SOUTH PLAINS
GROUNDWATER NEWS

NOVEMBER 2003 VOLUME 11, NUMBER 1

UNDERSTANDING THE OGALLALA

PART 2--GROUNDWATER MOVEMENT

Note: This is the second article of the series entitled "Understanding the Ogallala". Recharge will be the topic presented in the third article.

The Ogallala Aquifer contains an enormous quantity of water which covers its eight-state expanse. This volume of available water is affected by the various rates of discharge from the aquifer, as well as the variable rates of recharge to the aquifer. As expected, these rates vary according to location, and are influenced by the depositional materials which make up the formation. When analyzing the movement of groundwater within the Ogallala, certain time periods and associated data provide useful information. Pre-development versus post-development data serves as one example. Data presented in this article are generally characteristic of the southern Ogallala (Figure 1) which includes the South Plains UWCD.

Several areas of study provide a good overview of groundwater movement. The first part of this article contains definitions of some key terms and processes regarding groundwater movement. The second and third sections of the article include a look at groundwater movement in the pre-development vs. post-development time periods.

Understanding key terms and processes provides the basis for their use in further discussion. For simplicity, these are listed below:

- Unconfined aquifer—an aquifer that exists under water-table conditions. Water here is under the pressure exerted by the overlying water and atmospheric pressure. In an unconfined aquifer, the water table is free to rise and fall.
- Porosity—the part of a water-bearing formation's volume consisting of openings. It is an index of how much groundwater may be stored in a saturated material. Porosity represents the volume of void space which may hold water.
- Hydraulic conductivity—the capacity of a porous medium to transmit water. This refers to the ease with which fluid moves through the formation.
- Transmissivity—represents the transmission capability of the entire thickness of an aquifer.
- Specific yield—ratio of the volume of water drained by gravity per unit volume of saturated material.
- Water table elevation—the elevation of the water table normally expressed as feet above mean sea level.
- Saturated thickness—water saturated interval measured from the top of the water table to the base of the aquifer.
- Spring—surface leakage of water from the aquifer usually expressed by groundwater flow to the surface.
- Static water level—the level at which water stands in an unconfined aquifer when no water is being removed via pumping or free flow. Expressed as the distance from the ground surface (or similar measuring point) to the water level in a well.
- Hydraulic gradient—the slope of the water table.
- Water table—the level in a geologic formation below which all space is saturated.

This list of definitions provides the framework for further discussion of groundwater movement within the Ogallala, which is an unconfined aquifer.

The movement of groundwater in the Ogallala during pre-development generally includes the years up to about 1940. During the early

Ogallala…continued on page 2

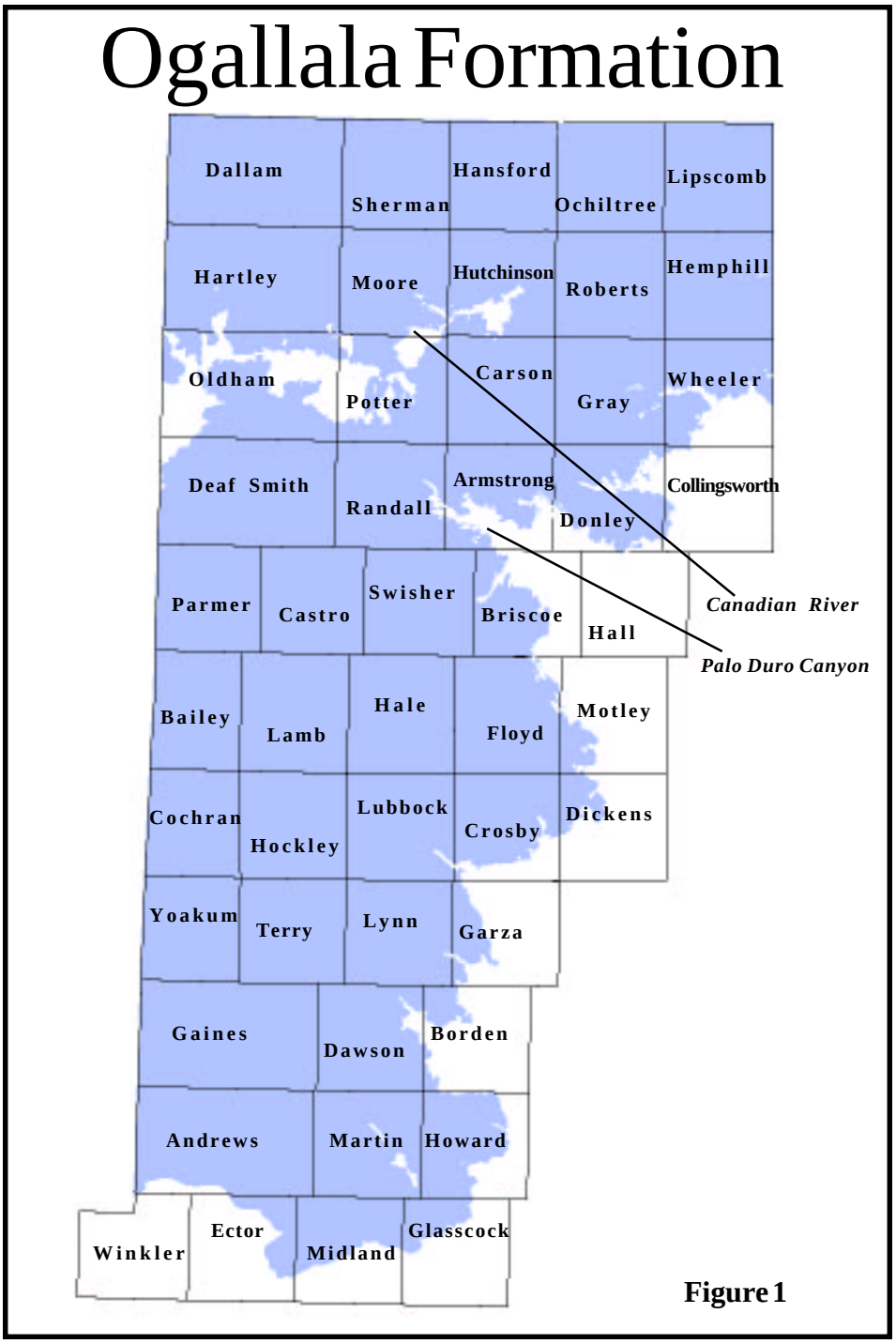

Figure 1

Ogallala…continued from page 1

part of the 20th Century, and even the late 19th Century, people certainly were aware of the importance of groundwater. However, the drilling of wells around the South Plains region was not widespread until irrigation became more common.

Groundwater flow in an unconfined aquifer is subject to the potential energy available to "drive" water through the formation. The potential energy is calculated as the difference in elevation at two points of the water table. Quite literally, water does run downhill. This means that groundwater moves from a higher elevation to a lower elevation. The South Plains water table, as does the land surface, generally slopes toward the southeast, with the natural movement of groundwater in the same direction. Locally, this direction may change due to the location of discharge points such as springs or pumping wells. Because of headward erosion of both the Pecos River on the west and the Canadian River on the north, the Southern portion of the Ogallala has been cut off from a subsurface inflow of water. Consequently, even during pre-development years the groundwater conditions here were essentially unaffected by those conditions occuring north of the Canadian River.

During pre-development, the major discharge mechanisms included springs. These springs were not only found near the Caprock escarpment, but were also present further west. Often, these springs were located on the edges of ancient draws and saline lakes. Within the South Plains UWCD, these features include the two Lost Draws, Sulphur Springs Draw, Rich Lake, Mound Lake and the Brownfield Lakes. Perhaps the best source of spring information, Springs of Texas, contains information for as many as fourteen springs within the District.

As a result of these discharge points, some small ponds or lakes formed in this area long ago. The presence of springs locally verifies the water table was substantially higher than it is today. Since the development of irrigation, most of the springs within the District have disappeared as the water table dropped.

Since widespread development, thousands of irrigation wells now penetrate the Ogallala. Within the South Plains UWCD, an estimated 4,200 active irrigation wells supply groundwater for agricultural irrigation. Of this number, there are over 100 which have pump test data accompanying the well log. Additionally, there are approximately 140 wells the District uses for annual

Ogallala…continued on page 3

District Board Adopts Management Plan

The District's Board adopted a renewed management plan during the September meeting. Texas water law requires that districts readopt the plan with or without revisions at least once every five years.

During the process, the District had to include several items that were not previously required. These items include referencing the Southern Ogallala Groundwater Availability Model (GAM), and developing two new goals which address drought and conservation.

The use of the GAM provides estimates of future conditions during the Plan's 10-year life, as well as current estimates of recharge and the usable quantity of groundwater. Additionally, the District used site-specific information when calculating estimates of recharge, usage, and the usable quantity of groundwater.

The information provided in the plan is an important aspect of a district's operation. After identifying the estimated current and future condition of the aquifer, a board may make better informed decisions.

The District's plan has been reviewed by the Texas Water Development Board (TWDB) for compliance with all applicable requirements. The TWDB certified the plan as administratively complete.

If you are interested in reviewing the District's goals and/or estimates of the aquifer's future condition, come by the District office for a copy of the Plan.

Ogallala…continued from page 2

water level measurements. The combination of these data sources provides significant information regarding groundwater movement.

The natural slope of the water table today still generally trends toward the southeast. However, there are probably more local variations now than previously existed. These variations are a result of areas that are heavily irrigated. Nonetheless, the principles mentioned previously still hold true. Specifically, groundwater moves downhill.

Perhaps a more interesting question, then, is how fast does groundwater move? Analysis of pump test data within the district indicates hydraulic conductivity ranges from 0-500 ft/day. The majority of the District, though, falls within the lower range. In fact, the portion of the District with hydraulic conductivities higher than 3-5 ft/day is quite small. Those isolated areas with higher hydraulic conductivities are often located along or near buried ancient stream channels. Coarser formation materials, with their greater capability to transmit water, are often associated with these channels. These coarser materials exhibit a lower porosity, but the specific yield of the aquifer is higher than in other areas where the porosity is higher.

Likewise, analysis of the aquifer's transmissivity from pump tests helps us understand the well yield/groundwater movement correlation. A well whose pump test initially yielded a transmissivity of 2 gpm/ft will exhibit a decline in production approximately equal to 2 gpm for each foot of water table decline. Hence, after years of decline, reduced well yields are quite understandable.

The earliest records of water level measurements available for the South Plains UWCD begin in the late 1930s. Comparing those historical water levels to more recent levels allows the District to observe the different properties of the aquifer. For instance, some water level measurements indicate little change in this interval of nearly 70 years, while others have significant variation. In non-irrigated areas of the District, the slope of the water table may be minimal, and, coupled with low hydraulic conductivity, may result in very slow groundwater movement and slight water level changes.

In conclusion, the Ogallala is an unconfined aquifer of varying saturated thickness and other hydrologic properties. Groundwater movement in an unconfined aquifer occurs when a difference in elevation is present at two points of the water table. The slope of the water table during pre-development was regionally southeast. Discharge occurred primarily through springs located along draws and lakes, as well as the Caprock escarpment, during this time period. A wealth of information regarding the aquifer's properties has been available since the drilling of thousands of irrigation wells. Pump test data indicates hydraulic conductivity ranges from 0-500 ft/day within the District, with most of the District located in the lower range of 3-5 ft/day. Today, the regional slope of the water table continues to be southeasterly, with local variations often influenced by heavy irrigation water use. Historic and current water level measurements help identify the areas of the aquifer where rates of groundwater movement vary.

The Board of Directors and Staff of the South Plains UWCD wish you a happy and safe holiday season.
May He bring you adequate rain, abundant crops, and peace in the coming year.

IRS to Visit District

An IRS engineer will visit the District on December 15 to review information for the cost-in-water depletion program. This program allows irrigated landowners to receive a tax benefit due to declining groundwater levels. This program is specific to the High Plains landowners using groundwater from the Ogallala formation.

Each year, the IRS must review and approve land sales data that establishes the cost of water. Also, the District's water table decline map must meet IRS guidelines.

Since 1999, approximately 197 landowner requests have been fulfilled. Eligible properties are those which have been acquired since 1979. Those who have previously requested this information will soon receive a reorder form.

If you would like additional information or have any questions, call or come by the District office

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Calendar of Events

Nov. 27-28	*Thanksgiving Holiday Office Closed*
Dec. 2	*Board Meeting 8:30 am District office*
Dec. 25-26	*Christmas Holiday Office Closed*

Looking Ahead to 2004

Jan. 1	*New Year's Day Office Closed*
Jan. 6	*Board Meeting 1:30 pm District office*
Jan. 21	*South Plains Ag Conference and Tradeshow*
Feb. 3	*Board Meeting 1:30 pm District office*

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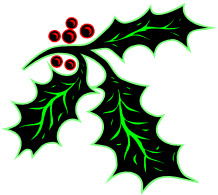

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