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# GEO 327G – Fall 2016 Project: Expansion of the Columbia South Shore Well Field

## Problem:

If the Portland, OR surface water supply is rendered useless by turbidity or another natural event, then the Columbia South Shore Well Field must be expanded to accommodate the city's water demands. The two ways to accomplish this goal are to add more wells in the existing protection area, or expand the protection area to the east. The locations of proposed new wells are based on ease of access to water, and therefore the depth to the water table.

## Background:

The Columbia South Shore Well Field (CSSW) in northeast Portland, OR provides a supplementary water supply for the city of over 800,000 residents. The primary source for the area is the Bull Run watershed, an unfiltered surface supply to the East of the city. During periods of high demand and when the Bull Run supply is undergoing routine maintenance or is unusable due to turbidity, the CSSW augments the city's water supply at a peak capacity of 100 MGD (million gallons per day). The CSSW is contained in a wellhead protection area that is bounded by PDX International Airport to the west, the Columbia River to the north, the Troutdale Airport (and a FedEx distribution center) to the east, and Interstate 84 to the south (large neighborhoods begin) (Figure 1). These boundaries were established as 30-year time of travel boundaries, meaning that it would take 30 years for water to move from the borderline to a drinking water well (City of Portland, 2016).

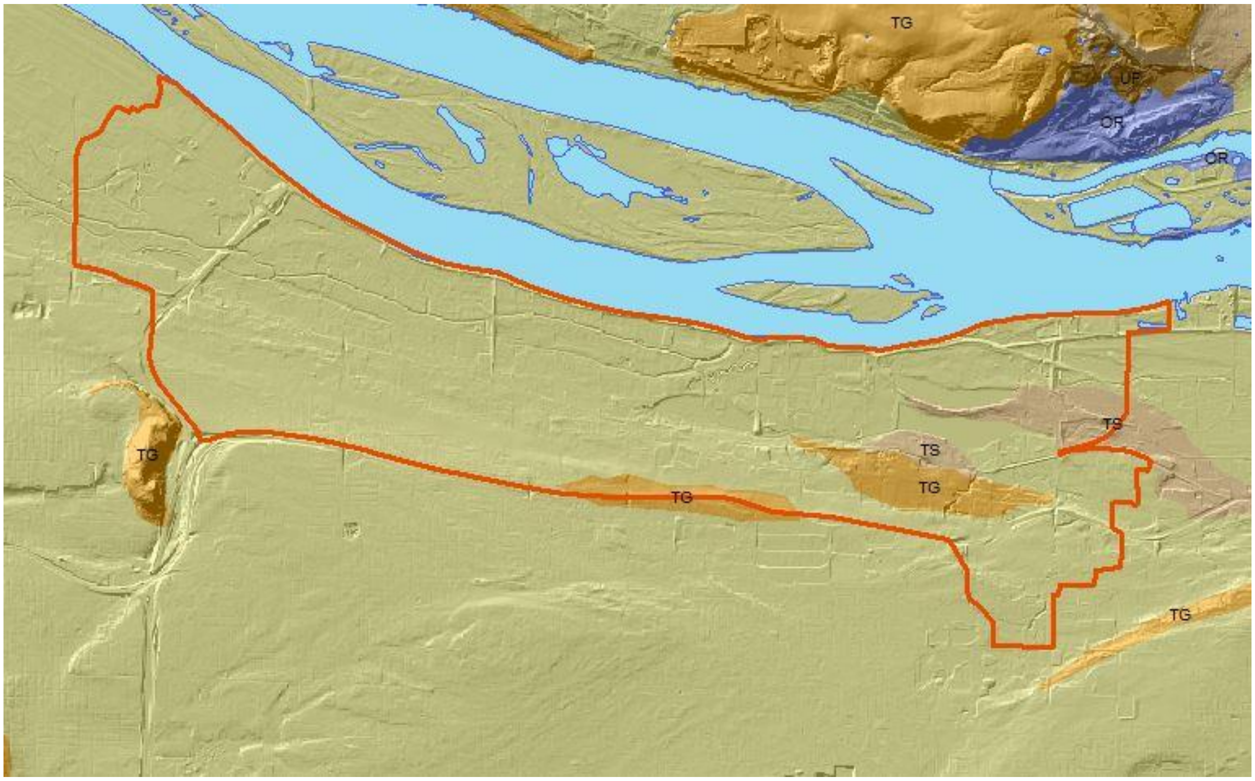


Figure 1: CSSW Wellhead Protection Area

## Procedure:

Create feature classes:

1. Create personal geodatabase: My_data
2. Create geology feature dataset
3. Create map_area polygon feature class
4. Create contact line feature class
5. Create map points point feature class
6. Create domains for each feature class in geodatabase (Domains include: point type, unit name, unit abbreviation)

DEM:

U.S. Geological Survey, 2013, USGS NED n46w123 1/3 arc-second 2013 1 x 1 degree ArcGrid: U.S. Geological Survey.

1. Download and save to local folder
2. Import raster to map and project into coordinate system (GCS NA 1983, NAD 83, HARN, Lambert conformable conic).
3. Create hillshade using hillshade tool
4. Clip to area of interest (map_area) using extract by mask tool

Rivers:

U.S. Geological Survey, National Geospatial Program, 20160908, USGS National Hydrography Dataset (NHD) Best Resolution for 20160908 State or Territory FileGDB 10.1 Model Version 2.2.1: U.S. Geological Survey.

1. Download and save to local folder
2. Import feature class to map and project into coordinate system (GCS NA 1983, NAD 83, HARN, Lambert conformable conic).
3. Clip to area of interest (map_area) using extract by mask tool

Well Locations:

Snyder, D.T., 2008, Estimated depth to ground water and configuration of the water table in the Portland, Oregon area: U.S. Geological Survey, Scientific Investigations Report SIR-2008-5059, scale 1:60,000.

Plate 1: Estimated depth to ground water in the Portland Oregon area

1. Save well location map as TIFF
2. Load into blank ArcMap document
3. Add hillshade
4. Georeference TIFF, rectify, and save
5. Add rectified TIFF to document
6. Using editor toolbar, create points
7. Add depth to water table field to map_points feature class
8. Fill in depth to water table for each well location

Hydrogeologic Units:

Swanson, R.D., McFarland, W.D., Gonthier, J.B., and Wilkinson, J.M., 1993, A description of hydrogeologic units in the Portland basin, Oregon and Washington: U.S. Geological Survey, Water-Resources Investigations Report 90-4196, scale 1:103,000.

Plate 1: Hydrogeologic Units in the Portland Basin

1. Open blank ArcMap document
2. Load hillshade
3. Convert jpeg image to TIFF format
4. Load into ArcMap and fit to display using georeferencing toolbar
5. Georeference by selecting common points
6. Delete points to reduce RMS error
7. Rectify and save

Digitizing hydrogeologic map:

1. Load rectified TIFF of hydrogeologic units
2. Digitize hydrogeologic units using create contact feature in editor toolbar

3. Create topology of hydro units
4. Fix dangle and overlap errors using fix topology error tool
5. Use feature to polygon tool to save fixed topology as polygons
6. Create name and abbrev text fields set to corresponding domains
7. Use editor toolbar to assign name and abbreviations for hydro units to all polygons
8. Symbolize units
9. Add streams/waterbodies and hillshade
10. Clip water and hillshade to map area using extract by mask

Wellhead Protection Area:

https://www.portlandoregon.gov/water/article/461798 (well field image)

1. Open blank ArcMap document
2. Load hillshade
3. Convert image to TIFF
4. Load into ArcMap and fit to display using georeferencing toolbar
5. Georeference by digitizing wellfield border into polygon
6. Rectify and save

Water table elevation map:

1. Create spline using water table depths attached to well points
2. Symbolize stretched, set lowest value to 0, set highest value to 220 (arbitrary, highest point value is 196)
3. Symbolize with Brown to Blue Green Diverging, Bright color ramp

## **Analysis:**

There are 45 wells in the wellhead protection area (WHPA) with a large amount (20+) concentrated on the east side around Blue Lake and within Blue Lake Regional Park. The depth to the water table in the WHPA averages about 30 feet, but 22 of the wells penetrate the water table less than 15 feet deep.

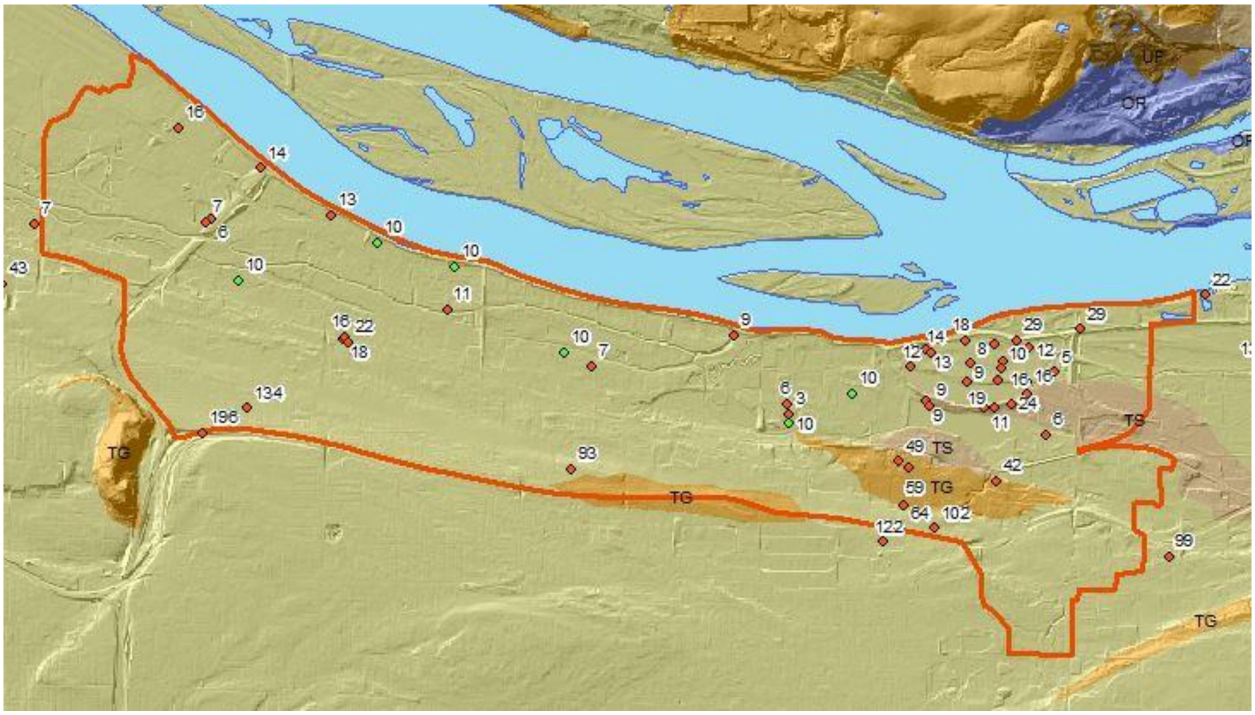


Figure 2: Actual wells shown in red with depth to water table (feet) labels

The shallow wells are the ones that are focused on because a shallow water table is ideal for efficient construction and production. Therefore, proposed well sites will be based on the search for a depth to water table of approximately 10 feet (Figure 2) (proposed wells in green all have default values of 10 feet).

The dominating hydrogeological unit throughout the CSSW is an unconsolidated sedimentary aquifer, so in terms of drilling and production, the geology of the area is somewhat homogeneous (Swanson et al., 1993). Areas where the Troutdale gravel (TG) or Troutdale sandstone (TS) dominate are characterized by deeper water tables, and will thus be ignored in well proposals (Figure 2).

## Proposal:

There are vast areas within the WHPA that do not have an operating water well, so it appears that the CSSW could be expanded greatly in the future. For the time being, it is not necessary because the CSSW is a secondary water source for the City of Portland. However, population growth and unforeseen natural events could one day force the city to rely heavily upon groundwater supplies. In such a case, it appears there are two options for the expansion of this groundwater supply network.

First, the number of wells within the current boundaries of the WHPA could be greatly increased. The proposed wells in green on Figure 2 are examples of locations where new wells could be placed. These locations are based on the building density, proximity to other shallow water table wells (using spline surface on Final map), and the dominant hydrogeologic unit. Clearly these locations are examples of where new wells could be drilled, and the area is large enough that it could accommodate many more than the few proposed in this project. The addition of each well would greatly increase the operating capacity of the CSSW (by roughly 2 MGD).

The second option is to expand the WHPA itself to the east. It is bounded by PDX International Airport to the west, by the Columbia River to the north, and by neighborhoods (and an interstate highway) to the south. To the east of the WHPA are the Troutdale Airport and a FedEx distribution center, but just east of those is Sandy River Delta Park. This area appears essentially identical lithologically and in proximity to the Columbia River (a source of recharge) to the current WHPA. There are no wells drilled here, so barring any difficulties securing the area (permits, park protection), it appears to be a perfect location for future expansion. Note: wells shown in Figure 3 that are outside of WHPA boundaries were used to construct water table surface map, but are used for industrial water supply *not* public use.

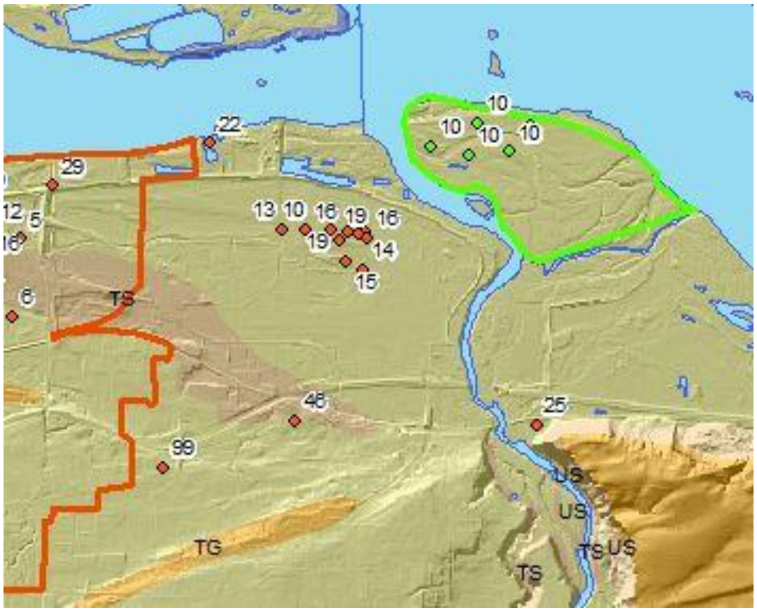


Figure 3: Proposed wellhead protection area (green) at Sandy River Delta Park

From the interpolation of the spline water table surface (Figure 4), it appears that Sandy River Delta Park is a prime location for future drinking water wells. The depth to the water table is expected to be less than 10 feet, it is composed of the same hydrogeologic unit as the WHPA, and it is surrounded by rivers. These factors indicate that wells drilled in the area would be cost effective, productive, and actively recharged by the adjacent surface waters. The southern boundary chosen for the proposed area is a stream that cross cuts the delta. The area should be large enough to reflect the present WHPA's 30-year time of travel boundary.

## **Conclusion:**

For the moment, expansion of the CSSW is not of immediate concern. However, it is the second largest water source in the state of Oregon behind the Bull Run watershed, Portland's primary water source (City of Portland, 2016). Therefore, it is appropriate to consider what expansion might be necessary in the future as population rises, or natural events affect the quality of the unfiltered Bull Run supply. It is clear that Portland has numerous options for new well sites and well field expansion, and a continuous source of recharge from the Columbia River. Therefore the CSSW will continue to be a vital supply of supplementary, clean public drinking water (perhaps primary at some point) in the future.

## Map:

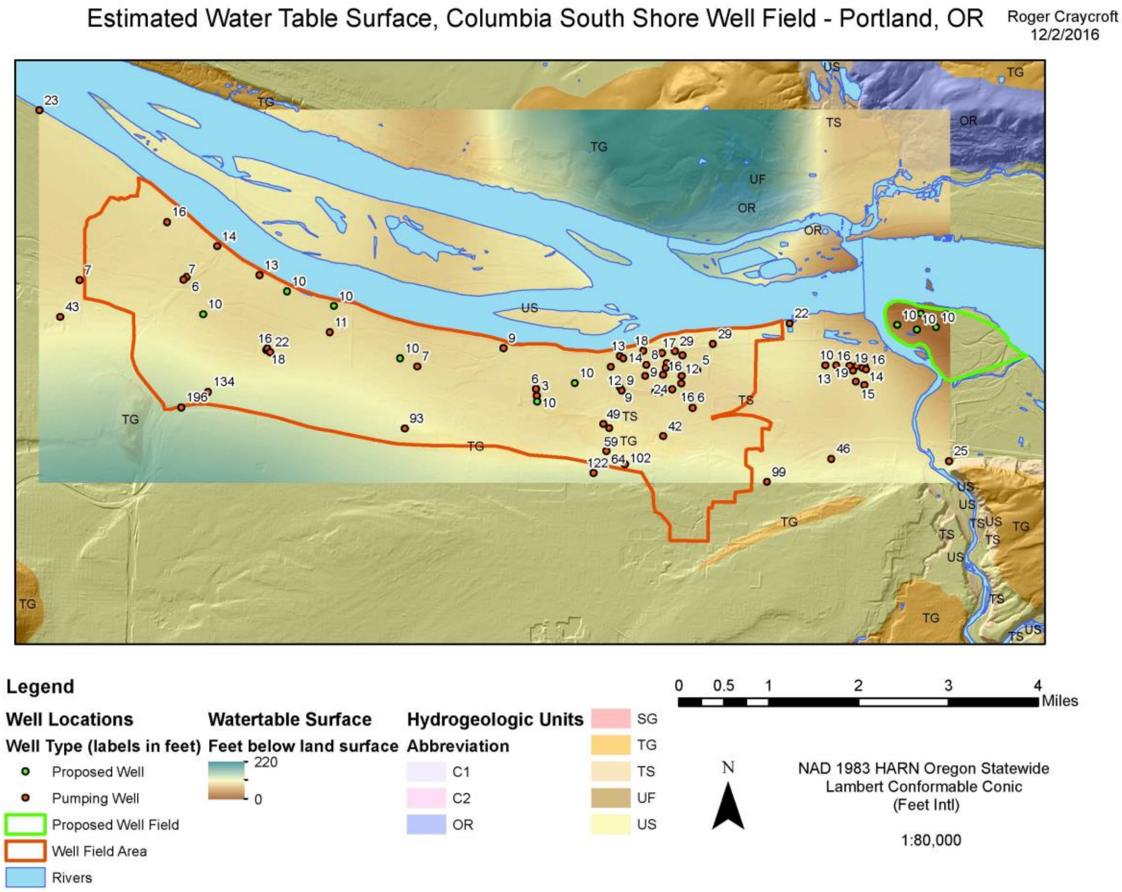


Figure 4: Map of hydrogeologic units with interpolated water table elevation surface

| Hydrogeologic Unit | Unit Abbreviation |
|---|---|
| Confining Unit 1 | C1 |
| Confining Unit 2 | C2 |
| Older Rocks | OR |
| Sand and Gravel Aquifer | SG |
| Troutdale Gravel Aquifer | TG |
| Troutdale Sandstone Aquifer | TS |
| Undifferentiated Fine-grained Units | UF |
| Unconsolidated Sedimentary Aquifer | US |

Figure 5: Hydrogeologic unit names matched with corresponding abbreviations

## References:

Brown, S.G., 1963, Problems of utilizing ground water in the west-side business district of Portland, Oregon: U.S. Geological Survey, Water-Supply Paper 1619-O, scale 1:24,000.

City of Portland, 2016, Groundwater Protection Area, https://www.portlandoregon.gov/water/29890, Accessed Dec. 2016.

Collins, C.A. and Broad, T.M., 1993, Estimated average annual ground-water pumpage in the Portland Basin, Oregon and Washington 1987-88: U.S. Geological Survey, Water-Resources Investigations Report 91-4018, scale 1:128,000.

Hogenson, G.M. and Foxworthy, B.L., 1965, Ground water in the East Portland area, Oregon: U.S. Geological Survey, Water-Supply Paper 1793, scale 1:62,500.

Snyder, D.T., 2008, Estimated depth to ground water and configuration of the water table in the Portland, Oregon area: U.S. Geological Survey, Scientific Investigations Report SIR-2008-5059, scale 1:60,000.

Swanson, R.D., McFarland, W.D., Gonthier, J.B., and Wilkinson, J.M., 1993, A description of hydrogeologic units in the Portland basin, Oregon and Washington: U.S. Geological Survey, Water-Resources Investigations Report 90-4196, scale 1:103,000.

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USGS National Boundary Dataset (NBD) for OregonOregon 20161028 State or Territory Shapefile, vector digital data, U.S. Geological Survey, National Geospatial Technical Operations Center, 10/28/2016.

# Estimated Water Table Surface, Columbia South Shore Well Field - Portland, OR

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12/2/2016