Lewis & Clark NRD Natural Resources District

Protecting Lives Protecting Property Protecting the Future

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Natural Resource District

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Hydrogeology and Aquifer Delineation of the Lewis and Clark Natural Resources District

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1.0 INTRODUCTION

The Lewis and Clark Natural Resources District is located in the northeast corner of Nebraska (see Figure 1, Location Map). The District has a complex assemblage of aquifers that supply most of the water used for irrigation, drinking and by industry. Surface water from the Missouri River and its tributaries supply the remainder of the water supply requirements for the District.

Currently there are 2,138 registered wells in the Lewis and Clark NRD and the wells are illustrated on Figure 2, Registered Well Location Map. Table 1 compares the number and type of registered wells in 1986 when the first groundwater management plan was written for the District and the number of wells in late 2009. In this 23 year period, the number of irrigation, municipal, industrial and commercial water wells has doubled. The spatial distribution of the wells is not equally distributed across the district and some areas show well densities of greater than five wells per square mile (see Figure 3, High Capacity Well Density Map). With this increase in demand on the groundwater resources of the Lewis & Clark NRD, comes the need to ensure that the aquifers are adequately managed and protected for use well into the future.

Table 1 Registered Wells in the Lewis and Clark NRD, 1986 and 2009

Registered Well Type	Number of Wells Registered in 1986	Number of Wells Registered in 2009
Irrigation	479	1033
Municipal	26	64
Industry/Commercial	4	16
Monitoring	Not listed	314
Domestic	Not listed	461
Livestock	Not listed	250

The need to manage and protect the groundwater water supplies of the Lewis and Clark NRD is the primary responsibility of the staff and the Board of Directors of the Lewis and Clark NRD. In 1986, the District developed a Groundwater Management Plan that included the technical aspects of the groundwater supplies and policy considerations related to management of the groundwater resources. The plan was developed for the staff, directors and the citizens of the NRD to use in order to understand the nature of the groundwater resources and the best way to manage them. The plan was updated in 1995 with additional information regarding water quality investigations that were initiated in an effort to provide information on the concentration, scope, and trends of potential contaminants in the District. In the 1995 update, the Lewis & Clark NRD reported no significant change in water levels and therefore, no immediate threat to water quantity, however, groundwater quality was of concern due increased nitrate-nitrogen concentrations in Knox County.

Since publication of the last Groundwater Management Plan update in 1995, the District has had to implement a water quality management area in and around the town of Creighton in response to increased nitrate-nitrogen concentrations in groundwater. The seventy square mile groundwater management area defines well installation and chemical

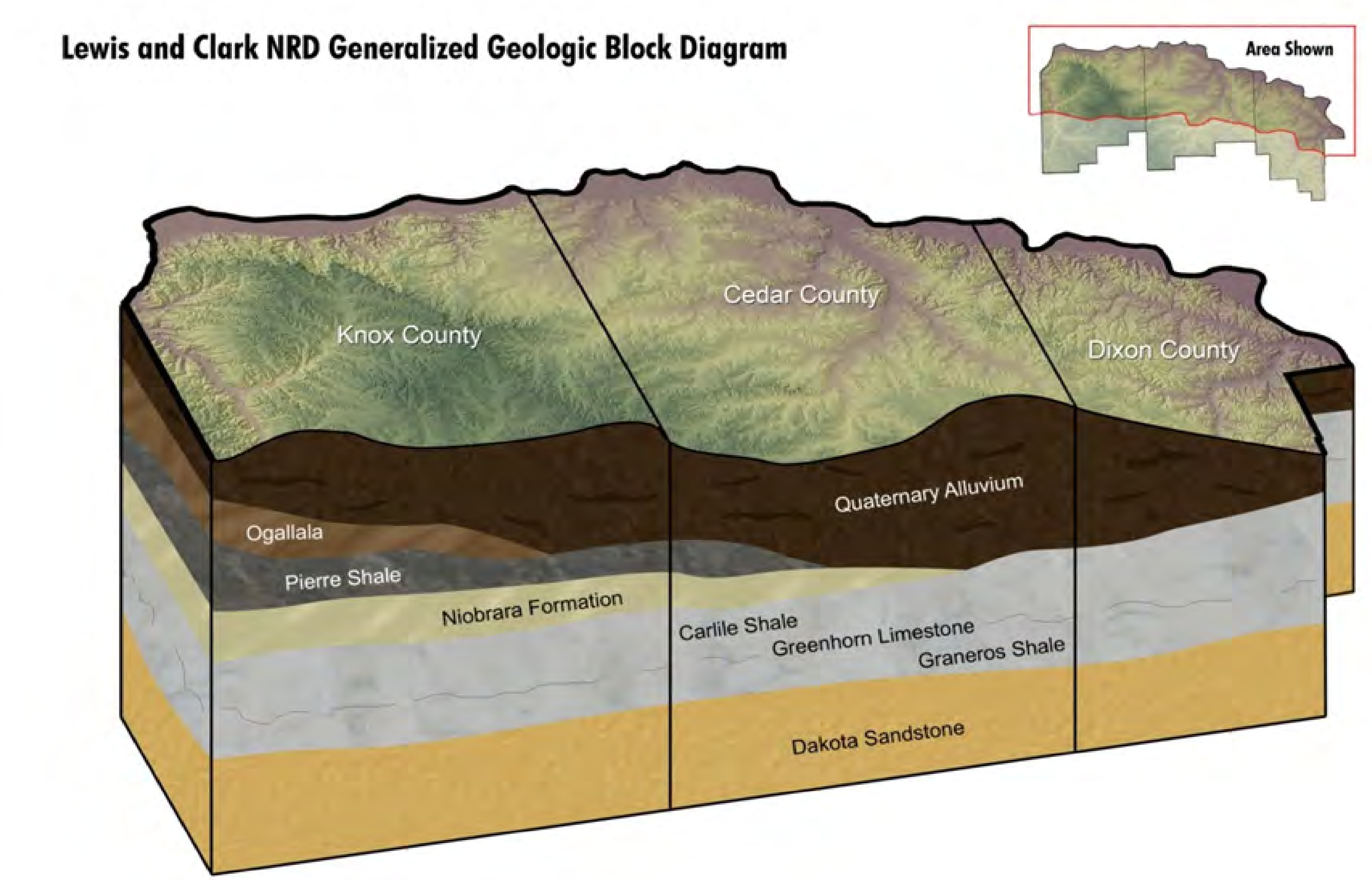

Table 2 Geologic Units in the Lewis and Clark Natural Resources District and their Water Bearing Properties (Adapted from L&C NRD, 1985)

Era	Period	Epoch	Formation	Lithology	Water Supply
Cenozoic	Quaternary	Holocene		Alluvial deposits	Principal source of water supply to wells, reported yields range from 550 to 1,500 gal/min; also transmits water to recharge other aquifers.
	Tertiary	Pleistocene		Sand and gravel deposits interbedded with clayey till.	
		Miocene	Ogallala	Sand, silty clay, interbedded with a little volcanic ash and orthoquartzite.	Not a significant source of water supply; may yield water to some domestic wells.
Mesozoic	Cretaceous	Late Cretaceous	Pierre Shale	Shale and claystone, interbedded with thin bentonite layers, marl and sand; fissile to thin bedded, soft, weak.	Not a source of water supply to wells.
			Niobrara Limestone	Argillaceous limestone, chalky, medium bluish-gray weathering to dark yellowish-orange; soft, sub-firm, highly fractured in places.	Significant source of water supply to wells through secondary porosity. Reported yields range from 360 to 900 gal/min.
			Carlile	Moderate gray calcareous shale, fissile, soft, weak; interbedded with clayey siltstone.	Not a source of water supply to wells.
			Greenhorn	Light to medium dark gray limestone, interbedded with argillaceous limestone, marl, calcareous shale, and two very thin layers of bentonite.	Not a source of water supply to wells.
			Graneros Shale	Medium to dark gray shale, fissile, soft, weak; interbedded with thin layers of silt and sand in lower part. Few scattered thin layers of bentonite material.	Not a source of water supply to wells.
		Early Cretaceous	Dakota	Sandstone, yellowish white in color, cemented in part by calcium carbonate interbedded with medium to dark gray claystone and shale; numerous thin layers of black carbonaceous material.	Significant source of water supply to domestic and stock wells. Irrigation wells possible. Potential yields may be as much as 600 gal/min.
Paleozoic				Predominantly limestones and dolomites, but some thin sandstone and shale beds.	Not a source of water supply to wells.
Precambrian			Sioux Qartzite	Orthoquartzite, grayish-orange pink, fine to coarse-grained.	Not a source of water supply to wells.

application requirements that are intended to minimize the concentration and extent of nitrate-nitrogen contamination in the aquifers.

It is in response to both the pressures of increased demand and groundwater contamination that this report was prepared. The report is intended to provide a detailed geologic framework and delineation of the aquifers that supply groundwater to the district. A thorough understanding of the aquifers is critical as water supply demands and issues related to groundwater contamination continue to increase.

2.0 GEOLOGIC SETTING

A generalized block diagram of the subsurface geology of the Lewis and Clark NRD is presented in Illustration 1 on page 2. As illustrated in the diagram, the NRD is underlain by Quaternary Alluvium composed of clay, silt, sand, and gravel deposited by glacial processes during the Pleistocene and Holocene. Beneath the alluvium, the first seven formations that occur in the District are illustrated. Not all of these formations are water bearing and Table 2 is presented to provide insight into the geologic formations and their water bearing capabilities.

For a more detailed look at the subsurface geology, generalized north-south and east-west geologic cross sections are presented in Figure 4. The cross sections are loosely based on unpublished cross sections developed by the former Director of the Nebraska Conservation Survey Division, Vincent Dreeszen. The cross sections illustrate the subsurface geology as identified in the test holes drilled by the Conservation Survey Division. For reference points, the test hole identification numbers are provided at the top of the illustration and the location of the profiles are illustrated on Figure 5, UNL-CSD Bedrock Geology Map.

The cross sections are intended to provide a visual representation of the complexity of the geologic units that blanket the District. As illustrated on the east-west cross section (A-A'), thick glacial deposits called loess and till overlie silt and sand units. The saturated silt, sands and gravels of the Lewis and Clark NRD are highly productive aquifers and for this reason their lateral distribution is presented in more detail later in this report.

For another view of the bedrock geology, instead of looking at the distribution of these bedrock units from the side, take a birds-eye view of the first bedrock unit encountered in the subsurface of the Lewis & Clark NRD. Figure 5 illustrates the distribution of the bedrock units as mapped by the University of Nebraska, Conservation Survey Division (UNL-CSD).

Using this map and the block diagram, one can begin to gain an understanding of the three dimensional distribution of the important bedrock formations that comprise the groundwater aquifers for Lewis & Clark NRD. For example, the Ogallala Group occurs in all three counties; however, as illustrated in the block diagram, the distribution is discontinuous. The distribution is irregular due to glacial erosion that occurred across the District. Similarly, the Niobrara Formation was eroded by the glacial advances in Dixon County and therefore when drilling into the bedrock units in parts of Dixon County, the Niobrara Formation is absent and the first bedrock unit encountered is the Carlile Shale directly underlying the Quaternary Alluvium.

3.0 AQUIFER TYPES

There are two main aquifer types that produce significant quantities of water in the Lewis and Clark NRD. These two main aquifer types were described by the organizations currently conducting an assessment of the groundwater and surface water relationships in Eastern Nebraska. The research project is entitled the Eastern Nebraska Water Resources Assessment (ENWRA) and the goal of the project is to develop a three-dimensional geologic framework and water budget for eastern Nebraska. ENWRA has published several documents about the current findings of their investigations and the publications are available on the project website (www. enwra.org). In the publication entitled "Introduction to a Hydrogeological Study", the ENWRA team described the types of aquifers encountered in eastern Nebraska (Divine, et al, 2009). The same aquifer types are used in this report to describe the aquifers of the Lewis and Clark NRD in order to remain consistent with the nomenclature currently in use.

The two main types of aquifers in the Lewis and Clark NRD are bedrock aquifers and aquifers in the unconsolidated units that overlie the bedrock (alluvial aquifers). The first group includes aquifers that consist of consolidated to semi-consolidated rock. The second group includes three main subtypes: 1) paleovalley aquifers that represent buried ancient stream valleys; 2) alluvial aquifers that were deposited in modern and abandoned stream valleys; and 3) isolated smaller scale aquifers of multiple origins (Divine, et al, 2009).

The two aquifer types have distinctions that are based on their lithology, geochemistry, and stratigraphic position that affect their viability as water supplies. For example, the coarse grained sediments of the ancient river valley deposits can transmit significantly more water than the finer-grained deposits of the Ogallala Group that occur in this area. Other aspects of aquifer host rock that affect the viability of the aquifer include geochemistry. An example of this is the Dakota Formation with its relatively high levels of total dissolved solids. A third aspect of the aquifer's viability is simply the depth at which the water must be pumped. As shown in Figure 6, Depth to Bedrock map, the depth to bedrock varies from rock exposed at the ground surface to areas where the depth to bedrock is over 400 feet below ground surface. Where the bedrock aquifers are deeper than the unconsolidated units, the well installation and pumping costs can be expensive. The following sections provide information on the overall geologic setting of the Lewis & Clark NRD and more detailed information on the two main types of aquifers and their subdivisions.

3.1 BEDROCK AQUIFERS

Of the formations shown in Illustration 1 and listed in Table 2, only two, the Dakota and Niobrara Formations, provide significant quantities of water such that they are considered water supply aquifers for the Lewis and Clark NRD. The **Ogallala Group**, known as the primary aquifer across most of western and central Nebraska, is not a significant source of water in most parts of northeast Nebraska. In the south central portion of Knox and Cedar County, saturated Ogallala Group sand and sandstone units provide adequate water for irrigation wells; however, in most of northeastern Nebraska, the Ogallala consists of primarily silts and clays with low transmissivities (Dreezen, VH, unpublished report).

The **Niobrara Formation** is described as a chalky, argillaceous limestone, medium bluish-gray that weathers to dark orange-yellowish in color (Simpson, 1960). Where the limestone has been exposed and weathered at the earth's surface, the limestone is soft and highly fractured. In the Lewis & Clark NRD, there are over 100 wells completed in the Niobrara Formation. The majority of these wells are located in the north central portion of Cedar County, primarily north of the town of Hartington. In general, the Niobrara Formation produces good quality water from the secondary fracture porosity when the limestone occurs at depths ranging from 2-48 feet below ground surface (Simpson, 1960).

The **Dakota Formation** is described as a yellow to whitish colored sandstone with interbedded claystone and shale. Currently, there are less than 100 wells completed within the Dakota Formation in the Lewis & Clark NRD. Even though some of these wells completed in the Dakota sandstone units are very productive (600 gallons per minute), there are several reasons that there are not more wells completed in this formation. First, water quality can be an issue with the Dakota Formation since total dissolved solids are above secondary drinking water standards in certain wells. Additionally, the Dakota Formation lies stratigraphically below the alluvial aquifers and the Niobrara Formation so from a purely economic perspective, drilling through shallow more productive aquifers is not practical. For this reason, Dakota Formation well completions are primarily isolated to areas were alluvial and/or Niobrara aquifers are absent such as areas along the northern portions of the Lewis & Clark NRD.

3.2 ALLUVIAL AQUIFERS

The second major type of aquifer in the Lewis & Clark NRD is alluvial aquifers. As stated above, the alluvial aquifers are comprised of unconsolidated sediments that overlie the bedrock. The alluvial aquifers have been subdivided into three main types by the ENRWA group and are described in more detail below.

3.2.1 Paleovalley Aquifers

Paleovalley aquifers represent ancient river valleys that were formed when the rivers and streams cut channels into the bedrock surfaces. The paleovalley aquifers were filled with coarse sands and gravels as the river system developed over time. As first described by J.E. Todd in 1914 the river drainage pattern and orientation do not coincide with the current drainage patterns as illustrated by the fact that some of the drainage patterns cut across the current Missouri River channel. The paleovalleys were incised both before and between major glacial advances of the Late Pliocene and Pleistocene (Johnson and Keech, 1959). After deposition of the sands and gravels, the river deposits were subsequently overlain by low-permeability tills. Since the paleovalleys are often hidden under a thick blanket of clay sediments, they can be indistinguishable from the ground surface. Although paleovalley aquifers have not been mapped in detail across the Lewis & Clark NRD, the aquifers can be very productive due to their high porosity and permeability.

3.2.2 Stream Valley Aquifers

Sand and gravel deposits associated with modern stream valleys such as the Missouri River alluvium are known for their excellent water production capabilities. Along the northern margin of the Lewis and Clark NRD, the Missouri River Alluvium is an example of this type of alluvial aquifer.

3.2.3 Smaller Aquifers of Multiple Origins

Throughout Eastern Nebraska, numerous small alluvial aquifers occur that in general produce less significant quantities of water than the paleovalley and stream valley aquifers. These smaller aquifers were deposited by streams that flowed on top, within or under glaciers (Divine, et al, 2009). Domestic and stock wells are typically completed within these smaller aquifers.

4.0 AQUIFER DELINEATION

With increased pressures of well development and groundwater contamination, the Lewis & Clark NRD initiated this study to delineate the aquifers across the district. The intent was to better understand the extent and distribution of the aquifers so that groundwater management decisions can be based on geologic, geospatial, as well as regulatory requirements.

The first step of the aquifer delineation process was to gather and evaluate the existing hydrogeologic data across the Lewis & Clark NRD. Information was gathered from the University of Nebraska, School of Natural Resources Conservation and Survey Division (UNL-CSD), the Department of Natural Resources (DNR), published reports, and the Lewis and Clark Groundwater Management Plan (Lewis & Clark NRD, 1986 and 1995). Geographic Information System (GIS) data sets were developed, integrated and interpreted to produce geographic data sets illustrating the hydrogeologic characteristics of the entire district.

The next step of the process was to review well logs provided by the DNR and CSD. The well logs and GIS datasets were carefully evaluated to identify what type of aquifer the majority of wells in an area were completed within. Aquifers were delineated using the two aquifers types; bedrock and alluvial. For areas where the majority of the wells are completed in bedrock aquifers, the aquifer delineation was based on an interpretation of the formation the wells were completed across. For example, there are numerous irrigation wells completed in the fractured Niobrara Formation north and northwest of the town of Hartington. Based on the distribution of the Niobrara Formation bedrock wells, the area where the majority of the wells are completed in the formation was delineated as the Niobrara Bedrock Aquifer area (see Figure 7, Aquifer Delineation Map). Similar delineations were completed for wells completed in the Dakota Formation as described in more detail below.

For areas in which the principal source of groundwater was alluvial deposits, well logs were reviewed and the likelihood of a productive aquifer being present at each location was determined by the presence of saturated sand and gravel deposits. Significant aquifers were identified as areas with 30 feet or more of saturated sand and gravel deposits, similar to methods to delineate aquifers in the Lower Platte South NRD (Druliner and Mason, 2001) and in the Lower Platte North NRD (Olsson Associates, 2009).

As with any scientific evaluation, the interpretations and conclusions are only as good as the data set used to develop them. To complete the evaluations, only well logs that had useful lithologic description were included in the study. Sand and gravel thickness was not the only parameter evaluated. After the gravel thickness was spatially interpolated, it was compared to other sources of spatial data such as the bedrock surface and aquifer transmissivity as mapped by UNL-CSD. Cross checking with other data sources was completed to ensure that the lithologic log interpretations were consistent with the overall geologic framework for the District.

The following sections describe in more detail how the major aquifers were delineated across the district. Figure 7, illustrates the aquifer delineations that were established through the hydrogeologic analysis. Note that the aquifers were delineated based on the well logs, data sets, and maps available at the time of the study. Reinterpretations of the delineations may be warranted should new information become available.

4.1 Missouri River Alluvial Aquifer

The Missouri River alluvial aquifer represents the saturated clay, silt, sand and gravel deposits that were deposited by the Missouri River. The sand and gravel units within the aquifer are highly productive and provide irrigation water to the farms along the floodplain of the river system. The margins of the aquifer are well defined by the bluffs on the margin of the floodplain (See Figure 7, Aquifer Delineation Map). The thickness of the aquifer is variable based on the thickness of the sand and gravel deposits that overlie the erosional bedrock surface. Within the Lewis & Clark NRD, the thickness reaches 123 feet in north Cedar County.

4.2 Niobrara Bedrock Aquifer

The Niobrara Bedrock Aquifer is a unique bedrock aquifer that occurs primarily across north central Cedar County (See Figure 7, Aquifer Delineation Map). At one point in geologic time, portions of the Niobrara limestone were re-exposed at the ground surface and subjected to weathering and fracturing. The Niobrara bedrock aquifer was formed by fractures and weathering in the surface of the Niobrara limestone that provided the necessary porosity for groundwater storage. The Niobrara Formation displays the weathered and fractured characteristics primarily within the north center portion of Cedar County. Conversely in Knox County, the Pierre Shale overlies the Niobrara limestone and therefore, the Niobrara was not re-exposed fractured or weathered at the ground surface and therefore the Niobrara Formation is not a source of water to wells. The majority of the Niobrara bedrock aquifer wells are located north, northwest of Hartington in central Cedar County with isolated occurrences of productive Niobrara Formation wells southeast into Dixon County.

4.3 Dakota Bedrock Aquifer

The Dakota Bedrock Aquifer occurs beneath the entire Lewis & Clark NRD, however; wells completed in the aquifer are primarily located along the northern margin of the Lewis & Clark NRD (See Figure 7, Aquifer Delineation Map). The reason for this is as follows. Across most of the Lewis & Clark NRD, the Dakota Aquifer is overlain by the Ogallala and the alluvial sand and gravel glacial deposits. In areas where there are saturated sand and gravel deposits overlying the Dakota Formation, the first productive water source is the alluvium. In areas were the bedrock surface is high (See Map 5, Depth to Bedrock Map), the sand and gravel deposits are absent which means that the first productive aquifer is the Dakota sandstone. Therefore the economics of constructing a Dakota Bedrock Aquifer well are not favorable across most of the district when a shallower sand and gravel well would likely produce better water quality and higher capacity wells.

4.4 Undifferentiated Sand and Gravel Aquifers

The majority registered wells in the Lewis & Clark NRD are completed in the undifferentiated sand and gravel aquifers of multiple origin (See Figure 7, Aquifer Delineation Map). The large undifferentiated sand and gravel aquifer area was identified by reviewing the well logs of registered wells and UNL-CSD test holes in the District then quantifying the vertical and estimating the lateral distribution of the saturated sand and gravel deposits. Map 7a-d illustrates the results of the analysis with thick sand and gravel deposits occurring in east-central and southern Knox County, southern Cedar County and the very southwestern portion of Dixon County.

As pointed out above, the Lower Platte North and Lower Platte South had similar aquifer delineation studies completed for their districts. One point of distinction between the Lower Platte South and Lower Platte North NRDs was how wells completed in the Ogallala group were handled. In the Lewis & Clark NRD, there are several isolated occurrences of Ogallala Formation across the district. The discontinuity is the result of erosion of the Ogallala by glaciers that advanced across the district during the Pleistocene. Initially, the intent of this study was to distinguish between wells completed in the Ogallala from those completed in alluvial sand and gravel deposits. Based on the well log information provided on the majority of the irrigation wells in the area, there is not enough information to identify whether a well was completed in the Ogallala or alluvial sands and gravel deposits. After discussions with the Lewis & Clark NRD staff and Board of Directors on how these maps will be used, it was determined that distinction between these two types of aquifers was not necessary at this time. The intent is to provide information on where productive aquifers are present and distinctions about their depositional history and geologic framework were not necessary at this point in time.

The distribution of continuous saturated sand and gravel aquifers is of primary importance to the groundwater management of the Lewis & Clark NRD. For this reason, Figures 8a-8d, Sand and Gravel Thickness Maps, were generated for the entire district (Figure 8a) and then specifically, by county (Figure 8b-d). Gravel thickness was determined from well logs downloaded from the DNR website and test hole boring logs downloaded the UNL-CSD website. Logs were reviewed and if penetration depth was adequate and the logs were of sufficient quality, the saturated sand and gravel thickness was calculated from the well logs. Using this technique, the saturated sand and gravel thickness at each well was recorded in a geodatabase. The thickness of the saturated sand and gravel deposits were then interpolated across the Lewis & Clark NRD using GIS interpolation techniques. The distribution patterns illustrate sand and gravel deposits that varied from 0 to 175 in thickness. As a quality control check on the maps, sand and gravel thickness distribution patterns were compared to the surface of the bottom of the principal aquifer provided by the CSD (Figures 9, UNL-CSD Aquifer Saturated Thickness and Figure 10, UNL-CSD Aquifer Transmissivity Map) as well as to the maps developed during this study such as Figure 3 (High Capacity Well Density Map) and Figure 6 (Depth to Bedrock Map).

5.0 MAP AND DESCRIPTION DETAILS

For clarification on how the maps presented in this report were generated, the following sections provide additional insight and information. For reference purposes, data source information used to generate the maps is provided in the title block of each map. For all of the maps, the city, county, major highways and NRD boundaries were from the DNR website. Streams, watershed boundaries, Lewis & Clark Lake were from the United States Geological Survey (USGS). Hillshade relief across the maps was generated from USGS Digital Elevation Map data.

5.2 Location Map

Figure 1, Location Map was generated using data the data described above. No data interpretation was made to generate the map.

5.3 Registered Well Map

Figure 2, Registered Well Map was generated using data from the DNR registered well website (http://dnrdata.dnr.ne.gov/wellssql/). No data interpretation was made to generate the map.

5.3 High Capacity Registered Well Density Map

Figure 3, High Capacity Registered Well Density Map was generated by calculating the density of registered wells (with capacities listed as greater than 100 gallons per minute) per square mile across the entire Lewis & Clark NRD. No data interpretation was made to generate the map.

5.4 Generalized Geologic Cross Sections

Figure 4, Generalized Geologic Cross Sections illustrates the interpretations of subsurface geology as presented in unpublished cross sections by Vincent Dreeszen (Former Director of the Nebraska Conservation Survey Division). The cross sections are based on Dreeszen's work with the exception of the topographic profiles. The topographic profiles provided in the cross sections are not true representations of the surface topographic changes. They only represent the elevation of the test hole location and do not represent the topographic relief between the holes. For that reason, the cross sections are not built to scale and have a 50 percent vertical exaggeration in order to better illustrate the subsurface geology.

5.5 Bedrock Geology Map

Figure 5, UNL-CSD Bedrock Geology Map was generated using the geology map developed by UNL-CSD and posted on their GIS data website (http://snr.unl.edu/data/geographygis/NebrGISdata.asp). The maps illustrate the bedrock geology map as generated from CSD's digital coverage of the bedrock formations underlying alluvial deposits in the Lewis & Clark NRD. No data interpretation was made to generate the map.

5.6 Depth to Bedrock

Figure 6, Depth to Bedrock was generated by subtracting the elevation of the bottom of the principal aquifer from the ground surface elevation. The bottom of the principal aquifer represents the change from alluvial deposits to bedrock deposits with one exception, where the first bedrock unit encountered was from the Ogallala Group. As stated above in section 4.4, in many well logs, there is not sufficient information to distinguish between the alluvial sand and gravel deposits and poorly lithified sediments of the Ogallala Group. Another way to think of this map is that it represents the thickness of alluvium.

5.7 Aquifer Delineation Map

Figure 7, Aquifer Delineation Map was based on review of the registered well logs, UNL-CSD test hole logs, and geologic map of the district. More detail about this map is provided in Section 4.0. The aquifer distinctions were based on the majority of wells completed in an area.

5.8 Sand and Gravel Thickness Maps

Figures 8a through 8d illustrate the thickness of saturated sand and gravel across the district. As described in more detail above in Section 4.4, saturated sand and gravel thicknesses were determined from DNR well logs and UNL-CSD test hole boring logs.

5.9 UNL-CSD Aquifer Saturated Thickness Map

Figure 9 illustrates the saturated thickness of the principal aquifer as defined by UNL-CSD. For the saturated thickness map, no new data was incorporated into the CSD data set. No data interpretation was made to generate the map.

5.10 Transmissivity of the Principal Aquifer

Figure 10 is the UNL-CSD Aquifer Transmissivity Map illustrating the aquifer transmissivity as provided by the CSD. For the transmissivity map, no new data was incorporated into the CSD data set. No data interpretation was made to generate the map.

5.11 Additional Maps by the Conservation Survey Division

The UNL-CSD is currently mapping the surficial geology of selected areas within the Lewis & Clark NRD. Two of three maps are available online at the following website (Dillon, J.S. et al, 2009):

http://snr.unl.edu/data/geologysoils/digitalgeologicamaps/digitalgeologicmaps.asp

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