HYDROGEOLOGICAL CHARACTERISTICS OF THE AREA IN THE VICINITY OF THE PROPOSED IAA SITE

Prepared for:

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Hydrogeological Characteristics of the Area in the Vicinity of the Proposed Insurance Auto Auctions Site

Insurance Auto Auctions (IAA) plans to construct a new facility on a 35 acre site along the east side of Commonwealth Drive in East Dundee, Illinois (Figure 1). Commonwealth Drive provides access to the west side of the site. An existing 190-foot wide Commonwealth Edison (ComEd) Right-of-Way runs along the western boundary of the site. The historic use of the site and the surrounding area was as a gravel pit, which has since been filled in and contains several depressed areas due to the way in which it was filled and graded (Kimley-Horn, 2012).

1.0 IAA Site Study Area

The study area selected to assess the hydrogeology in the vicinity of the proposed IAA site is shown in Figure 2. The location of the IAA site is shown in red. The study area is approximately 5.3 miles east to west, 4.5 miles north to south and encompasses an area of approximately 24 square miles. The proposed site is located on a north-south trending topographic high. The high gently slopes downward to the east. The gradient of the slope to the west is much greater as it enters the Fox River Valley.

Well log data were used to assess the hydrogeology of the area. Well log information was obtained from the Illinois State Geologic Survey (ISGS, 2001) and updated on a regular basis. Data received from the ISGS were prepared, analyzed and developed into a more user-friendly database (BACOG, 2006). The black dots shown in Figure 2 are the locations of domestic wells whose stratigraphic information was used in the assessment. The red triangles represent the location of the area's municipal wells that obtain their water from the shallow aquifer system. The study area contains 244 domestic wells and 21 municipal wells. These wells are shown in a three dimensional representation in Figure 3. The figure also shows the stratigraphy of each well in terms of hydrogeologic units. The blue represents aquifer materials and the brown and tan represent aquitard and aquiclude materials of a glacial till layer respectively. Aquifer materials are dominant in the upper portions of the deeper wells located in the area of the topographic high to the right in the figure. These wells have till layers of varying thickness underlying the aquifer material. In the central cluster of wells the till layer is split in two by a layer of aquifer material.

The wells are much shorter to the west. These wells are located in the Fox River valley and are mostly located in deposits of aquifer materials. Further to the west, the wells become deeper to the west of the Fox River valley. Looking at the figure as a whole, it is obvious how the aquifer material is interconnected.

2.0 Recharge

The proposed IAA site is in a highly sensitive recharge area. Originally the northern and the southern portion of the site were in a highly sensitive recharge area while the central portion was in a sensitive recharge area. The recharge characteristics of the study area are shown in Figure 4. One can tell by reviewing Figure 3 that the area would probably be a very good recharge area because of all the aquifer material in the upper portion of the wells in the area of the proposed site. Highly sensitive recharge areas capture about 48.2 percent of the annual rainfall and the relative time of travel for the rainfall to enter the ground and reached the water table is less than approximately 20 days (Table 1) the portion of the site that has sensitive recharge characteristics captures about 30.3 percent of the annual rainfall and the relative time of travel for this water to reach the water table is about somewhere between 20 days and 1.5 years..

The recharge characteristics of the area are responsible for the economic value of the materials close to the surface. The site, as mentioned earlier, was a gravel pit that has since been filled in with available soil materials. Review of recent soil boring logs indicates that the type of fill material used ranged in permeability from a highly permeable sand and gravel to a relatively impermeable organic clay. Table 2 lists the type of materials identified in the borehole logs, their estimated hydraulic conductivity and the frequency in which they were encountered. This information was used to determine the relative frequency of the material and to estimate an average hydraulic conductivity for the fill material at the site. The resulting log K was -4.45 or a hydraulic conductivity of 3.55E-5 cm/sec. Since the soil material was placed into the pit without compaction, making the fill material relatively homogeneous, this value for hydraulic conductivity would be a good estimate of hydraulic conductivity in both the horizontal and vertical directions.

Table 2 also lists the total and the effective porosity of the fill materials encountered. These values were used to estimate the vertical and horizontal velocity of water movement through the fill material. Horizontal flow through to fill is slow because of the low groundwater gradients in the site area. As mentioned before, the site is located on a topographic high which is reflected by the water table at the site. The gradient is estimated to be about 0.0093. Multiplying this by the hydraulic conductivity of 3.55E-5 cm/sec and dividing it by the average effective porosity of the fill material (0.234) yields an average horizontal linear velocity of 1.41E-6 cm/sec or about 0.004 feet per day.

Vertical movement of the water through the unsaturated zone is affected by intrinsic properties of the solid materials of the fill by fluid properties and the energy state of the soil water (or soil moisture). This means that the vertical movement of water is fastest when the soil is saturated and that there is no movement when the soil moisture content is zero (US EPA, 1985). Using the information in Table 2, the vertical movement of water under saturated conditions would be 0.002 cm/sec or 0.430 feet per day. Therefore, the range of velocities for water to move vertically through the unsaturated zone to the water table would be 0.000 to 0.430 feet per day depending on the soil moisture content of the soil.

2.0 The " Clay Layer"

As can be seen in Figure 3, most of the fine-grained materials underlying the aquifer materials at the top of most of the boreholes in the proposed site area are actually classified as aquitard material. The material is a glacial till that is composed mostly of silt and clay particles intermixed with some sand and occasional deposits of gravel and some larger materials. Being classified as a aquitard means that the material does not prevent the movement of water through it, but only retards the movement. Therefore, it is a misnomer to refer to this layer as a "clay layer" which implies that the layer is impermeable. Further review of Figure 3 indicates that portions of the till layer are also classified as aquicludes. Little aquiclude material is contained in the till layer within the immediate area of the proposed IAA site. Aquiclude material becomes more dominant in the till layer to the east and lesser portions of the material are found to the west in the Fox River Valley.

The geotechnical work that was conducted by IAA included drilling a soil boring at the four corners of the site (TSC, 2012a and b). These borings went through the fill to the underlying till layer. The boring logs indicate that the till layer is located in the range of 27 to 37 feet below the ground surface at an average depth of 32 feet. A review of the well logs in the area of the IAA site, indicate that the underlying till layer is split into two parts in a portion of the site area and is whole in other parts. The areas where the till layer is split have the upper portion of the till layer thickness ranging from 20 to 30 feet with an average thickness of 26 feet. In this area there is an aquifer present between the upper and the lower till layer. This aquifer unit ranges in thickness from 3 to 45 feet with an average thickness of 18 feet. The underlying till layer ranges in thickness from 17 to 63 feet with an average thickness of 43 feet. In the area around the IAA site where the till layer is not split, the thickness of the till layer ranges from 94 to 118 feet with an average thickness of 106 feet.

Groundwater movement in the till layers is relatively slow. Groundwater gradients in the study area range from 0.003 to 0.052. The average hydraulic conductivity for till materials in the area is 3.28E-6 cm/sec and the average effective porosity is 11.0 percent. The average linear velocity of groundwater in the till material ranges from 8.95E-8 cm/sec to 1.55E-6 cm/sec which translates to 0.0003 to 0.0044 feet per day. Vertical movement of the groundwater results when there are differences in groundwater levels at a given location. These movements can be upward or downward and can vary over time. If vertical groundwater flow occurs within the till unit, it could average around 2.98E-5 cm/sec or 0.084 feet per day.

Figure 5 shows the extent of the till layer within the study area. Over the course of time, the Fox River has cut through the till layer. Review of Figure 5 shows that there are several yellow dots located on the till layer. These dots represent holes in the till layer that are direct connections between upper aquifers and those below. These yellow dots were placed at well locations that have no indication of till layers in their well logs. It is not known how extensive these holes are because distances between wells are sometimes significant.

4.0 Groundwater Regime

Figure 6 presents the historic potentiometric surface of the IAA site study area. The contour lines have a 10-foot interval and groundwater flow is perpendicular to the contour lines. The potentiometric surface closely resembles the study area topography presented in Figure 2. There is a groundwater high trending from north to south. The IAA site is located on this groundwater high. Groundwater flows east from this high and becomes part of the regional groundwater flow. West of the groundwater high the groundwater flows towards the Fox River. A review of Figure 3 indicates that a shallow aquifer is located in the central portion of the study area and extends east and west from that point. The location of this shallow upper aquifer is the reason that the central area of the study area is considered a highly sensitive recharge area. Further review of Figure 3 indicates that at some locations there are aquifers located at mid-levels within the till unit as well as underneath the till unit on top of the bedrock. These aquifers are interconnected and along with the bedrock aquifer are considered the shallow aquifer system.

Precipitation enters the ground through the recharge areas located in the study area. Most of the topographic high in the study area is a highly sensitive recharge area. Once the water reaches the water table it moves east and west from the groundwater high in the upper water table aquifer. Some of the water from this upper aquifer recharges the water in the lower aquifers through the holes in the till unit that were mentioned before. Not enough information is available to assess the movement of the groundwater to the east, but movement to the West eventually reaches the Fox River where it discharges. Before discharging however, the groundwater recharges the mid-level aquifers and the basal aquifer located on the bedrock surface.

The municipal wells nearest to the IAA site are located in East Dundee about 2 miles northwest of the site. West Dundee's wells are located across the river and have a significant impact on the groundwater in the area. The cone of depression of these wells is delineated by the violet area around the well cluster. These wells are drawing water from the overburden, the bedrock as well as from the Fox River. Evaluation of pump testing data from the East Dundee test well (LGS, 2005) indicates that the well has a radius of influence of a little over 800 feet while pumping at 1000 gpm.

As mentioned previously, groundwater gradients in the area range from 0.003 to 0.052. The hydraulic conductivity of the aquifer materials in this study area range from 0.001 to 10 cm/sec while effective porosity values range from 25.6 to 31.3 percent. Using this information, it was estimated that the aquifers within the study area have groundwater movement ranging from 0.0332 to about 4,700 feet per day. The hydraulic conductivity of the aquifer in the area of the East Dundee municipal wells was estimated to be 0.0196 cm/sec based on the pump test results. Effective porosity was estimated at 26.6 percent resulting in an estimated groundwater velocity to the pumping wells of 44.9 feet per day.

5.0 Summary

Insurance Auto Auctions (IAA) plans to construct a new facility on a 35 acre site along the east side of Commonwealth Drive in East Dundee, Illinois. The proposed site is located on a north-south trending topographic high. The high gently slopes downward to the east. The gradient of the slope to the West is much greater as it enters the Fox River Valley.

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Most of the fine-grained materials underlying the aquifer materials at the top of the majority of the boreholes in the proposed site area is actually classified as aquitard materials. The material is a glacial till that is composed mostly of silt and clay particles intermixed with some sand and occasional deposits of gravel and some larger materials. Being classified as a aquitard means that the material does not prevent the movement of water through it, but only retards the movement. Therefore, it is a misnomer to refer to this layer as a "clay layer" which implies that the layer is impermeable. Portions of the till layer are also classified as aquicludes.

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Precipitation enters the ground through the recharge areas located in the study area. Most of the topographic high in the study area is a highly sensitive recharge area. Once the water reaches the water table it moves east and west from the groundwater high in the upper water table aquifer. Some of the water from this upper aquifer recharges the water and lower aquifers through the holes in the till. Not enough information is available to assess the movement of the groundwater to the east, but movement to the west eventually reaches the Fox River where it discharges. Before discharging however, the groundwater recharges the mid-level aquifers and the basal aquifer located on the bedrock surface.

6.0 References

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1. Location of the Proposed IAA Site
2. Proposed IAA Site Study Area
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4. Recharge Characteristics in the IAA Site Study Area
5. Extent of the Till Layer in the IAA Site Study Area
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Proposed IAA Site

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Figure 1 Location of the Proposed IAA Site

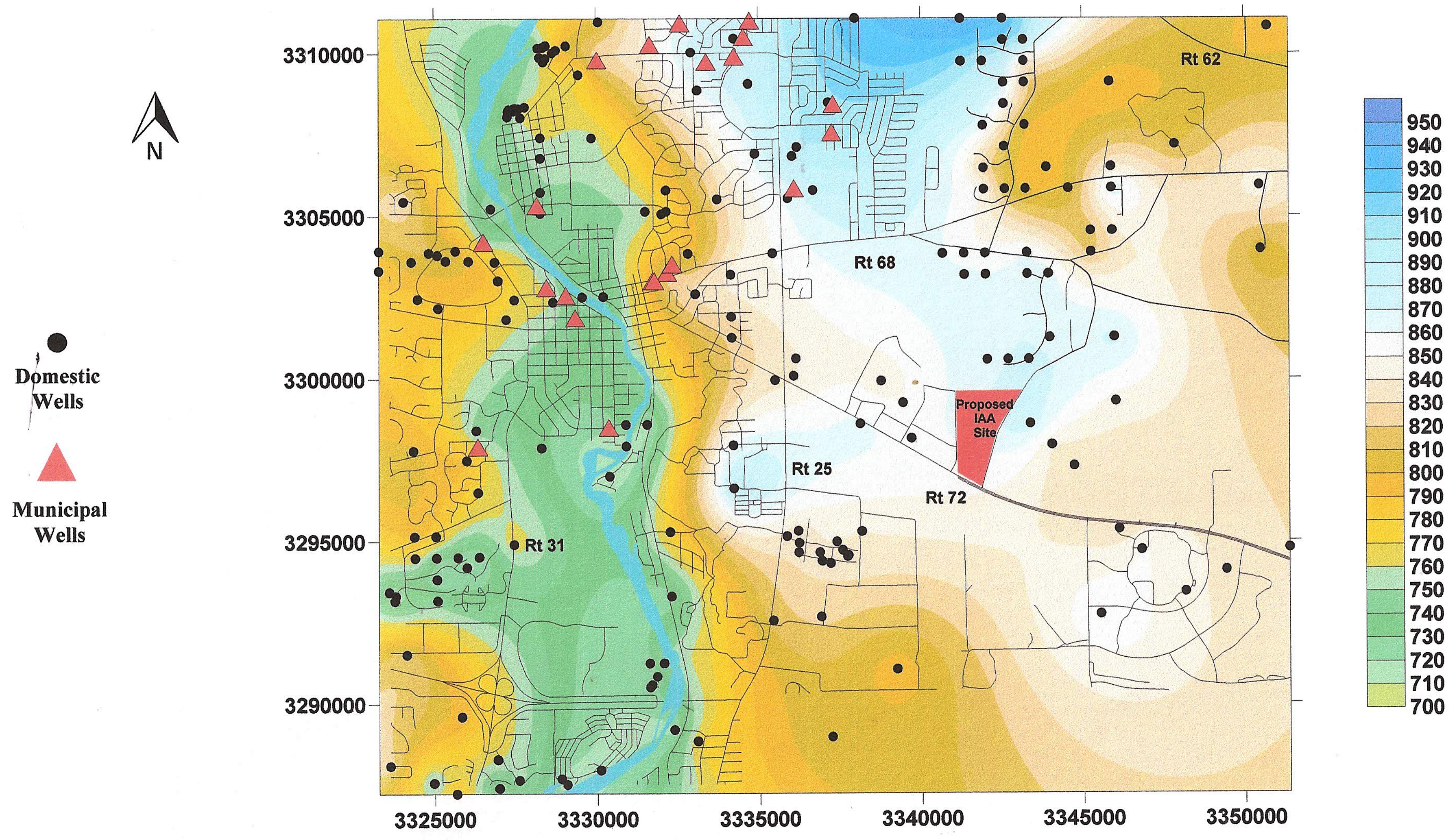

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Figure 2 IAA Site Study Area

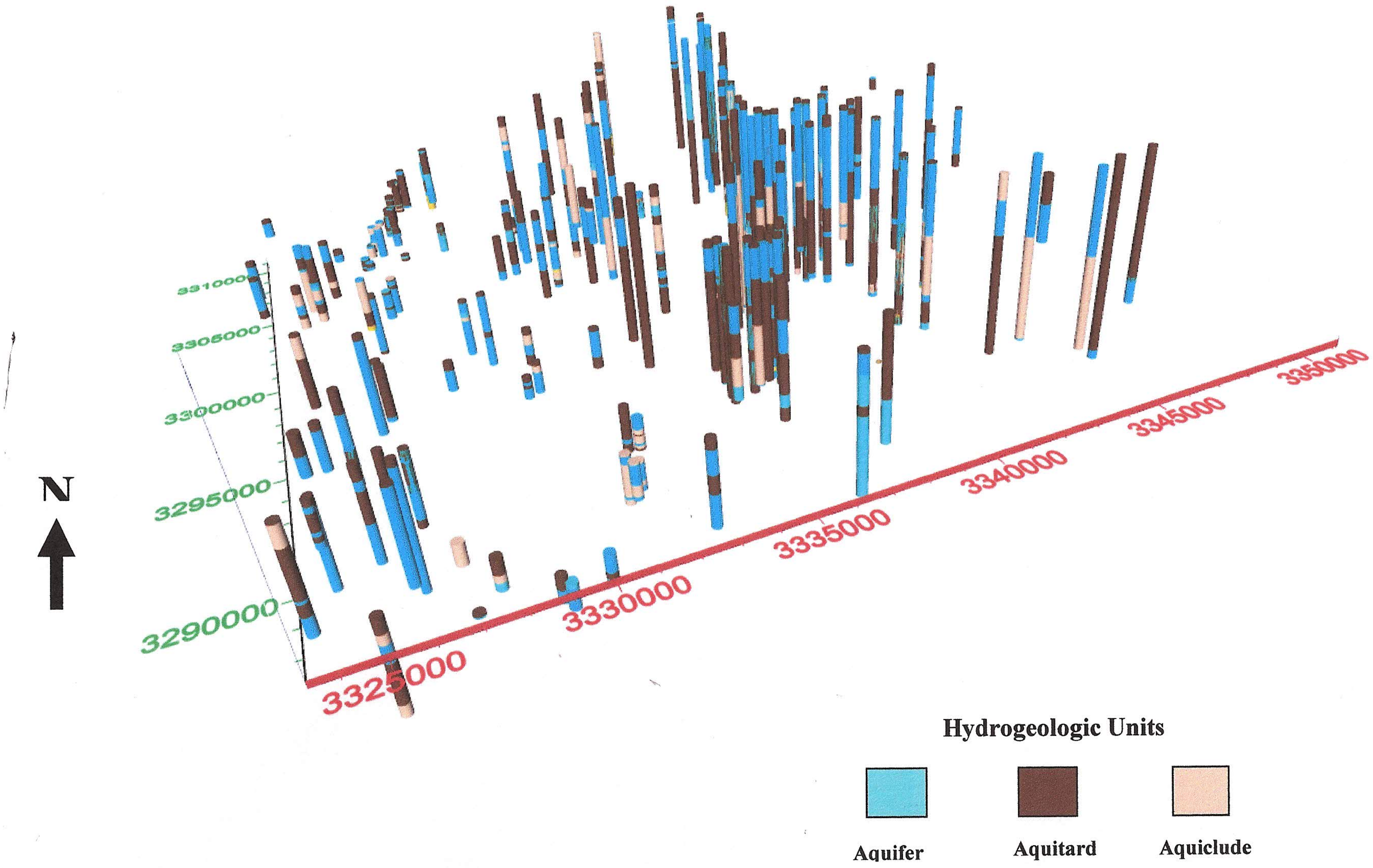

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Figure 3 Hydrogeologic Units of Wells in the IAA Site Study

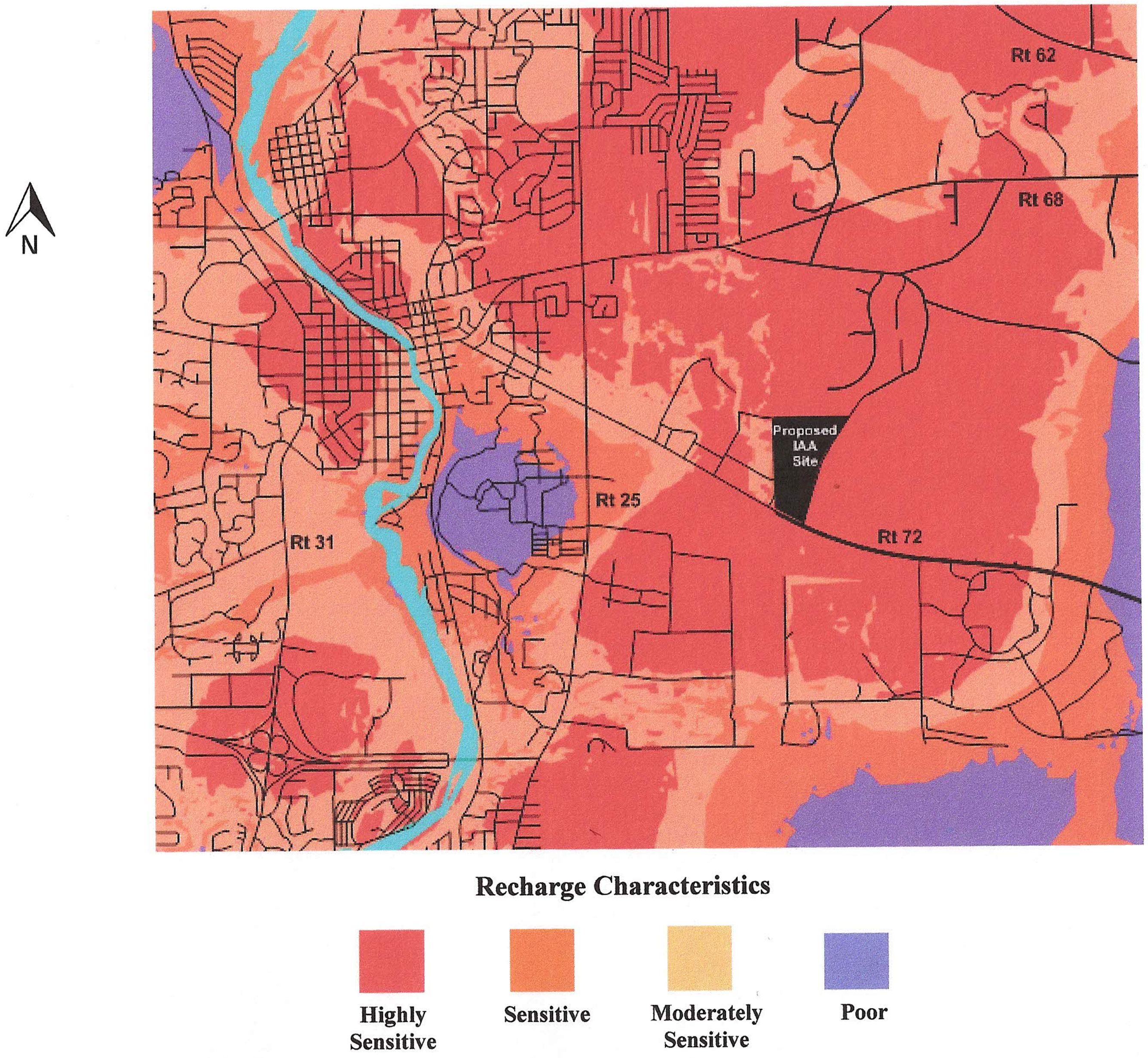

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Figure 4 Recharge Characteristics in the IAA Site Study Area

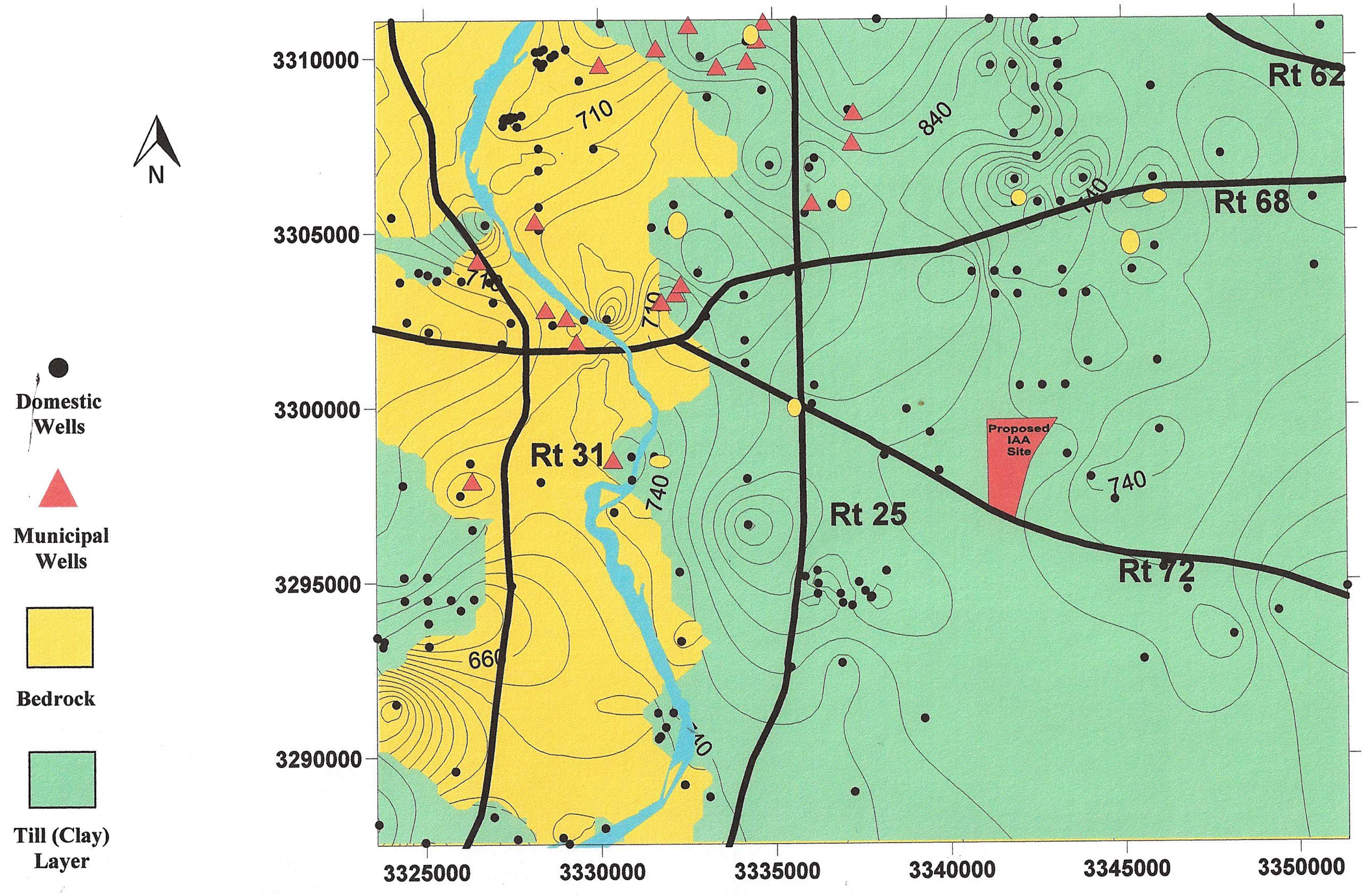

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Figure 5 Extent of the Till Layer in the IAA Site Study Area

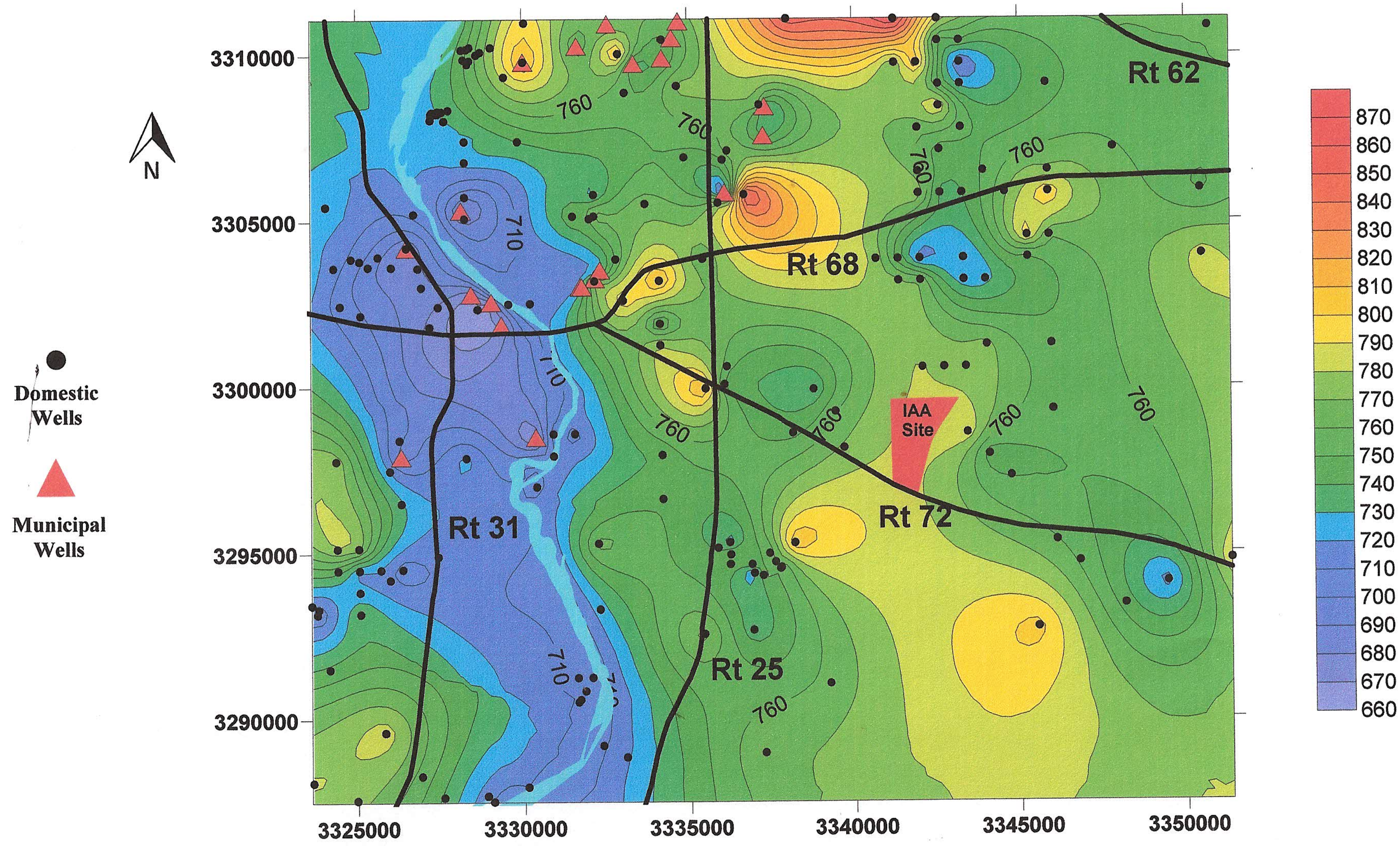

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Figure 6 Potentiometric Surface in the IAA Site Study Area

Tables

1. Summary of Recharge Characteristics
2. Fill Hydrologic Characteristics

Table 1 Summary of Recharge Characteristics

Recharge Characteristic	Log_{10} of Relative Time of Travel (years)	Relative Time of Travel (days/years)	Approximate Recharge Rate (% Annual Precipitation)
Highly Sensitive Recharge	< -1.26	<20 days	48.2
Sensitive Recharge	-1.27 to 0.18	~20 days to 1.5 years	30.3
Moderately Sensitive Recharge	0.19 to 1.62	~1.5 to 42 years	9.6
Poor Recharge	1.63 to 3.06	~ 42 to 1150 years	
Very Poor Recharge	> 3.06	>1150 years	

Table 2 Fill Hydrologic Characteristics

Fill Material	Log K (cm/sec)	Frequency Factor	Relative Frequency	Effective Porosity (%)	Effective Porosity (%)	Total Porosity (%)
Clayey sand	-4.80	1	-4.8	21.23		43.70
Clayey sand and gravel	-2.63	1	-2.63		25.76	40.60
Clayey sand and gravel	-2.63	4	-10.52		25.76	40.60
Clayey sand, little gravel	-5.36	3	-16.08	17.83		44.42
Organic clay	-7.50	1	-7.5	6.00		46.89
Sand and gravel	-1.00	1	-1		27.46	37.95
Sand and gravel, trace cobbles	-0.69	1	-0.69		27.93	37.41
Sand and gravel, trace silt	-1.31	2	-2.62		27.04	38.47
Sandy Clay, trace gravel	-5.09	4	-20.36	19.45		44.08
Silt, little sand and gravel	-2.08	1	-2.08		26.19	39.73
Silty clay	-6.00	1	-6	14.10		45.21
Silty clay, little sand	-6.18	3	-18.54	13.08		45.42
Silty clay, little sand and gravel	-5.17	19	-98.23	18.97		44.18
Silty clay, little sand, gravel, cobbles, and boulders	-4.92	1	-4.92	20.49		43.86
Silty fine sand	-3.80	1	-3.8	27.61		42.33
Silty sand and gravel	-2.00	2	-4		26.27	39.60
Silty sand, some sand and gravel	-3.33	1	-3.33	30.74		41.65
Silty Sandy Clay	-5.50	2	-11	17.00		44.60

Average Fill Characteristics

Average Log K:	-4.45
Average Total Porosity:	43.2%
Average Effective Porosity:	23.4%