EVALUATION OF WELL FIELD RISKS RELATED TO COAL ASH STORAGE

Lawrenceburg Municipal Utility Wells

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

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INTRODUCTION

Over the last decade more attention has been given to the potential problem of legacy contamination from coal ash waste near power plants throughout the country. The Tanners Creek power plant, once owned and operated by American Electric Power (AEP) in the city of Lawrenceburg, Indiana, created several coal ash deposits along the Ohio River at river mile 494, downstream of the city. The ash waste accumulated from the time the plant was constructed and began operation in the early 1950s to 2015 when the plant was closed. Some of the legacy ash deposits are unlined (i.e., no clay layer was installed at the bottom of the ash piles) and are in direct hydraulic communication with the local aquifer that is also the source for community water systems. Consequently, the question has been asked whether this ash waste is a risk to the municipal drinking water in Lawrenceburg.

This memorandum describes an analysis of the potential risks of groundwater contamination to the City of Lawrenceburg's drinking water (Figure 1). The risk analysis is based on a review of the available water quality and water level data from the utility and the IDEM files associated with the Tanners Creek power plant site supplemented by the results of a localized groundwater flow model used to determine whether contaminants could move from the source locations to the wells.

HYDROGEOLOGIC SETTING / BACKGROUND

The Ohio River Alluvial Aquifer has been described in many different technical reports and publications, including several early works by the USGS (Walker 1957, Gallaher and Price 1966) as well as more recent reports done on the alluvial system along the Kentucky reach by Michael Unthank, (USGS 1996, 1997, 2000, 2010, 2011). Since that time, Wittman Hydro Planning Associates (2010, 2011) performed an investigation of the aquifer and conducted extensive testing to determine the yield of a set of collector wells in the Charlestown State Park in Southern Indiana. All of these reports and investigations reached two conclusions:

1) the alluvial aquifer is extremely prolific and where it is not covered by thick silt layers, groundwater is vulnerable to contamination, and
2) groundwater flow directions are determined by the local interaction with the river and pumping that occurs in high capacity wells.

In Dearborn County and in the area near the city of Lawrenceburg, most of the high capacity wells are located where the sand and gravel outwash and alluvium is between 70 – 110 ft thick. These sand and gravel deposits overlying the relatively impermeable carbonate (limestone and dolomite) bedrock (Fenelon and Bobay 1994). The aquifer is productive and important to communities because it is composed of highly permeable sand and gravel deposits that are recharged primarily by the adjacent continental river.

Along the edges of the flood plain, however, in the terrace areas finer-grained (less permeable) material is deposited at the surface which restricts recharge and reduces yields.

Along the river, where water wells are productive and native groundwater quality is excellent, the aquifer supplies a number of community water systems and several important industrial water users. Each of the community water supply systems have engaged in the process of wellhead protection, where potential contaminant sources are identified, and a groundwater model is constructed to determine where releases could affect the groundwater used by public water supply wells (Carr 2008). However, none of these efforts included an analysis of potential contamination from coal ash at the AEP site.

Unlike situations where contamination is found in a well and the source is unknown, here all of the water quality data collected by the Lawrenceburg Municipal Utility has shown **no indication that wells have been affected by or are threatened by the ash sites in the area**.

FACTORS THAT DETERMINE RISK

Groundwater flow in the Lawrenceburg Alluvial Aquifer is controlled by the hydraulic properties of the subsurface and any differences in head that move water from source to sink. Testing and analysis has been done on multiple wells in the area to help determine and then map these properties. Aquifer tests were performed on several of the municipal wells in the area and that data was described in the wellhead protection reports for these municipal supply wells in the vicinity (Carr, 2008).

The pumping rate of wells removing water from the aquifer will determine the local influence of each individual well (Table 1). The location of those wells, relative to other wells and the rivers in the area, will also affect the resulting groundwater flow directions (Figure 1).

Aquifer recharge that occurs because of precipitation on the land, also determines groundwater flow directions in the system. And most of Indiana recharge rates on alluvial floodplain aquifers are in the range of 1 foot per year. In this system recharge may be limited by flood control drainage that removes some of the shallow recharge as it arrives at the water table.

Well that are located in aquifers along rivers can induce recharge into the aquifer by lowering water levels between the river and the well. Consequently, the hydraulic connection between the streams and the alluvial aquifer also determines how groundwater moves through the aquifer.

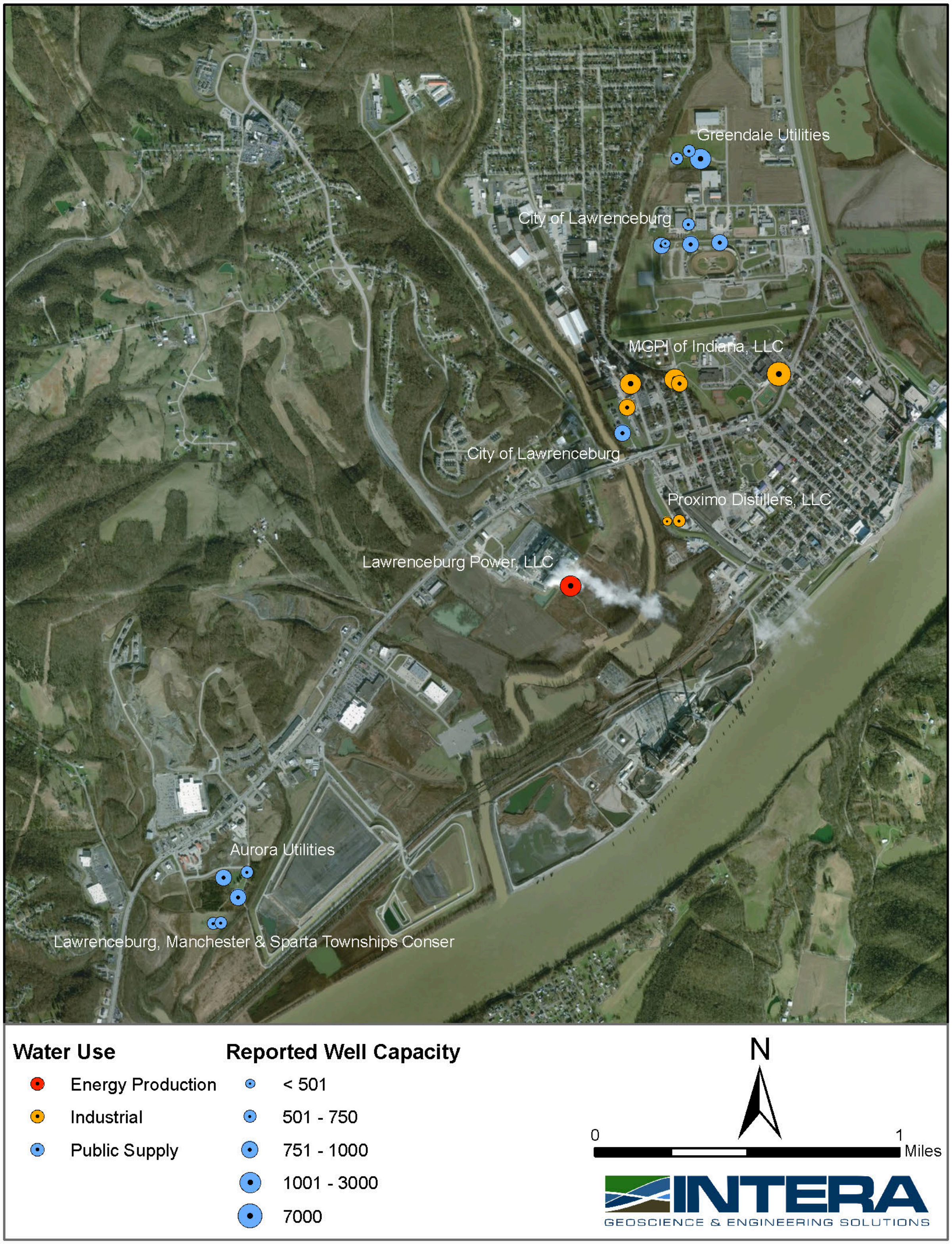

Figure 1. Location of wells in the vicinity of Lawrenceburg Municipal Utility wells.

Table 1. Pumping rates for wells in the study domain.

Facility Name	Well Number	Well Depth (ft bgs)	Pumping Capacity (gpm)	2017 Pumping (MGD)
Aurora Utilities	1	60	650	0.01
Aurora Utilities	3A	60	850	0.60
Aurora Utilities	4	75	850	0.33
City of Lawrenceburg	**1**	**82**	**1000**	**0.19**
City of Lawrenceburg	**2**	**75**	**1000**	**0.19**
City of Lawrenceburg	**3**	**74**	**1000**	**0.19**
City of Lawrenceburg	**4**	**87**	**1000**	**0.19**
City of Lawrenceburg	**10**	**75**	**375**	**--**
City of Lawrenceburg	**11**	**77**	**450**	**--**
City of Lawrenceburg	**12**	**79**	**500**	**--**
City of Lawrenceburg	**14**	**86**	**750**	**0.13**
Greendale Utilities	1	80	550	0.53
Greendale Utilities	2	80	550	0.47
Greendale Utilities	3	80	1100	0.03
Lawrenceburg, Manchester & Sparta Townships Conservancy District	1	67	700	0.17
Lawrenceburg, Manchester & Sparta Townships Conservancy District	2	64	700	0.17
MPG Ingredients	1	85	7000	6.10
MPG Ingredients	12	100	1500	1.14
MPG Ingredients	14	92	1000	1.37
MPG Ingredients	17	89	2000	2.80
MPG Ingredients	18	112	1000	0.03
Proximo Distillers	15	116	600	0.16
Proximo Distillers	16	116	500	0.14

ft bgs = feet below ground surface; gpm = gallons per minute; MGD = million gallons per day

WATER BUDGET

If we look at the total water budget for the wells pumping in the Lawrenceburg aquifer system, we would see that recharge is approximately 1/5 of the total pumping occurring in the system (Figure 3). This means that over the course of the year, on average, water is moving from the river into the aquifer along to reach near Lawrenceburg. This area is a losing reach of the Ohio River on the Indiana side.

Pumping rates in this aquifer are dominated by withdrawals for local distilleries. The MGP distillery pumps over 10 MGD. Most of that water is removed by a single radial collector well (i.e., a Ranney well) that pumps approximately 6 MGD with the remainder made up by several high yield vertical wells (Table 1). Each of the public drinking water systems pumps in the range of 1,000,000 gallons per day. The four utilities that pump water in this area include Greendale, Aurora, Lawrenceburg Manchester Sparta Township (LMS) and LMU.

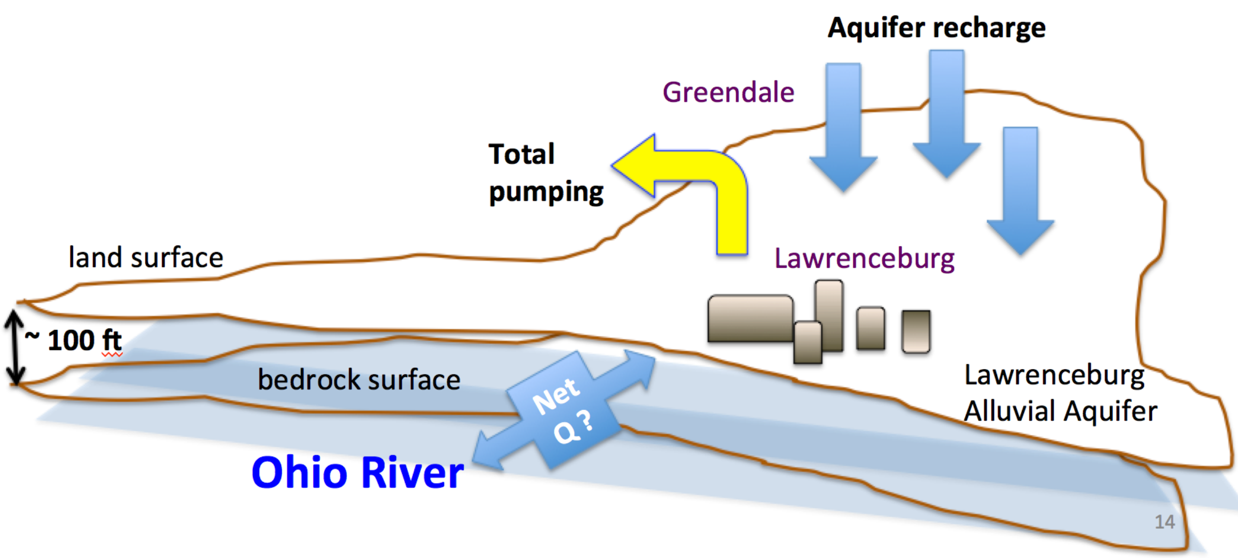

Figure 3. Local water budget: ***exchange with the River = recharge – pumping***

COAL ASH STORAGE

Where each wellfield is located determines whether it will pump water that was once flowing beneath the old coal ash piles. The location of the coal ash has been mapped both by the Indiana Department of Environmental Management and the parties who own the property. The largest ash piles are located adjacent to the river in the vicinity of the now-demolished power plant. Other coal ash storage piles have been identified along Tanners Creek and in other locations within the community (Figure 4).

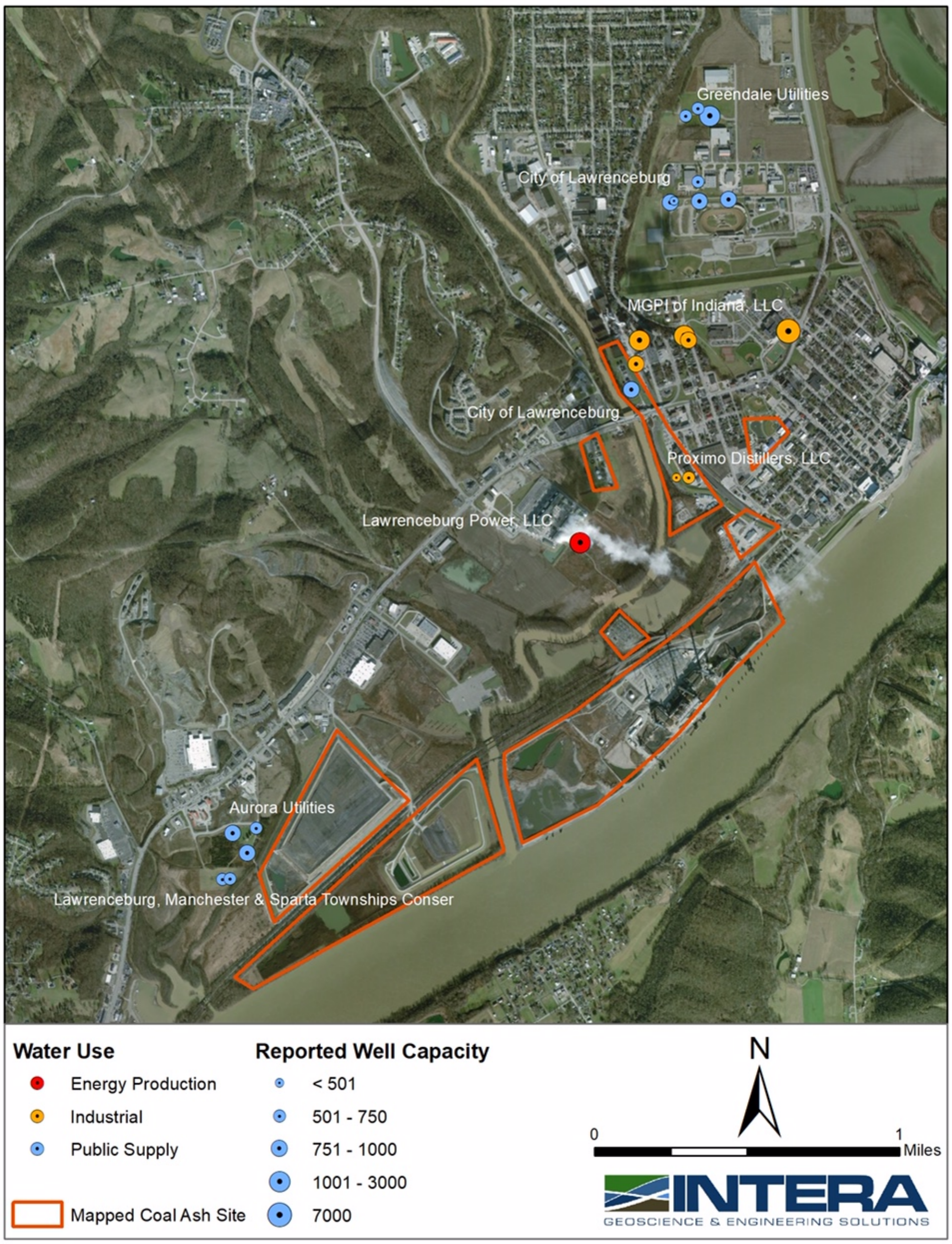

Figure 4. Examples of mapped coal ash storage locations near area of interest.

GROUNDWATER FLOW MODEL

In order to understand the potential risk posed by the coal ash storage piles, a groundwater flow model was constructed that integrates all pumping and natural features that determine the areas of the aquifer that contribute water to each well. This model was used to define the capture zones for all of the wells with specific attention paid to the LMU system.

The finite difference code, MODFLOW, was used to simulate groundwater flow patterns in the aquifer near Lawrenceburg. In this model, steady state conditions were assumed to apply. This means that all of the conditions that vary over a year were defined as the average conditions for those variables. For example, the aquifer recharge rate, which naturally varies from place to place and year-to-year, was assumed to be a constant value continuously. Pumping rates in each of the wells in the system were defined as the rates reported for 2017 withdrawals and assumed to be constant. IDNR databases were used to define these rates for each well (Table 1).

MODFLOW requires that the model of the system discretizes the aquifer domain into “cells” that can have different properties, including recharge rate, porosity, aquifer base elevation, etc. This network of cells is commonly referred to as a model grid and it is illustrated in Figure 5, below. The model domain was extended far up and downstream of the local area of interest to assure proper regional flow into the Lawrenceburg area. While the aquifer base was varied to reflect the thinning aquifer along the edges of the floodplain (Figure 6), other properties were held constant based on the available data from aquifer tests conducted in the vicinity (Table 2).

Table 2. Steady-state groundwater flow model properties.

Property or Variable – units	Values used in Model
hydraulic conductivity – ft/d	400 ft/d K_H
bedrock elevation - ft	360 – 430 ft
Recharge – inches/yr	6 inches/yr
river conductance – days	.001 – 1 ft/day K_v
porosity - dimensionless	0.25
pumping rates in wells - MGD	from IDNR 2017 data

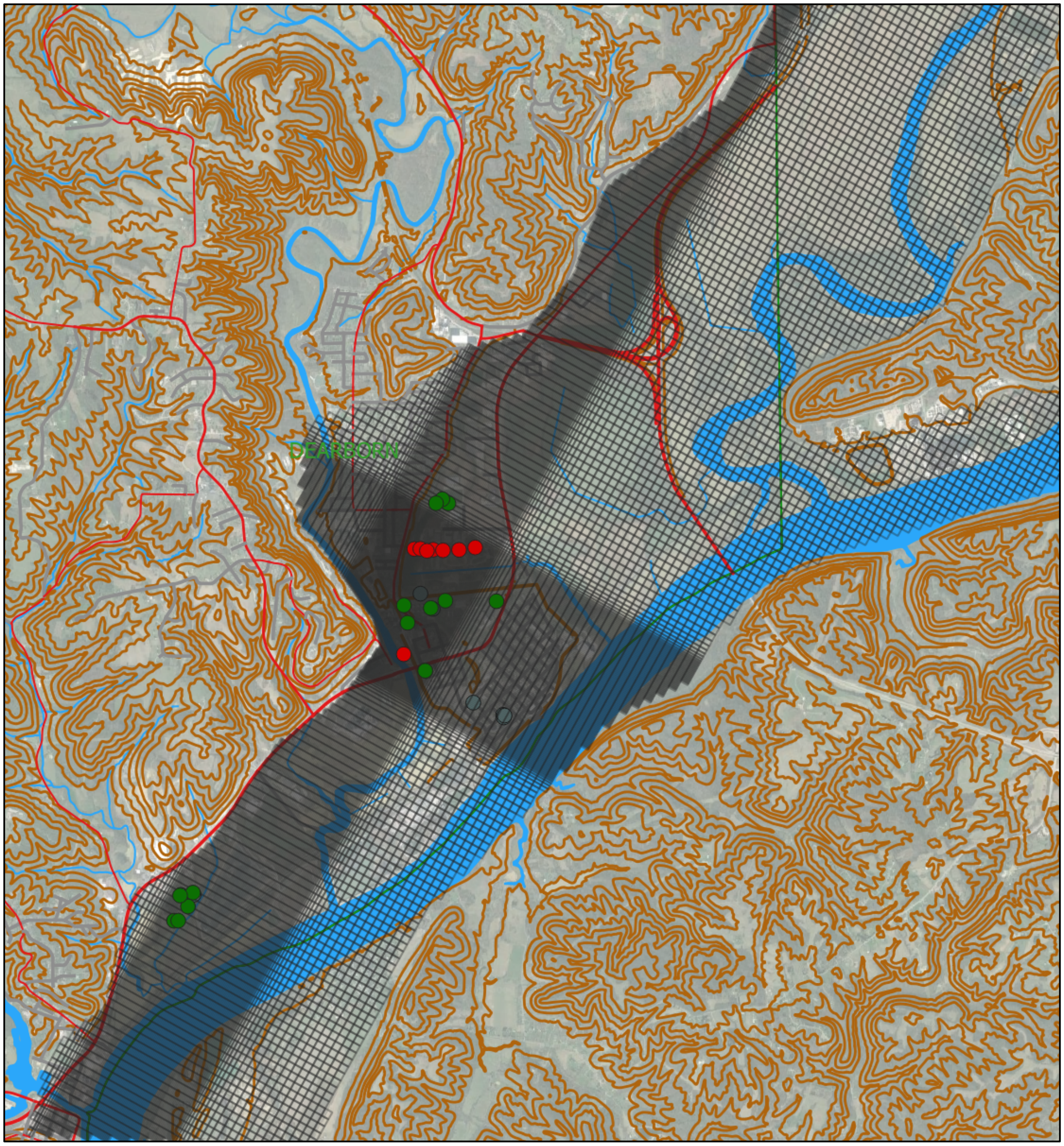

Figure 5. Model grid used in the MODFLOW model described in this report. Cell size decreased near wells. Red squares show the location of the existing Lawrenceburg Municipal Utility wells. Model extended up and downstream of the area of interest.

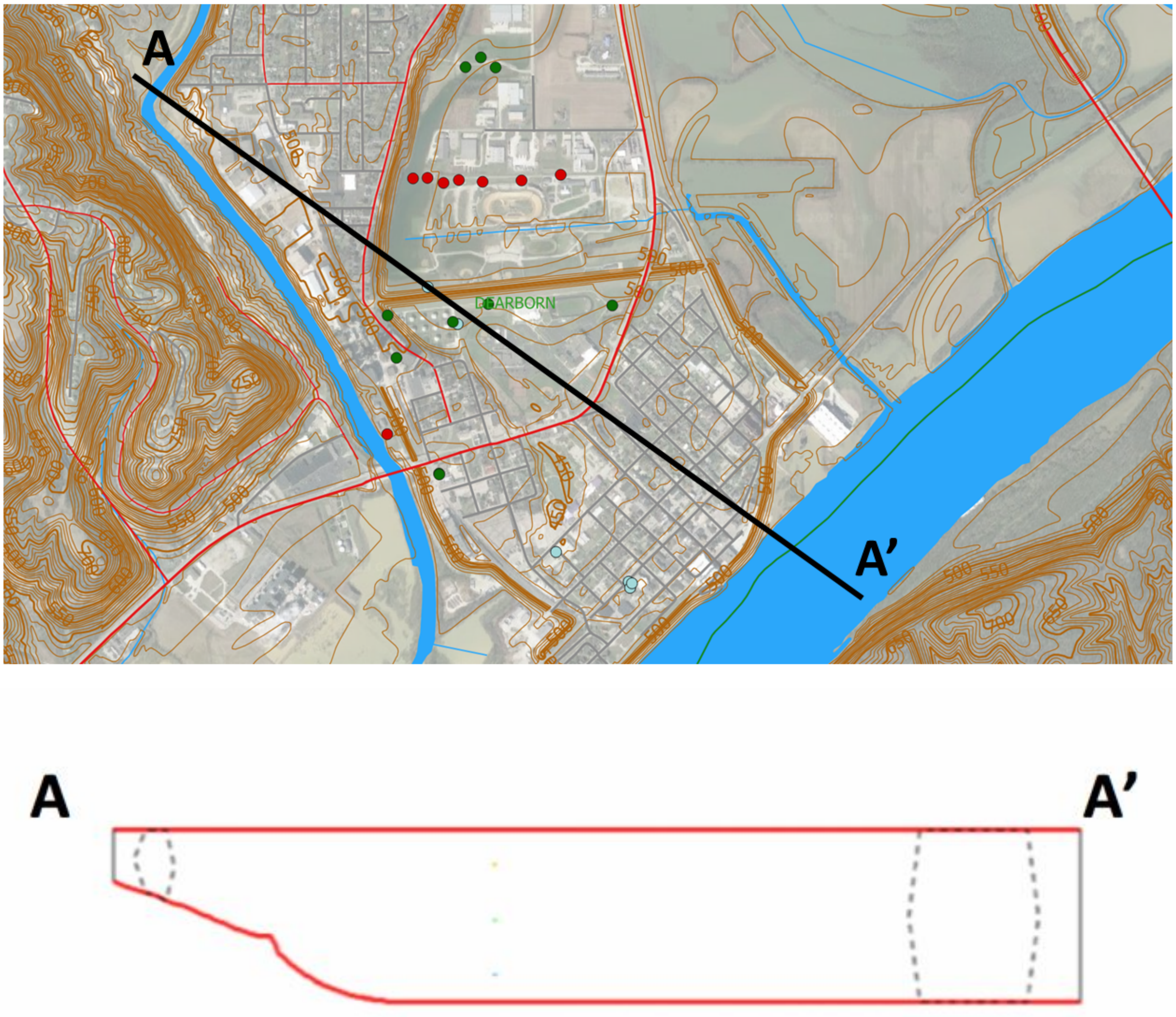

Figure 6. Illustration of the changes in bedrock elevation along green transect between the river and the well field through Lawrenceburg.

Modeled Flow Patterns

The operation of the very high capacity Ranney collector well used by the local distillery, protects the municipal water system in Lawrenceburg. This industrial water well owned by Midwest Grain Products, formerly Seagrams, dominates and defines the groundwater flow system in the aquifer that supplies the wells used by the city (Figure 7 and 8). This one industrial well annually pumps more groundwater than all of the public water supply wells combined (Figure 4). While this well and the distillery uses a large amount of water, the pumping is sustainable in this aquifer because of connection to the Ohio River allows it to supply water to the aquifer even under drought conditions.

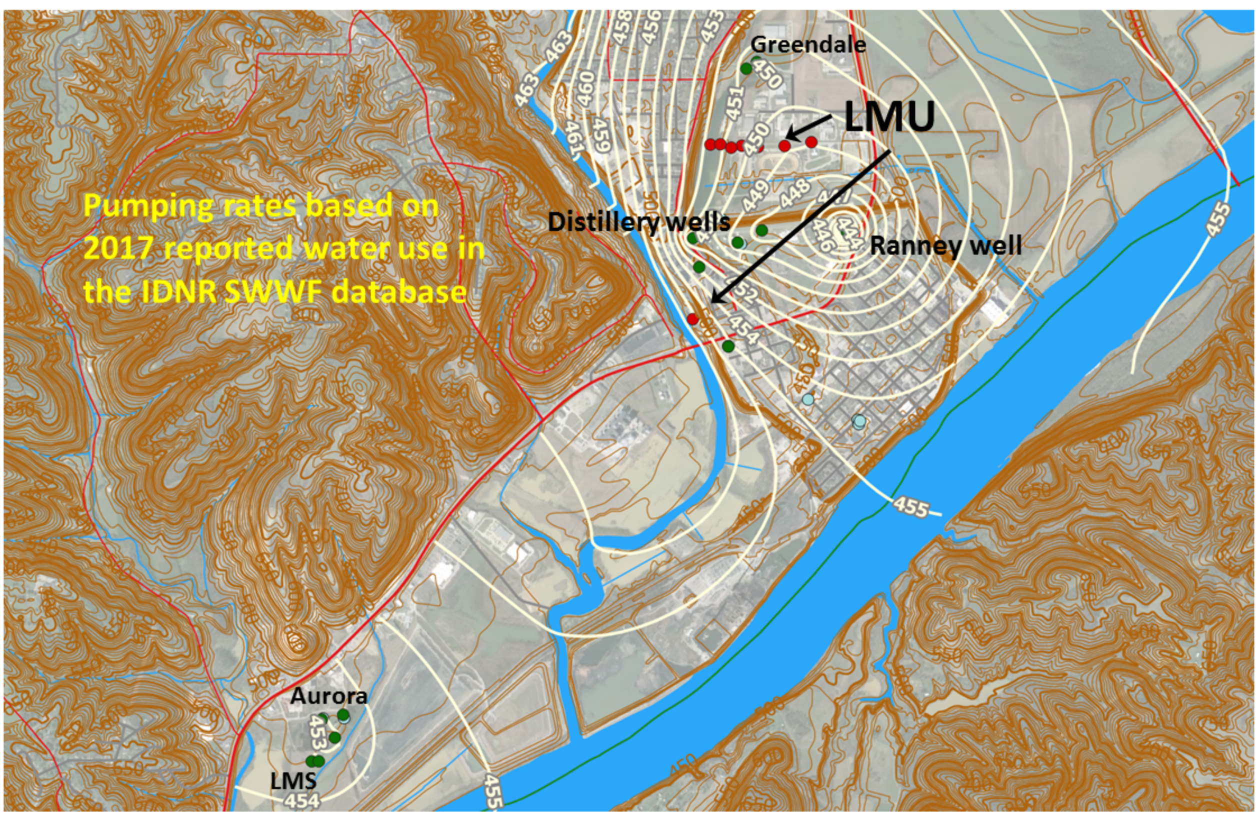

Figure 7. Potentiometric surface showing reductions in groundwater levels near the larger wells. Distillery wells are pumping in a line just south of the Lawrenceburg well field so they intercept groundwater that came from the ash storage sites.

Capture Zones

The LMU wells, with the exception of well #4 along Tanners Creek, are all north of the cone of depression created by the distillery wellfield. On the other side, north of the LMU wells, the city of Greendale has a wellfield that captures groundwater flowing from the north. In effect, the LMU system is "protected" by the capture zones of the neighboring industrial and municipal wells that intercept water flowing towards it from the north and south (Figure 8). Hydraulic analysis indicates that Well #4 is likely getting water from induced recharge from Tanners Creek.

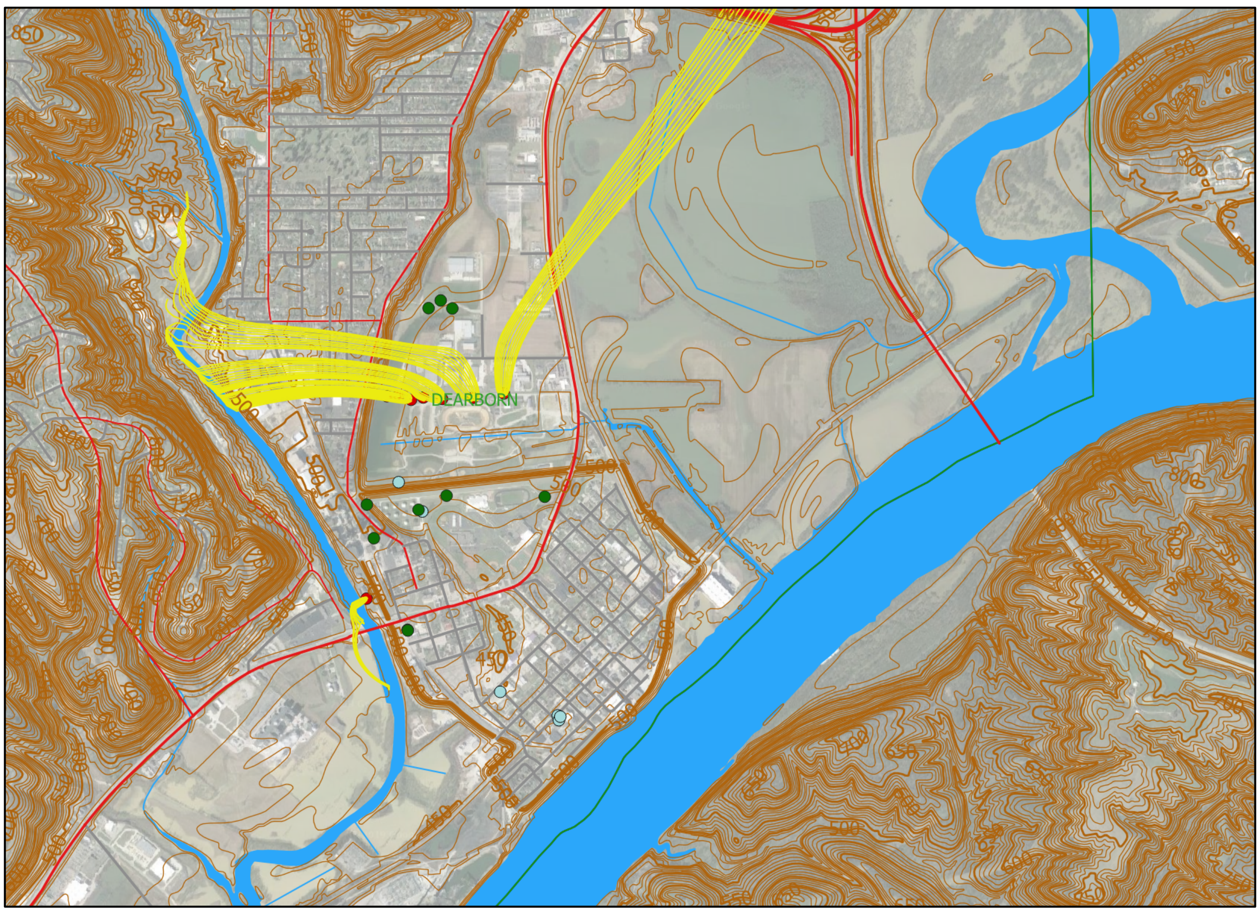

Figure 8. Capture zones of the Lawrenceburg Municipal Utility wells.

FINDINGS AND RECOMMENDATION

- Based on the water quality data from the wells in the area and the modeling used to reflect the hydraulics of the stream-aquifer interaction along the River near Lawrenceburg, there is no indication of any risk or water quality concern in public drinking water. In addition, another long-term safety factor for LMU wells is the industrial pumping in the Lawrenceburg aquifer that creates a hydraulic barrier to potential contamination from the South.

- Concerns about the proximity of the coal ash do not account for the water budget of the system. Only a small fraction of the water pumped by the wells has made contact with the ash. Most of the water pumped by all of these wells is simply groundwater that has moved slowly through the aquifer below the surface storage piles of ash into the wells.

- While water quality is currently good, it is generally good practice to manage an aquifer of this importance collaboratively among the water users. For example, groundwater monitoring could be coordinated – water levels and groundwater quality samples could be taken regularly in all wells. A monitoring plan could be developed for this effort.