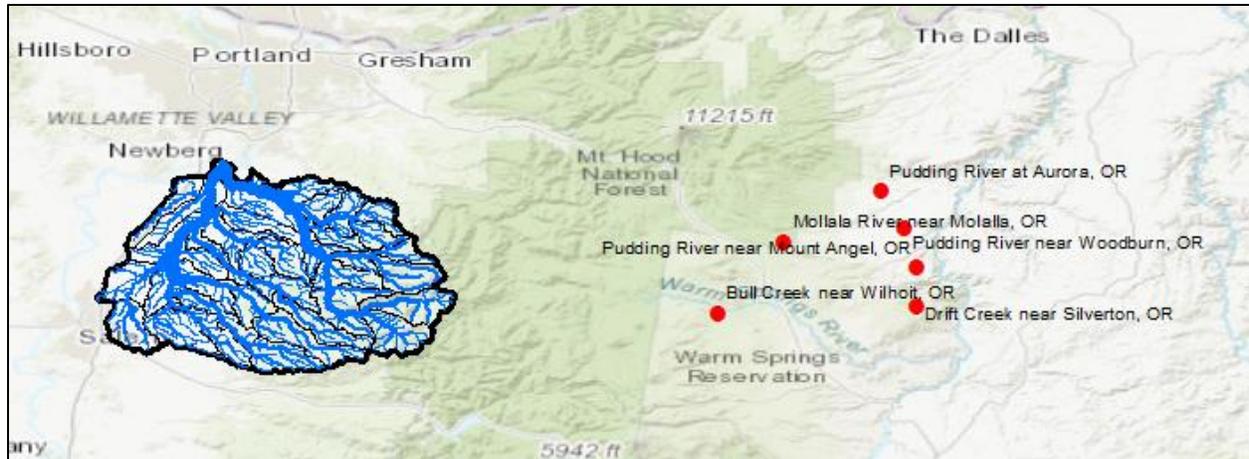
Figure 8: Stream Gages in Molalla-Pudding Basin

As seen in Figure 8 above, my stream gages are not where they are supposed to be. They are in GCS_North_American_198, just like the whole basin is in. I tried changing the projection and added more decimal points in the table and nothing is changing this outcome. I do not know what went wrong.

Appendix:

[1] Horizons System Corporation. (n.d.). NHD plus version 2. Retrieved from
http://www.horizon-systems.com/nhdplus/

[2] *USDA. (n.d.). SSURGO soil data. Retrieved from
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053627*

[3] *USGS stream gages*. (n.d.). Retrieved from
https://waterdata.usgs.gov/or/nwis/inventory?huc_cd=17090009&site_tp_cd=ST&format=stati
on_list&group_key=county_cd&list_of_search_criteria=huc_cd_by_code%2Csite_tp_cd