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Static Water Level Data from Well Drilling Logs in Proximity to a Proposed Quarry Site, Clark County, Ohio

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Analysis of Static Water Level Data from Water Wells in Proximity to a Proposed Quarry Site, Clark County, Ohio

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Abstract

The static water level of a well is the distance from ground level down to the water within the well during a stabilized period of no downhole activity. A local mining company has purchased approximately four hundred acres of land in Mad River Township, just north of Yellow Springs, Ohio. The primary purpose of this project was to determine the accuracy of the groundwater data used by the mining company's consultant when they produced a regional groundwater map. Water well driller's logs that indicated static groundwater levels were the source of much of the information used in creating the regional groundwater map in the consultant's report. The state of Ohio also has a series of groundwater maps that were derived from some of the same drillers' logs. In this current study that lasted approximately half a year, static groundwater level measurements were taken at ten different wells in the area where the planned Phase II quarrying activity is to take place. Eleven different measurement events occurred over the half-year period. The measurements were made with an electric water level meter. The data was processed with Surfer software in order to determine the gradient and direction-of-flow of groundwater in the study area. Polynomial regression was run on the data to give the groundwater-surface a planar attitude for the area of study. The gradient was calculated to be 0.72% with a west-northwest direction of flow. Previous data collected in 2018 from some of the same wells were examined in Surfer and it showed a gradient of 1.37% with a west-northwest flow direction. The process of comparing the new Surfer-derived maps, which reflect accurate measurements, to the state of Ohio's and the consultant's groundwater maps was done, and those comparisons indicate that there are apparent inaccuracies with the state's and the consultant's maps. Site-specific comparisons of the consultant's potentiometric map with the maps derived from this current study show that the gradients and directions of flow vary significantly. The consultant's flow direction appears to be to the southwest with a gradient ranging from 0.013-0.017%. This current study indicates a flow direction of west-northwest with a much steeper gradient for the area of study, ~1%+/-.

Goals

The project involved measuring the static water levels for wells near a local mining company's proposed phase II quarry site. The plan was to use this data to create a potentiometric map to help determine the accuracy of groundwater maps produced by the state of Ohio and the mining company's consultants.

Methods

Over the course of the study period (fall-winter 2019-2020) static groundwater measurements were taken near the proposed Phase II area. Ten different wells were measured after receiving permission from landowners. Nine measurement sessions occurred over the course of the study period. The device used to measure the water level was a Solinst Mini Water Level Meter Model 102. This device is equipped with a weighted electrical probe that is attached to a cable that is marked every 1/100ft. After removing the well cap the probe was lowered into the well until the probe came into contact with water inside the well. The depth was determined based on an electronic signal from the meter. Measurements were recorded. Surface elevations for the wells were determined based on field GPS/GIS data, some of which came from the original driller's logs. Surfer GIS software was utilized for mapping the static water levels and to produce potentiometric surface maps that indicate direction and gradient of the groundwater flow near the proposed Phase II site.
The data from this current study was added to water level measurement data collected a couple of years ago in the same area by former CU student Eric Hannon. A series of Surfer maps (Figures 4-7) were created to compare consistency between the datasets with regard to gradient and flow direction of the groundwater surface.

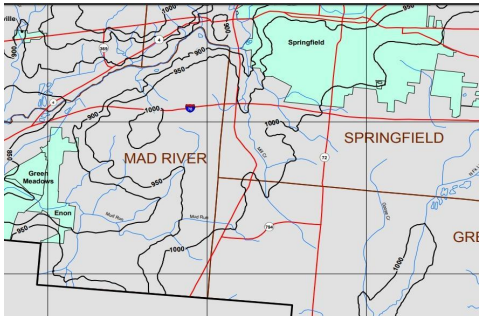

Figure 1. This map shows the elevations of the groundwater levels (black contours) measured from individual wells completed in the bedrock aquifers within Clark County. This potentiometric surface map roughly indicates the elevation and general direction-of-flow of the groundwater. These contours were created with over fifty years of data collected by the state. ODNR, 2015.

Figure 2. This map shows all the wells (red dots) that were measured during this current study. The red lines surround where the Phase II quarry site is planned.

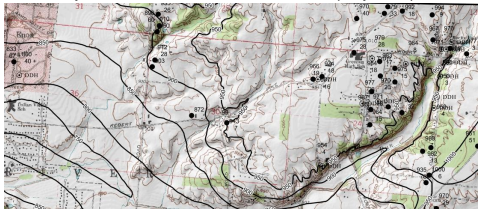

Figure 3. This map shows the bedrock topography of the Yellow Springs, Ohio Quadrangle. ODNR 2000.

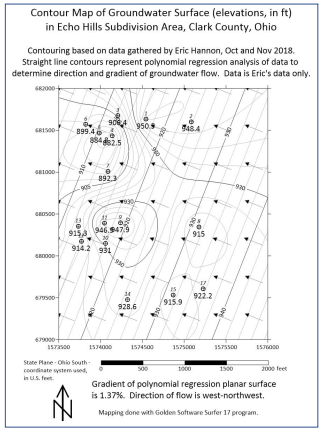

Figure 4. The polynomial regression shows a gradient of 1.37% with a direction west-northwest.

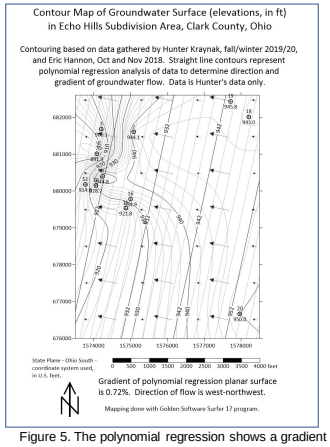

Figure 5. The polynomial regression shows a gradient of 0.72% with a direction west-northwest.

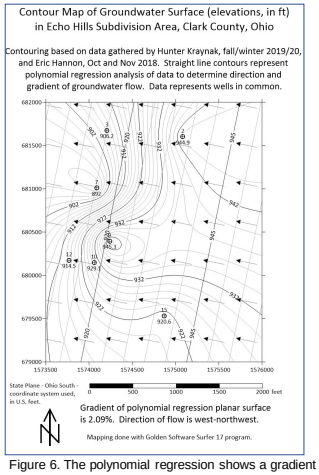

Figure 6. The polynomial regression shows a gradient of 2.09% with a flow direction west-northwest.

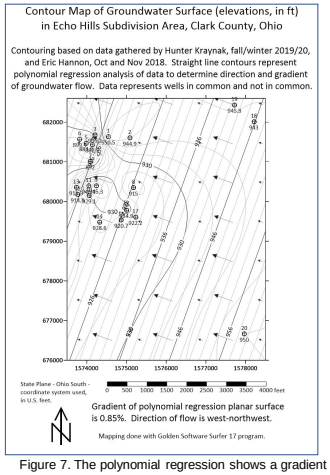

Figure 7. The polynomial regression shows a gradient of 0.85% with a flow direction west-northwest.

Conclusions and Recommendations

The measurements that represent "in-common locations" between the 2018 data and the 2019/20 data show a gradient of 2.09% (Figure 4). The measurements that represent "in-common and not-in-common locations" show a gradient of 0.85% (Figure 5). The data collected solely by Hunter Kraynak shows a gradient of 0.73% (Figure 6). The data collected by Eric Hannon shows a gradient of 1.37% (Figure 7). All these measurements indicate a flow direction to the west-northwest. The Ohio map (Figure 1) does not lend itself to a meaningful gradient calculation. The range of gradients derived from the consultant's potentiometric map shows a low gradient for the study area of ~0.015% and a groundwater flow direction to the southwest.
Future studies should focus on bringing more wells into the mix. The expanded geographic range would allow for better comparison to the consultant's potentiometric map. Also, a critical analysis of the driller's data should be made to determine which static water levels and surface elevations seem to be accurate. These original driller's logs are the basis for a lot of the information that is used by the consultant, the state, and the author of this study.

References:

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Acknowledgments

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