Geology of Wellington Heights

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Site Identification

The site under consideration is the Wellington Heights neighborhood in the Southeast quadrant of Cedar Rapids, Linn County, Iowa.

7.5’ by 7.5’ USGS Topographic Quadrangle

The neighborhood can be found on the Cedar Rapids South, IA map, digitally published by the United States Geological Survey on April 25, 2013. Its topological data is based on the 1999 National Elevation Dataset.

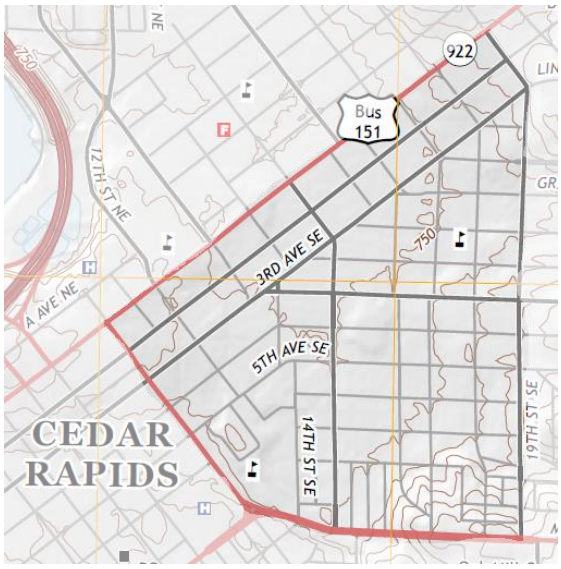

Figure 1 Excerpt from USGS 7.5' x 7.5' Quadrangle for Cedar Rapids South, IA, Iowa-Linn Co.

Public Land Survey System

According to the original Public Land Survey of the area, the neighborhood is located at “PM05, T83N, R7W, Sec.22,” or centrally located in Section 22 of Township 83 North, Range 7 West, fifth Principal Meridian.

This means that the location is approximately 7 x 6 miles = 42 miles west and 83 x 6 miles = 498 miles north of what is now Louisiana Purchase Historic State Park. This is the intersection of a north-south meridian starting at the old mouth of the Arkansas River and the east-west baseline starting at the old mouth of the St. Francis River (34° 38’ 44.0” N, 91° 3’ 42.0” W). This location, as with the rest of Iowa, Arkansas, Minnesota, North Dakota, and the eastern portion of South Dakota, is part of the first Public Land Survey done after the Louisiana Purchase.

Latitude and Longitude

The neighborhood's centroid has approximate latitude of 41.9851782N (or 41° 59' 6.6"N) and longitude of 91.6503899W (or 91°39'1.4"W).

Historical record

Native Americans are known to have been in the vicinity of what is now Cedar Rapids, Iowa, from at least as far back as 13,000 years ago. In nearby Cedar County, the Rummells-Maske Clovis point site - unfortunately plowed over - yielded 20 artifacts of points that were likely used in the slaying of mastodons and bison. These date to the Clovis period of the Paleoindian time period (13,500 to 10,500 years ago).

Approximately 8,000 years ago (the early Archaic period - 10,500 to 7,500 years ago), the human population of what is now Iowa grew. The people tended aware from roaming hunter and gatherer ways of life towards staying a single region and using what its local ecosystem has to offer.

Large ceramic pottery - known as Marion Thick - dating from 2,800 to 2,200 years ago (Early Woodland period) have been found to the East of Linn County, near the Mississippi River. This is believed to be part of a system of long-distance trade - including a collection of large mounds. To the Southeast of Linn County, in Louisa County, the Toolesboro Mound Group features a curious octagonal enclosure surrounded by soil that spans several acres. The structure is similar to features found in modern day Illinois and Ohio - suggesting engage of ideas and goods among the peoples in these regions.

By 1600 to 750 years ago - the Late Woodland period, evidence suggests that the East-West trade routes significantly dwindled if not ended. The geologic record shows plants and animals that are much more familiar to what we are familiar with today - nuts and fruits, deer, birds, and turtles. During this period mound-building came into a recurrence as evidenced by the Slinde and Fish Farm Mound Groups several dozen miles to the north of Linn County.

At the time of European American's arrival to the Cedar Rapids area, there were two main Native American peoples inhabiting the area. The Meskwaki ("Red Earth") people and the Oθaakiiwaki ("Yellow Earth," pronounced approximately "o-THAK-i-wak-ee") peoples are distinct groups who lived in the area and – among other locations. They are referred to as the Fox Tribe and Sac Tribe, respectively, by the United States government. While the groups associated with each other and shared linguistic similarities, the US falsely considers the groups a single entity in its federal recognition of them. Uniquely in American history, the Meskwaki were given authorization by the Iowa legislature to purchase some of land they were occupying in the 1850s. This purchased land wound up being in Tama County, some 50 miles west of Cedar Rapids. So these communities' presence were regrettably all but eliminated in the city.

Presumably, the Cedar River played a role in the communities of Native Americans who lived here, but the preserved European American record of the area predominantly starts around 1840 when white people started settling along the river and established Cedar Rapids as a municipality.

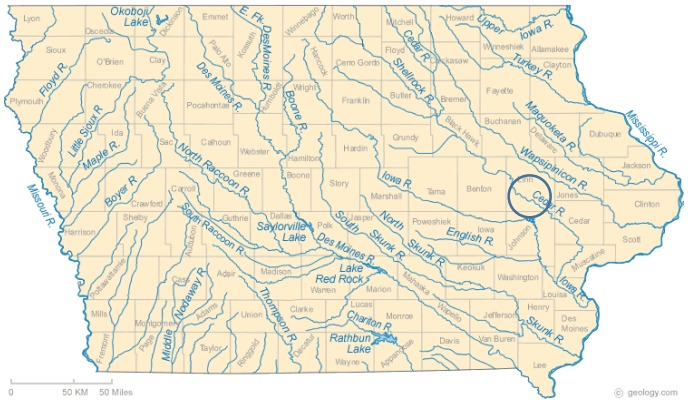

Figure 2 Iowa's Rivers, Cedar Rapids area circled.

Bedrock Geology

Geologic Formations

Generally, Iowa's bedrock increases in age from West to East. Linn County is in the eastern portion of the state. So we have older bedrock in this region than in other parts of Iowa.

As shown in Figure 3, the Wapsipinicon Formation (Dw) is the bedrock understood to be below the vast majority of Wellington Heights. The Wapsipinicon period was part of the

Devonion period (420 to 360 million years ago), and has a general thickness of 240 meters. A little over half of Linn County's bedrock dates from the middle of the Devonian period. No GEOSAM well logs (nor their associated lithographies) are to be found directly within the Wellington Heights neighborhood. However, the data from five of the nearest wells predominantly show the Wapsipinicon being the first layer of bedrock. The content of this formation is primarily dolostone (limestone whose calcium atoms where replaced with magnesium), secondarily limestone itself, and additionally shale. Despite this, the first material found from the above is fine crystalline limestone, followed by brown gypsum-rich dolomite, shale, and finally massive and finely crystalline dolomite and limestone. (USGS, Herhsey 1969)

Also visible in Figure 3 is that a small area in the southwest portion of the neighborhood is identified as having Silurian bedrock. This is part of the bands of bedrock throughout Linn County and Cedar Rapids that date to the Silurian period (444 to 419 Mya). This was a period when 60% of marine creatures became extinct. This suggest the sporadic fossil fuel deposits in Iowa are from the organic material from the receding and advancing sea that once covered this area.

Bedrock Map

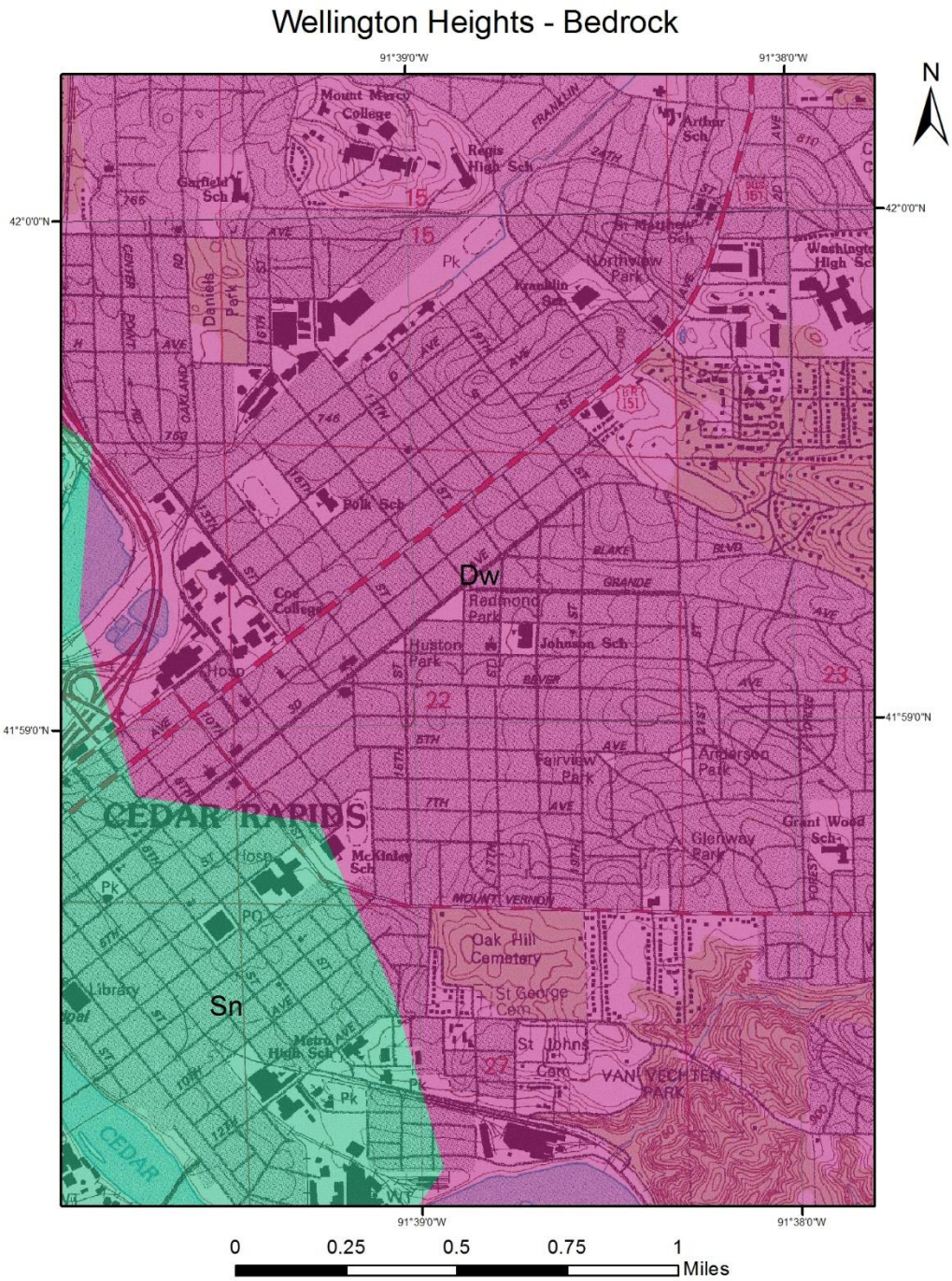

Figure 3

Field Samples

Largely affected by human development.

Sandy.

Some farming → erosion

Quaternary Geology and Topography

Landforms

Most of Linn Country is part of the Iowa Surface. However, central Cedar Rapids including Wellington Heights is part of an outcropping of the remaining Southern Iowa Drift Plain (SIDP). (Iowa DNR) The region is characterized by Pre-Illinoisan drift (deposits that came from the glaciations in the 2.5 Mya – 0.5 Mya period), topped by 6 to 30 feet of loess attributed to the Wisconsinon glaciation. The hills and valleys in the landform (featured in a number of Grant Wood paintings) are due to 500,000 years of erosion allowing plenty of rivers to erode the landscape. This difference is noticeable as I drive from Ames (in the Des Moines lobe) to Cedar Rapids along highway 30, going from mostly flat land to rising and falling hills in the SIDP.

The Iowan Surface is less than a mile and a half away to the south and less than two miles away to the north (GIS maps). Similar to the SIDP, the Iowa Surface has an underlayment of Pre-Illinoisan drift. However, its loess is less thick, it is characterized by more paha, and it has more frequent sinkholes. The East-Central Iowa Drift Plain is only 15 miles away to the northeast (GIS maps). This is actually widely considered part of the SIDP that has simply been cut off from it by the Mississippi River Alluvial Plain.

Landform Maps

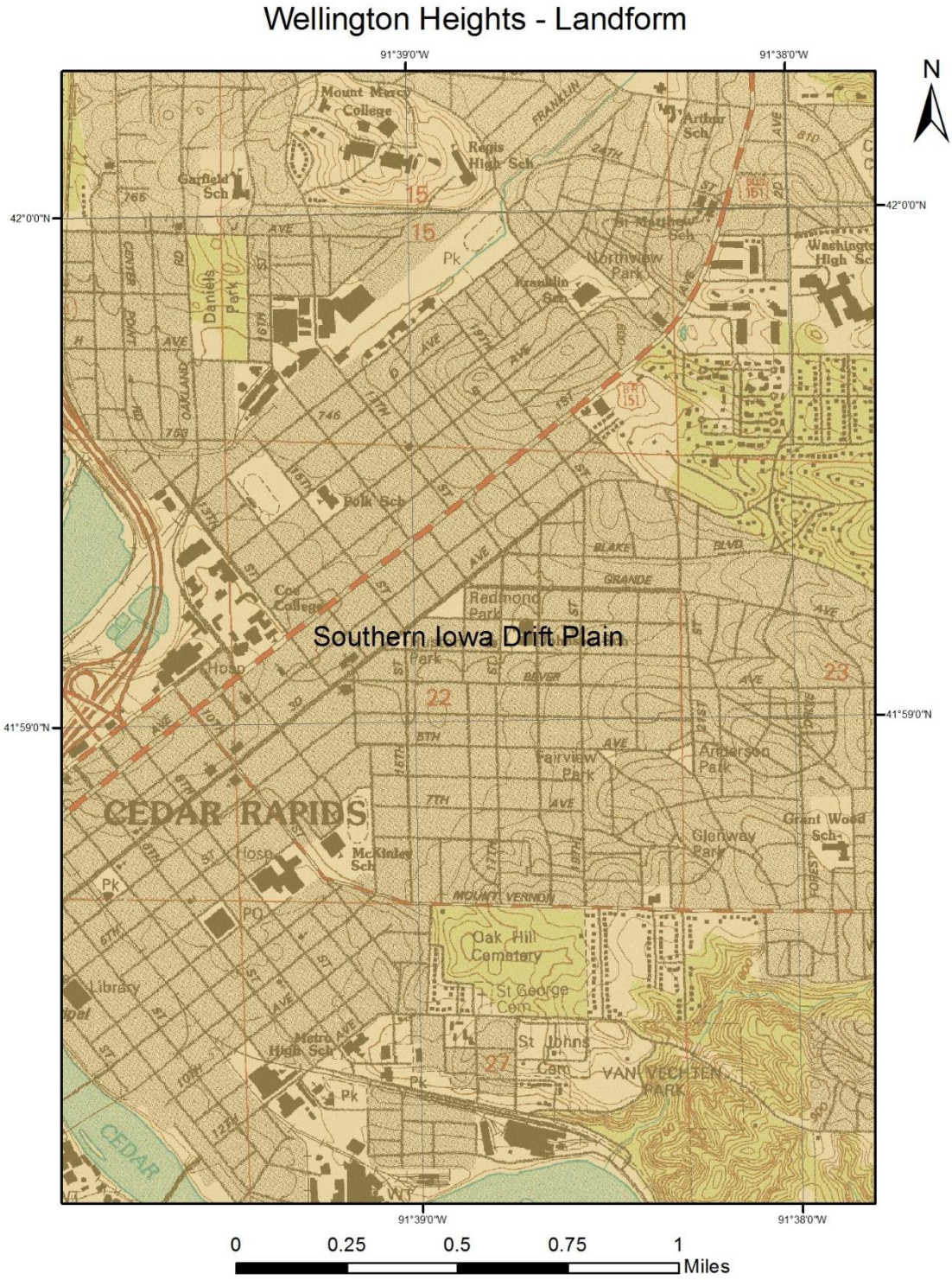

Figure 4

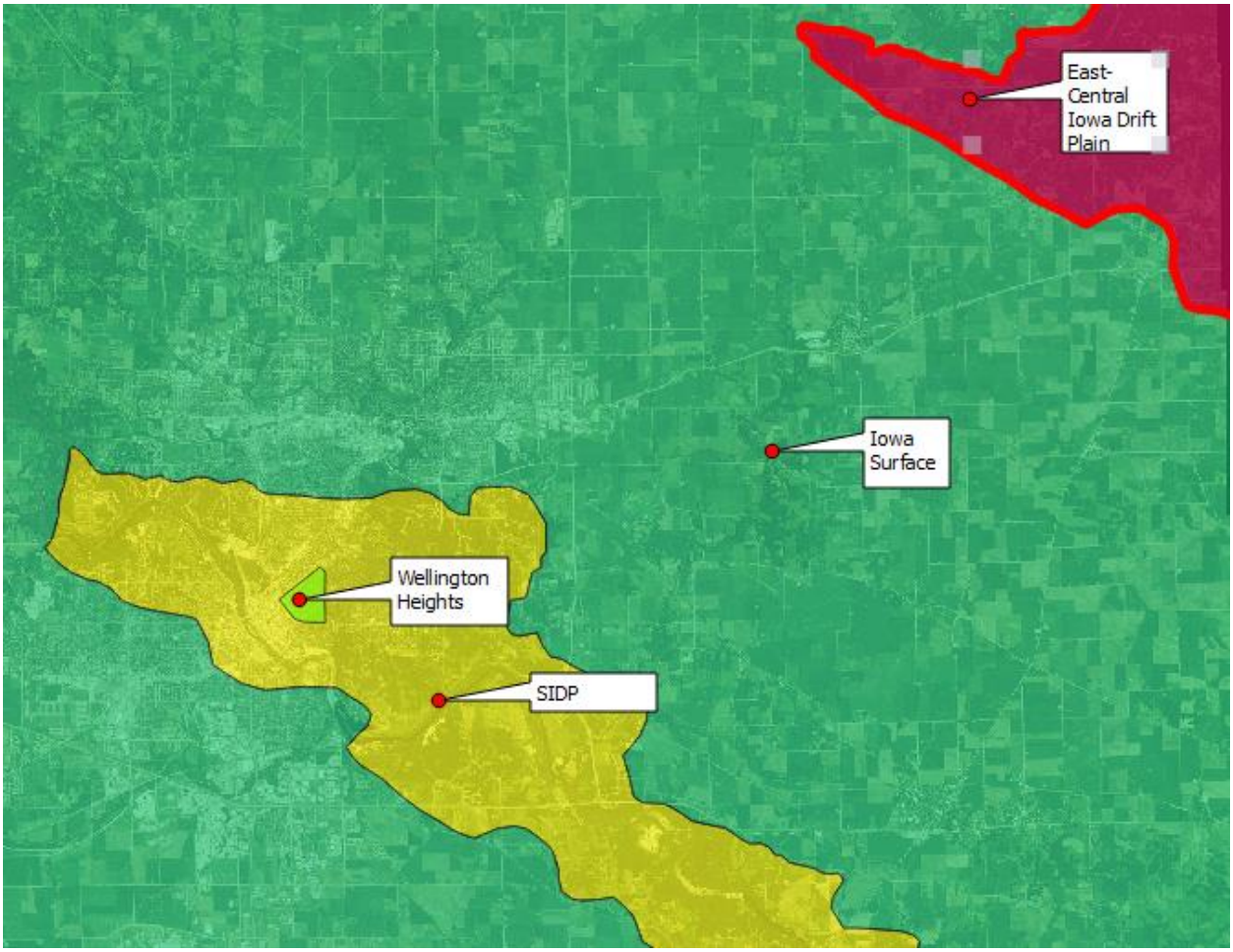

Figure 5 Landform regions around Wellington Heights. Made by Leif Segen in QGIS with 2013 NAIP imagery and IGS's 2009 edition of The Landform Regions of Iowa.

Soils

As shown in Figure 6 below, there is no particular soil associated with Wellington Heights. It is an urbanized area with soil more dependent on the results of human landscaping and construction than geologic history. That said, it is likely that the pre-human intervention soil was dusty being predominantly Wisconsinon deposited loess.

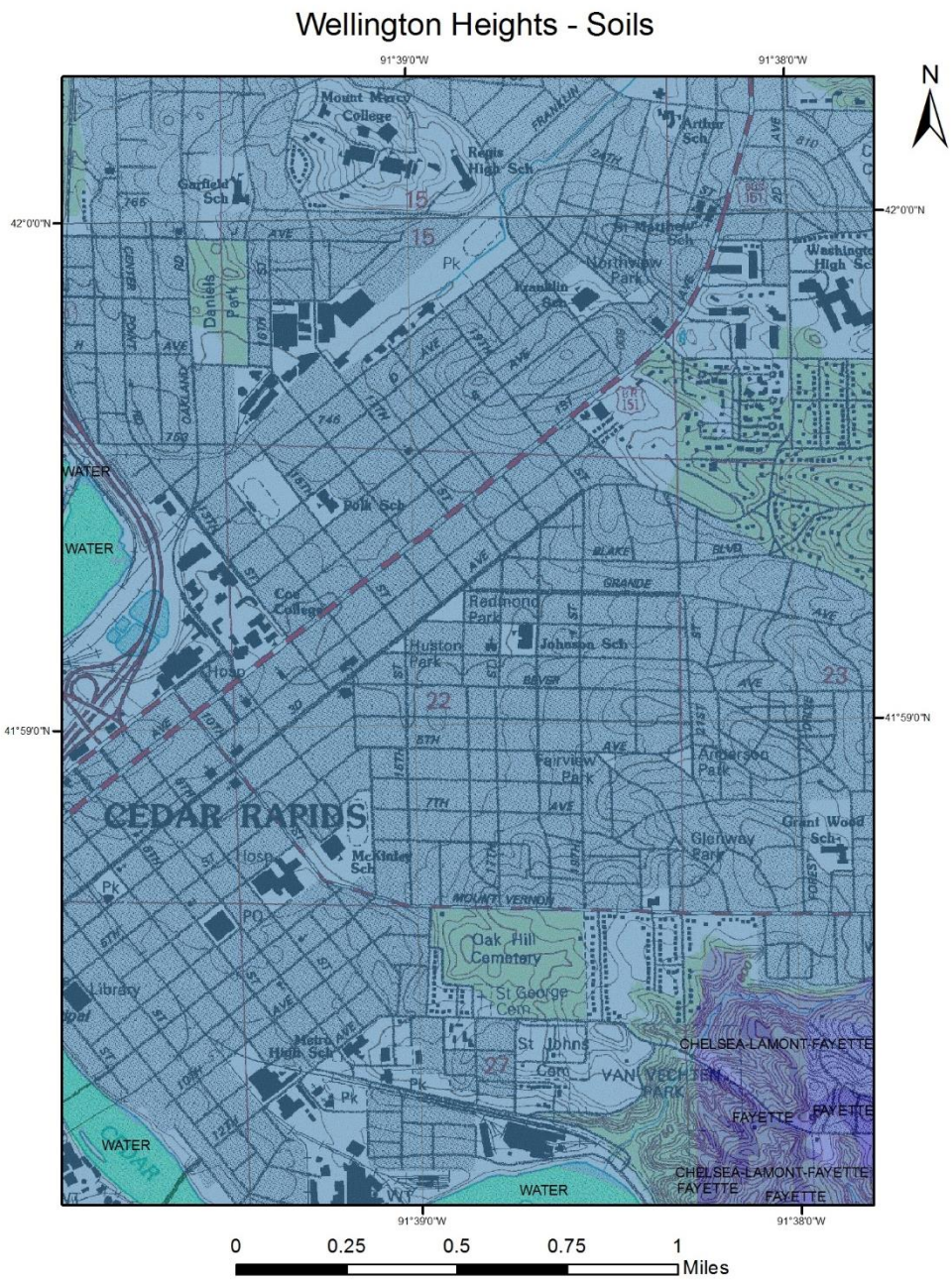

Figure 6

Geologic Evolution / Local Earth History

The Precambrian surface below in the Cedar Rapids area is at an elevation of approximately 2000 feet below modern-day sea-level (approximately 2750 feet below

Wellington Heights). Just to the south and east of the neighborhood there are unconformities (Plum River Fault Zone) due to offsets in the mid-Paleozoic Era, 300 Mya. (Anderson 1998)

The Cambrian period (540 Mya to 485 Mya) was when Iowa was covered in a shallow sea. The sea ebbed and flowed over these millions of years. The Wonewoc formation with rock types indicative of shoreline is covered with two more formations (Lone Rock and St. Laurence) that indicate offshore settling of biomaterial (deep sea). Finally the Jordan Sandstone formation, indicative of shoreline sediment, resulted in 20 to 140 feet of sandstone – about 100 feet think under Cedar Rapids. (Anderson 1998)

The Ordovician Era (485 Mya to 444 Mya) deposits feature several formations with characteristics that suggest muddy environments – suggesting further, yet gradual, retreating of the sea. The Cedar Rapids area of the Maquoketa formation features 100 or so feet of shale (due to plankton type deposits) interspersed with groups of cherty dolomite. (Anderson 1998)

Silurian Era (444 Mya to 419 Mya) rock records are predominately dolomite – indicative of marine life. It (and Devonian Era material) are what remain after much erosion that erased any record material between the Devonian and Quarternary periods in this part of Iowa. (Anderson 1998)

The Mid-Devonian Wapsipinicon Group – the main bedrock below Wellington Heights – features limestone and dolomite, similar to previous periods. However, this group also features evaporates like gypsum and anhydrite. These chemical sedimentary rocks indicate there were periods of drying up seas – much like the Dead Sea in the Middle East. Beyond that, there were actually *multiple* instances of transgression and regression (rising and lowering seas) throughout the Devonian period (419 Mya to 359 Mya). (Anderson 1998)

Then there is a 350 million year gap in the local rock record. It gets picked up in the Quarternary period, though, with Pre-Illionoisan glacial deposits (2.5 Mya to 0.5 Mya). Glaciers forming to the north (modern Minnesota and Canada) picked up all sorts of rock as they advanced. When they melted, these rocks became alluvial material flowing through streams and

rivers as well as sediment. The same happened more recently with the Wisconsin Glaciation (85 Kya to 11 Kya). Contrary to common misconception, the hills to the west and south of Cedar Rapids are attributed to the Wisconsinon period were not carved by glaciers. Instead, the sediment that was dropped in the Des Moines lobe and other North American lobes of the said glaciation, were carried in the wind and dropped, forming paha from loess deposits that have similarities with sand dunes. The power drainage features that are characteristic of ice-contact such as lakes and bogs as found in the Des Moines lobe region have long-since eroded.

In recent millennia and centuries the Iowa River (a mile east of Wellington Heights) played a major role in continued erosion. As recently as 2008, there was a major flood in Cedar Rapids (and much of Iowa). The erosion was not as geologically significant as what happened at the Coralville dam to the south. Instead, the erosion decimated the buildings in several neighborhoods.

Project for Students

Because I am not at the stage of richly understanding the sequence of geological events that led to current formations, my project focuses on the precursor to developing those models. This project focuses on using data to accurately represent the formations present in a small area. I envision eventually compiling information from multiple students' projects in an area to empirically develop a class-wide model for the geology of our city.

Goal

You will create a visualization of the geologic formations present below your neighborhood. You will also communicate how you created the visualization and what you learned from this project in the form of a two page write-up.

Method

The method of visualization is limited only by your creativity. The only requirements are that some form of labeling the formations present and that there is some form of 3D representation of the shape of formations – not just the stratigraphy of individual locations, but inferred stratigraphy between sights. Suggestions include:

- Hand crafting a model
- Hand drawing cross-sections
- Minecraft – An suggestion for using Minecraft to represent geology is available here: http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/minecraft/3d/home.html
- DICOM files – The free software available at 3D
- 3D printing
- Autodesk Inventor (free for students)
- Highly annotated Google My Maps

Resources Available

- The Iowa Geological Survey's GEOSAM data about the contents of well coring. Data must be used from a minimum of 5 well sights.
- USGS Topological Maps

Example

Below is an example of one way to do this project. I started by looking up well stratigraphies from my neighborhood. There were none that actually had stratigraphy data within the bounds of my actual neighborhood, so I had to choose ones that are nearby.

	WNUMBER	ELEVATION	LAT	LONG
A	428	740 ft	41.97894	-91.6586
B	379	738 ft	41.97848	-91.6591
C	1867	746 ft	41.99508	-91.6569
D	2328	799 ft	41.99225	-91.6199
E	13138	726 ft	41.97068	-91.6523

I then made a Google "My Map" from within Google Drive to show the locations of the wells (Figure 7).

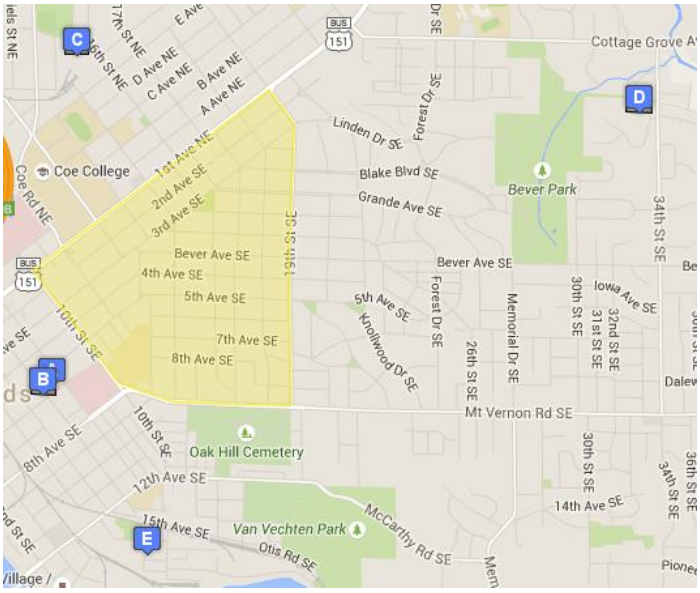

Figure 7 Well map

Next I (hypothetically) printed out this image an affixed it to a large board (foam board or plywood. I measured and cut out dowels that had the correct relative height, considering the elevation, and glued/screwed them in to the board. (See Figure 8.) To the side of each dowel, I taped a printout of the stratigraphy – visible in the side view in Figure 9. I made the stratigraphies using MS Excel by first shrinking the row height, merging the number of cells equivalent to the number of feet for each formation depth, and entering an appropriate description. These are shown in Figure 10. Finally I tied strings between the dowels to begin to visualize the shape of the boundaries between geologic formations.

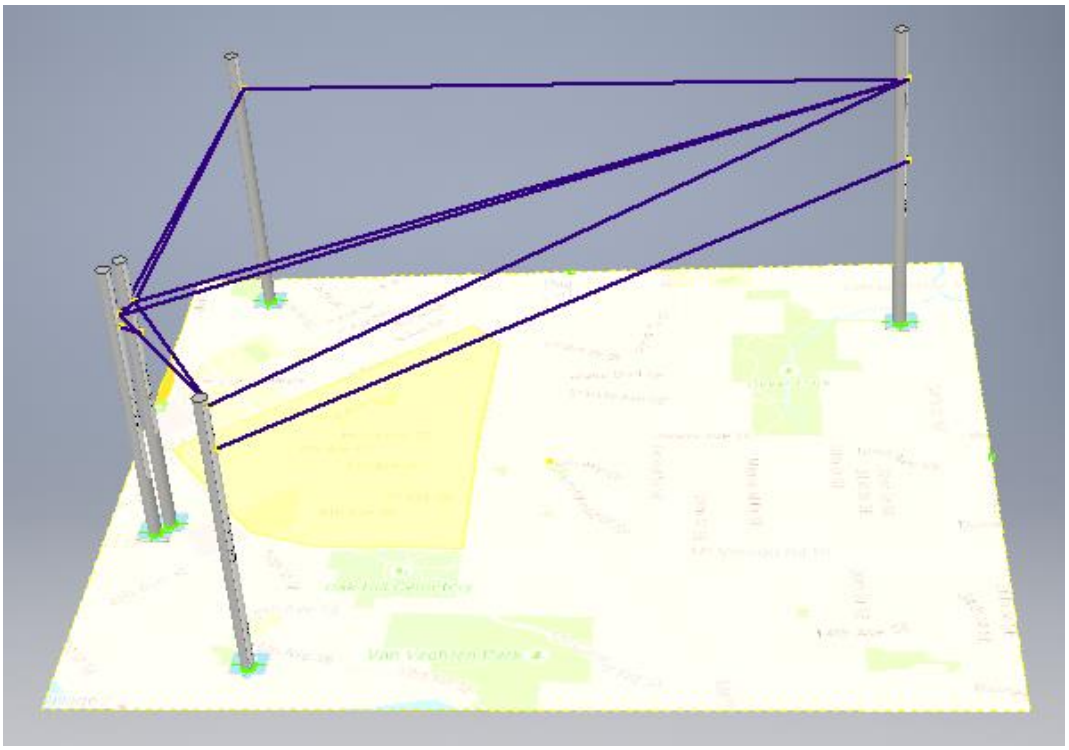

Figure 8 Overview of project. The map has a 1 cm=10,000 ft scale. The vertical dowels have a 1 cm = 1 ft scale. The heights of the dowels is arbitrary, but relative

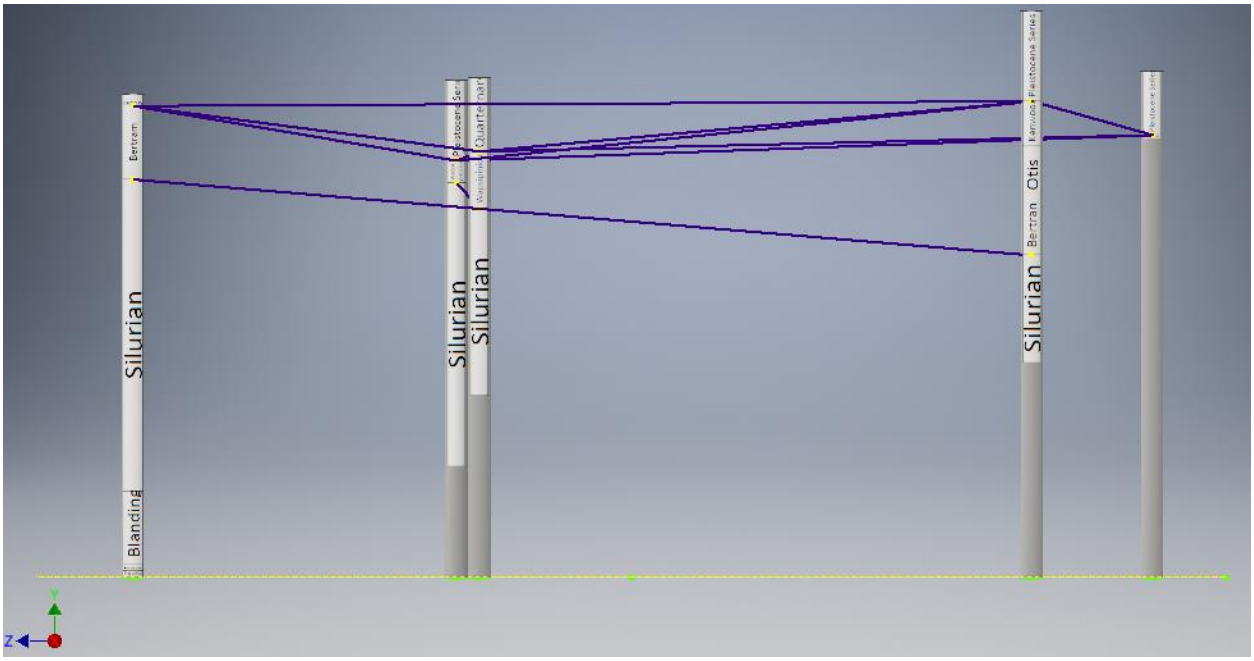

Figure 9 Side View of Project

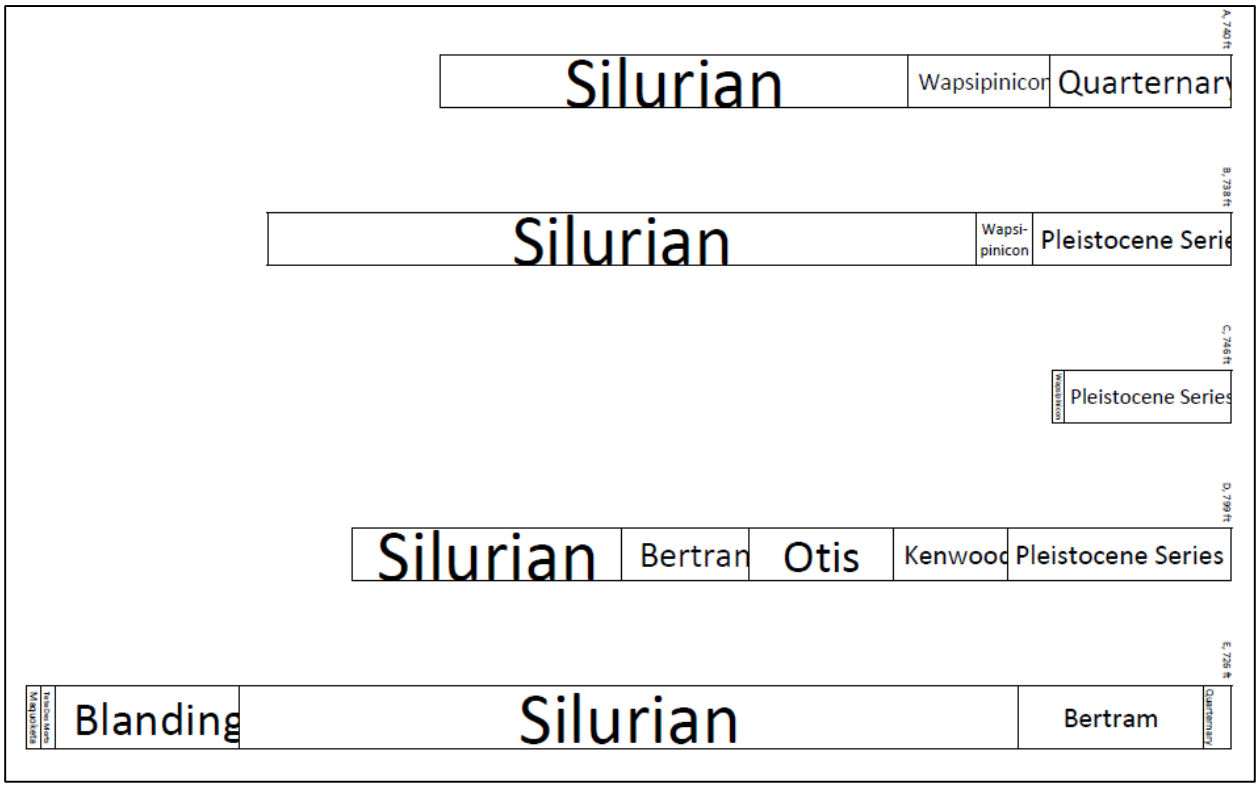

Figure 10 Print outs for stratigraphy of each well

Extension

Students who are ready for more (or who need more support) can make 3-D topological representations (with foam board, Minecraft, etc.) to better understand the difference in vertical and horizontal scaling.

Reflection

The reflections that students write will be guided in class to include discussion of listed uncertainty of location of wells, how to resolve seeming contradictions between adjacent wells, what sort of assumptions need to be made, when assumptions are appropriate and when they are not. Making these habits of mind and elements of the Nature of Science explicit helps students to climb the ladder of abstraction and enables them to have a richer understanding of how the methods of science are applicable in all aspects of live.

Works Cited

Anderson, Wayne I. *Iowa's Geological Past: Three Billion Years of Earth History*. Iowa City: U of Iowa, 1998. Print.

“Article.” *The Public Land Survey System (PLSS)*. Web. 21 Jul. 2015. <http://nationalmap.gov/small_scale/a_plss.html>

Colvard, Elizabeth. "Topographic Map Margins Information for Educators." *Topographic Map Margin Information* (2013): n. pag. *Resources for K-College Teachers | USGS Education*. U.S. Geological Survey. Web. 25 Apr. 2015.

"Iowa Lakes, Rivers and Water Resources." *Iowa Lake Map, River Map and Water Resources*. Geology.com, n.d. Web. 23 July 2015.

"Landform Regions of Iowa." Iowa Detpt. of Natural Resources. Web. 24 July 2015.

QGIS Development Team, 2015. QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.

U.S. Geological Survey. *Cedar Rapids South quadrangle, Iowa-Linn Co.* [PDF map]. 1:24,000. 7.5 Minute Series. Washington D.C.: USGS, 2013. <http://ims.er.usgs.gov/gda_services/download?item_id=5944110> (25 Apr. 2015).

"Wapsipinicon Formation." *Mineral Resources On-Line Spatial Data*. Web. 23 July 2015.

Wikipedia contributors. “Fifth Principal Meridian.” Wikipedia, The Free Encyclopedia. Wikipedia, The Free Encyclopedia. Web. 24 Jul. 2015.

Wikipedia contributors. “History of Iowa.” Wikipedia, The Free Encyclopedia. Wikipedia, The Free Encyclopedia. Web. 21 Jul. 2015.

Wikipedia contributors. “Iowa Archeology.” Wikipedia, The Free Encyclopedia. Wikipedia, The Free Encyclopedia, 16 Jan. 2015. Web. 7 Jul. 2015.

Wikipedia contributors. “Meskwaki.” Wikipedia, The Free Encyclopedia. Wikipedia, The Free Encyclopedia. Web. 21 Jul. 2015.

Wikipedia contributors. “Sauk People.” Wikipedia, The Free Encyclopedia. Wikipedia, The Free Encyclopedia. Web. 21 Jul. 2015.

Wikipedia contributors. “Silurian Period.” Wikipedia, The Free Encyclopedia. Wikipedia, The Free Encyclopedia, 27 Jun. 2015. Web. 7 Jul. 2015.

Wikipedia contributors. “Wisconsin Glaciation.” Wikipedia, The Free Encyclopedia. Wikipedia, The Free Encyclopedia. Web. 24 Jul. 2015.

Wikipedia contributors. "Universal Transverse Mercator coordinate system." Wikipedia, The Free Encyclopedia. Wikipedia, The Free Encyclopedia, 3 Apr. 2015. Web. 25 Apr. 2015.

GIS map: “The Landform Regions of Iowa.” https://catalog.data.gov/dataset/the-landform-regions-of-iowa Iowa Geological Survey. Metadata: ftp://ftp.igsb.uiowa.edu/gis_library/ia_state/Geologic/Landform/Landform_Regions.html

GIS map: “2013 National Aerial Photography Imagery Program (NAIP) Ortho Imagery of Linn County, Iowa.” USDA-FSA Aerial Photography Field Office. Pub: 20130924. Publisher: USDA FSA Aerial Photography Field Office, Salt Lake City, Utah