SURFACE-GROUNDWATER STUDY OF THE ALLUVIUM AND TERRACE AQUIFER OF THE SALT FORK OF THE ARKANSAS RIVER AND SALINE SURFACE WATER IN NORTH OKLAHOMA

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Task 410

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EXECUTIVE SUMMARY

The Alluvium and Terrace Aquifer of the Salt Fork of the Arkansas River is a fresh water aquifer used for agricultural, municipal, and domestic purposes. Water wells located close to the river or other saline surface water are sensitive to induced infiltration. The purpose of the study is (1) to develop some insight into the groundwater - surface water interactions and their effects on water quality and (2) to determine the effects of well pumping on the water quality of the alluvial and terrace aquifer.

A review of the data on groundwater - surface water interactions revealed that the area from the Great Salt Plains dam to eight miles downstream is a losing stream where the alluvial and terrace aquifer would be impacted by chloride-laden stream water. The groundwater from the bedrock formations around the Great Salt Plains Reservoir is moving upward and interacts with fresh groundwater and surface waters thus lowering their quality.

A geographic information system (GIS) was utilized in producing two water table maps, an aquifer bottom map and a map identifying areas sensitive to induced infiltration. Hydraulic gradient, transmissivity and pumping rate were used to determine the sensitivity distance using the formulas to determine the zone of contribution of a pumping well. Those results were grouped into six classes based on the minimum safe pumping distance. Transmissivity and position of a well relative to groundwater chloride plumes were the most important factors in determining sensitivity. The higher the transmissivity the lower the sensitivity. All other factors being equal, areas located upgradient of chloride sources are less sensitive than areas located downgradient of sources.

Most of the area had no or low sensitivity to induced infiltration. Large areas of the aquifer are useable for municipal, industrial or irrigation use without concern for inducing infiltration to pumping wells or degrading aquifer water quality with salt water.

Keeping wells located beyond the minimum sensitivity distance would not only protect the water quality of the well; it would also avoid degrading aquifer quality. For a given pumping rate the most sensitive areas would be those with a low hydraulic gradient and low transmissivity.

BACKGROUND

The Alluvium and Terrace Aquifer of the Salt Fork of the Arkansas River is a fresh water aquifer used for agricultural, municipal, and domestic purposes. Surface water in the area flows over salt formations, and is saline. Water wells located close to the river or other saline surface water are sensitive to induced infiltration from pumping. This study was undertaken by the Oklahoma Water Resources Board (OWRB) to:

(1) Determine surface-groundwater interactions and possible relationship to groundwater quality.

(2) Determine the impact of groundwater pumping on the water quality of the Alluvium and Terrace Aquifer of the Salt Fork of the Arkansas River and on the saline surface water sources.

Geographic Information System

All data collected for this project were input into computer databases allowing the data to be used by a geographic information system (GIS). Maps for this project were produced by a GIS using data from databases created for this project, existing OWRB databases and in-house digitizing. Legal descriptions from the OWRB well inventory database were converted to a global reference system by the Oklahoma City office of the United States Geological Survey, Water Resources Division.

Geography

The study area consists of approximately 780 square miles of alluvium and terrace deposits along the Salt Fork of the Arkansas River in Alfalfa, Grant, Kay and Noble Counties, Oklahoma.

The area consists of gently rolling prairie plains dissected and drained by the Salt Fork and it's tributaries. The major tributaries include the Chikaskia and Medicine Lodge Rivers, Deer, Polecat, Bois d'Arc, Sand, Sandy, Pond, Crooked, and Driftwood Creeks.

The Great Salt Plains, a 10,000-acre salt flat, is located in the western portion of the study area. The salt flats surround the Great Salt Plains Lake, which was constructed by the U.S. Army Corps of Engineers in 1941. The lake covers an area of 8,690 acres and has a conservation pool of 31,420 acre-feet

Geology

The alluvium and terrace deposits of the Salt Fork of the Arkansas River are of Quaternary age, and are comprised of gravel, sand, silt, and clay. Dune sands are present in parts of the area. The deposits are quite broad in Alfalfa County, blanketing a large portion of the county and beyond into Kansas. In that county these sand deposits extend south from the Kansas border to a distance of 23 miles. From western Grant on to Kay and Noble Counties the deposits narrow and primarily follow the river where they range from one to five miles in width.

The bedrock formations underlying the Quaternary alluvial and terrace deposits are primarily siltstones and shales of Permian age. A small area at the eastern most portion of the study area near the confluence of the Salt Fork and the Arkansas River is underlain by shales and limestones of the Pennsylvanian Oscar Group. The bedrock in the eastern half of the study area is dipping west to southwest and in the western half is dipping south to southwest. Older formations are exposed at the surface in the eastern portion of the study area and younger rocks exposed in the western portion (Bingham and Bergman, 1980; Morton, 1980). These younger rocks of lower Permian age contain salt beds. The Lower Cimmaron Salt underlies a portion of Alfalfa County while the Lower Wellington Salt appears to underly a large portion of the study area (Jordan and Vosburg, 1963).

DATA REVIEW

Precipitation

Digital precipitation data were obtained from the NOAA rain gauges at Cherokee, Jefferson, Great Salt Plains Dam, and Ponca City (Table 1.) Generally precipitation amounts were greater than normal during 1992 and 1993. In 1992, Ponca City had the greatest amount of rain of all the gauges with 43.1 inches, a 6.7 inch increase over 1991, while the Great Salt Plains Dam measured the lowest total rainfall with 33.5 inches, an increase of 9.1 inches over 1991. The 1993 rainfall annual averages ranged from 34.8 inches at Jefferson to 41 inches at Ponca City. In general, these 1992 and 1993 totals are higher than either the 1991 totals or the 30 year averages for these rain gauges. The exception was the Jefferson gauge where the 1992 and 1993 totals were below the 30 year average of 39 inches. The 30 year annual average in inches is 34.6 for Ponca City and 28 for Great Salt Plains Dam. The increases in precipitation over the 1991 levels appear to be reflected by the increase in water levels as discussed below.

Aquifer Bottom Elevations

Sufficient data were available from drillers logs to determine the aquifer bottoms or top of bedrock for 423 wells in the study area. A contour map was produced from these data. The map (Plate 1) shows low areas of bedrock in two places. First, there is a low area along the river bed due to erosion. However, there is also another low area, which is a large bowl shaped depression located

TABLE 1. RAINFALL (INCHES) FROM NOAA GAUGES.

Station Name	1991	1992	1993	30 yr. AVG
Ponca City	36.4	43.1	41.0	34.6
Cherokee	26.9	37.0	38.6	27.7
G. Salt Plains	24.4	33.5	39.1	28.0
Jefferson	24.2	34.7	34.8	39.0

in Alfalfa County in which rests the Great Salt Plains Reservoir.

Water Level Measurements

The OWRB has 9 network wells in the groundwater basin for which water levels have been measured annually since 1975. Forty-five (45) wells were added to the network for this study for a total of 54 wells. These wells were selected by conducting a record search of driller's logs, followed by a field survey. The well depth, screened interval, spatial distribution and accessibility were evaluated in selecting the wells chosen for the network. Locations of selected wells are shown on the water table maps (Plates 2 & 3) and are listed in Appendix B. Water levels in these wells were measured monthly for over a year. A few months were missed due to weather conditions making roads impassible.

Water levels generally increased during the period from April 1992 to April 1993 with an average increase in water level of 4 feet during that period. The average increase ranged from 4.69 feet for Grant County to 3.7 feet for Alfalfa County. These changes in levels reflect the increase in precipitation and associated decrease in water use. A typical well hydrograph showing the upward trend in water levels is shown in Figure 1.

Hydrogeology

Two water table maps were prepared using water levels from the OWRB network of wells (Appendix B). A winter month, December 1992, and a summer month, July 1992, were mapped (Plates 2 & 3). These months were selected since they were seasonally very different and would be expected to show the most difference. The summer map shows the water table conditions with irrigation and evapotranspiration effects and December, in contrast, shows the water table conditions when evapotranspiration and irrigation effects would be negligible.

The maps show little seasonal variation in the water table. Neither flow patterns nor hydraulic gradient were significantly different. Both maps indicate that groundwater in Kay and Grant Counties discharges into the river. Where contours point upstream the river is a gaining stream. The map of Alfalfa County shows a bowl shaped groundwater basin with the Great Salt Plains Reservoir in the center. Since this groundwater basin is a closed system, all groundwater discharges into streams that flow into the Great Salt Plains reservoir except for any minor amounts that might seep into the underlying bedrock.

The water table maps indicate that the alluvial and terrace deposits of the Salt Fork of the Arkansas River consist of two hydrologically separate groundwater basins. There is a groundwater divide on the eastern edge of the Great Salt Plains reservoir where the hills provide the eastern limits of the reservoir. This divide coincides closely with the Alfalfa - Grant County line at Range 8 West as can be seen on Plates 2 & 3. One groundwater basin is in Alfalfa County and the other in Grant, Kay and Noble Counties.

In general, flow direction in Kay and Grant Counties is toward the river and in Alfalfa County toward the Great Salt Plains Reservoir. The average hydraulic gradient varies from 0.002 in Grant County to 0.0034 in Alfalfa County. The average saturated thickness of the aquifer is 22 feet.

The average saturated thickness by county, in feet, is 26 for Alfalfa, 25 for Grant and 15 for Kay. The total saturated thickness ranges from a few feet to 110 feet.

The U.S. Army Corp of Engineers (USACOE), as part of their Chloride Control Project, drilled numerous borings and coreholes into the bedrock in the area of the Great Salt Plain Reservoir. They found that the piezometric surface of the bedrock was above the lake bottom and the water table surface of the surrounding area. In one area, south of the lake, the head in the bedrock was as much as 18 feet above the water table. This indicates that water is discharging from the underlying bedrock into the lake and the overlying alluvial and terrace deposits (USACOE, 1981).

Stream Flow Measurements

Due to the wetter than normal winter, an adequate dry period was not available and low flow measurements were not obtained.

Winter stream flow measurements were taken along the Salt Fork of the Arkansas River and other feeder streams as part of the Arkansas River Chloride Control Project. Measurements along the stretch from Ingersoll to the Great Salt Plains Reservoir indicated that

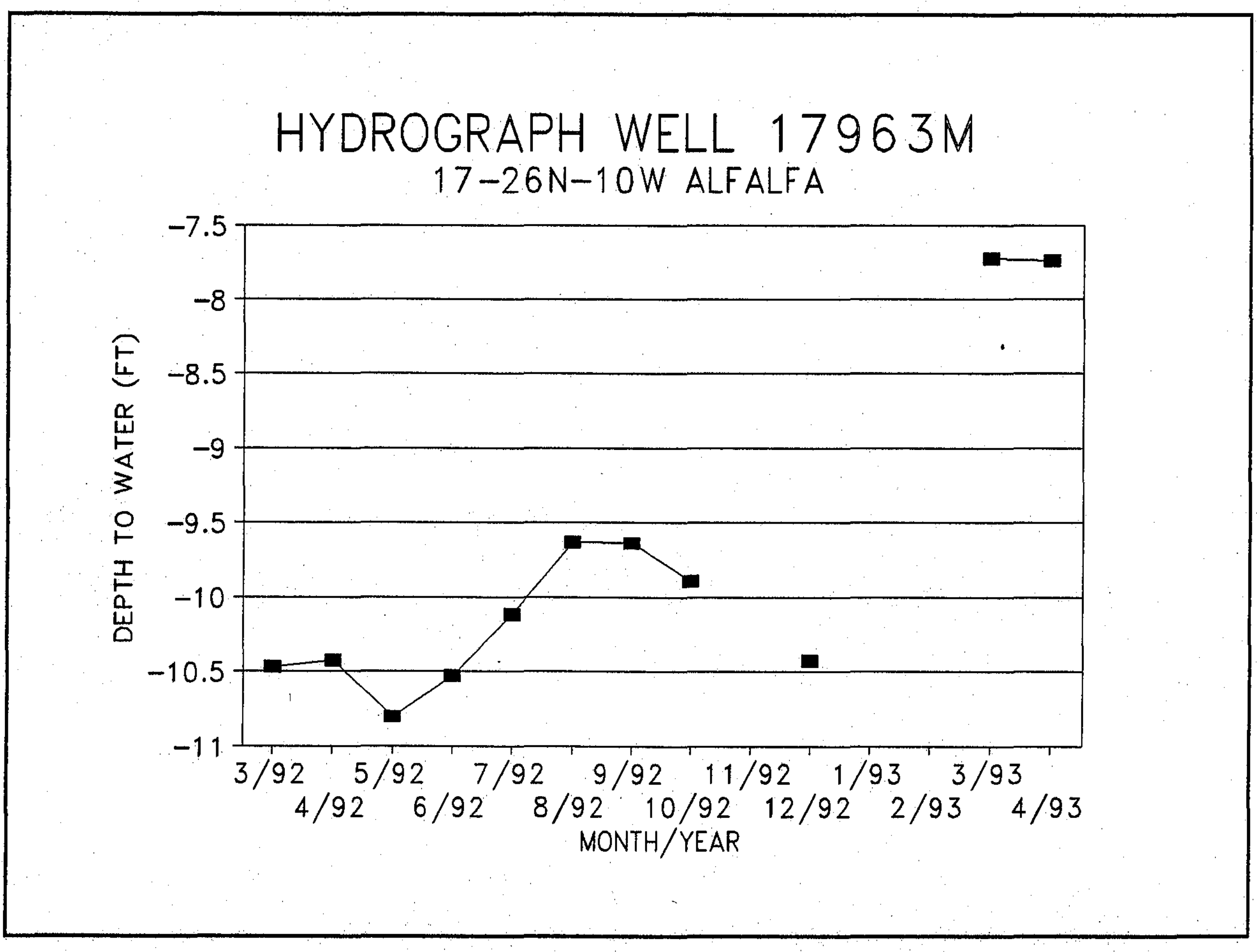

Figure 1 Well Hydrograph.

the river was neither a gaining nor a losing stream. From below the dam to eight miles downstream, the Salt Fork was a losing stream. It then became a gaining stream and remained that way up to the confluence with the Arkansas River (SYN-AN, 1975).

The United States Geological Survey has two gauges, at Jet and Tonkawa, on the Salt Fork of the Arkansas River within the study area. The Jet gauge recorded a total discharge of 107,314 acre/ft of water in 1991 and 305,538 acre/ft of water in 1992. The Tonkawa gauge indicated a total discharge of 210,350 acre/ft of water for 1991 and 762,080 acre/ft of water in 1992. The threefold increase in discharge reflects the increase in rainfall.

Water Use

OWRB reported water use data were reviewed for calendar years 1991 and 1992. Since there are two groundwater basins for this study the water use was broken down by basins. Figures 2 and 3 show

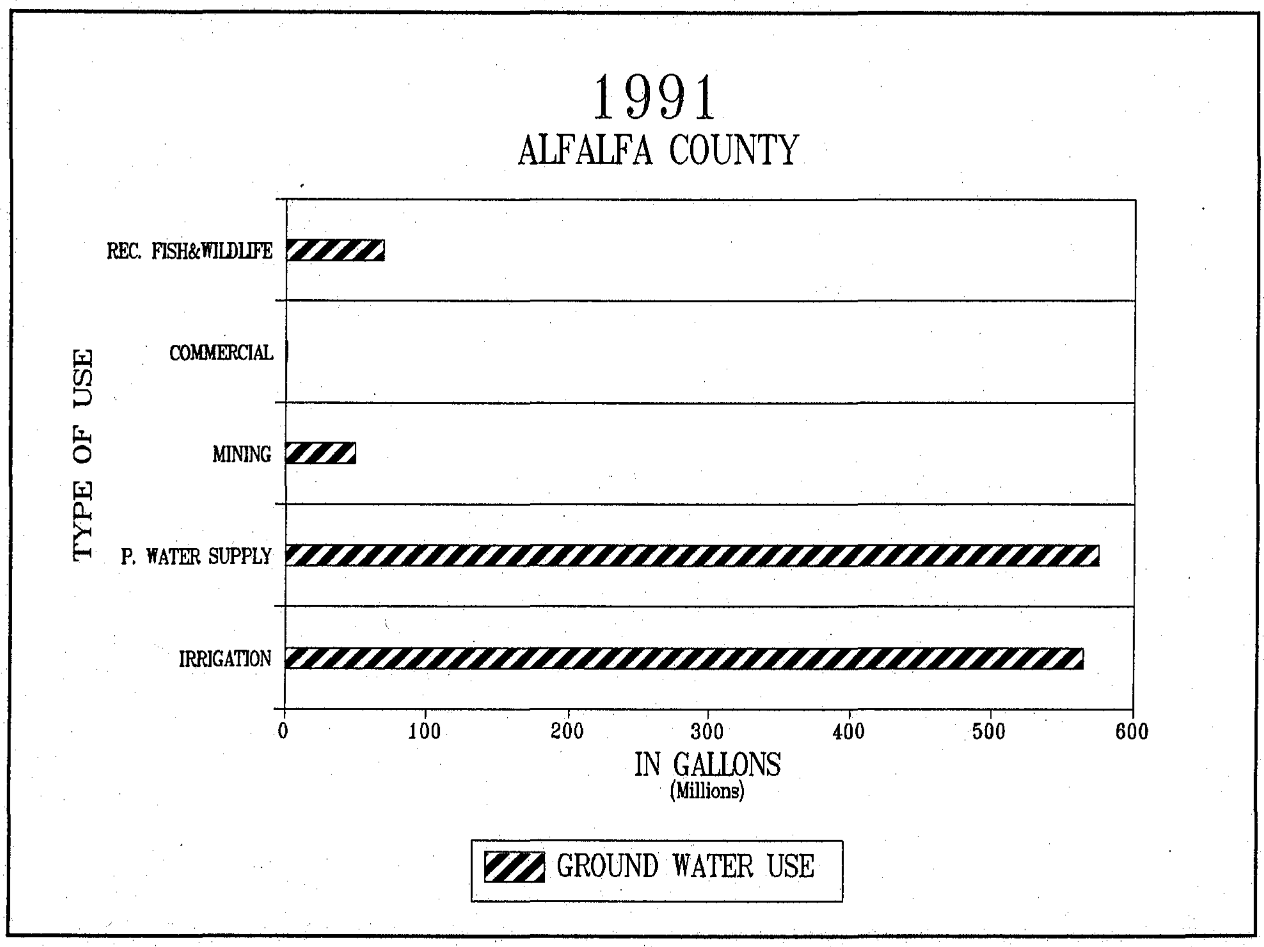

Figure 2. Water Use Alfalfa Co. 1991

public water supply was the largest use of groundwater in both basins. Data for 1991 was chosen to display here as being more representative of average water use than 1992. Usage in 1992 for some categories, such as irrigation, was reduced due to the high rainfall. In 1991 the reported use for Alfalfa County was over 575 million gallons for public water supply, while Kay and Grant had a combined total use of 683 million gallons. Irrigation and recreation, fish and wildlife were also uses of groundwater in Alfalfa County. Kay and Grant Counties had much less use in these categories than Alfalfa County. Fish and wildlife were also uses of groundwater in Alfalfa County.

Water Quality

Surface water quality is generally good in the tributaries to the Salt Fork of the Arkansas. The Great Salt Plains reservoir is saline and discharges from this reservoir are the major source of chloride in the river water.

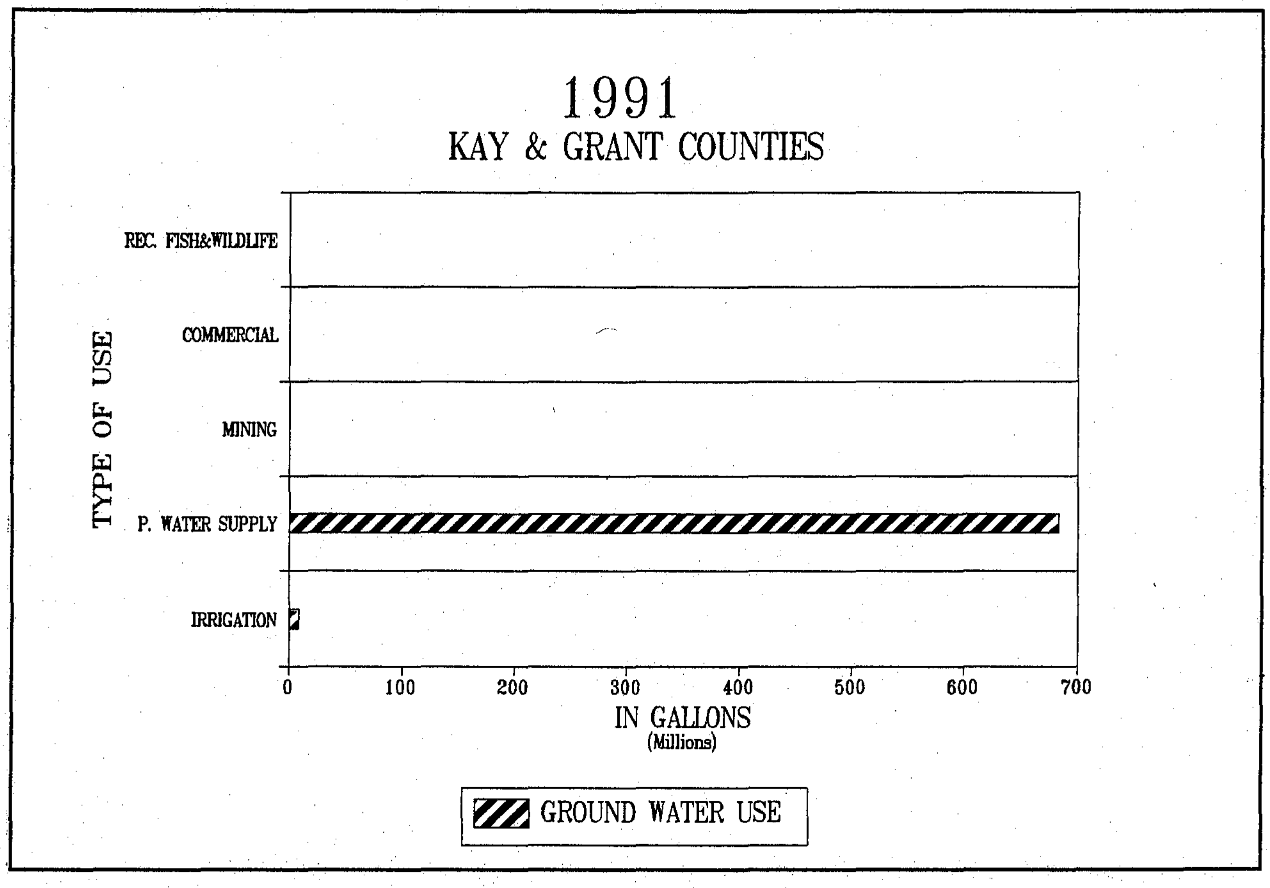

Figure 3. Water Use Grant & Kay Co.'s 1991

In Alfalfa County, groundwater is affected by saline discharges from the bedrock, especially in the vicinity of the Great Salt Plains Reservoir. In areas where the piezometric surface is above the top of the bedrock, saline water moves upward and mixes with otherwise fresh water of the overlying alluvial and terrace deposits. Groundwater discharges to streams in these areas of upward moving water, making the streams saline. Other areas of the County, upgradient of the discharges, have good quality water.

Surface water quality samples taken near Ingersoll in section 14 of 27N-R11W near the western edge of the study area showed a chloride concentration of 220 milligrams per liter (mg/l). Farther east in Alfalfa County where the piezometric head in the bedrock is above the water table, groundwater discharge to the streams is saline. Samples in this area had chloride concentrations ranging from 205 to 29,300 mg/l. This chloride-laden surface water discharges into the Great Salt Plains reservoir and impacts the lake's water quality. After discharging from the reservoir, the river's water quality improves with distance from the dam due to the dilution of the river with fresh water from the tributaries, surface run-off and groundwater discharge from the alluvial and terrace deposits. The chloride concentrations of the river ranged from 1,190 mg/l at the highway bridge north of Nash in section 11 of T26N-R9W to 540 mg/l in section 31-T25N-R2E a few miles from the confluence with the Arkansas River. Dilution is the greatest from the Chikaskia River, the largest tributary (SYN-AN, 1975).

Groundwater quality is generally good in the alluvial and terrace deposits of the Salt Fork of the Arkansas River. The OWRB maintained a network of wells monitored for ambient groundwater quality in this aquifer until 1992. From 1986 - 1991 sixty-eight samples were collected from 34 wells and submitted for laboratory analysis. Chloride concentrations had a mean value of 117.74 mg/l and a median value of 23.5 mg/l. These chloride samples had values ranging from 10 - 2,266 mg/l. The mean concentration for total dissolved solids (TDS) was 842.07 mg/l and the median concentration was 544 mg/l. The TDS values for these samples ranged from 86 - 6,934 mg/l (OWRB, 1993). The EPA secondary drinking water standard is 250 mg/l for chloride and 500 mg/l for TDS.

The USACOE identified a large groundwater chloride plume in Alfalfa County which mainly surrounds the Great Salt Plains Reservoir. The highest chloride concentrations are adjacent to the lake where chloride concentrations exceed 100,000 mg/l. Although concentrations decrease rapidly away from the reservoir there are large areas which exceed the 250 mg/l secondary drinking water standard (USACOE, 1976). See Plate 4 for the 250 mg/l outline of the plume.

In Kay, Grant and Noble Counties, groundwater quality in areas immediately adjacent to the river are impacted by high chloride levels. As part of the Chloride Control Project, a series of monitor wells were installed transverse to the river in three locations in Grant and Kay Counties. In general, chemical analysis of water from these wells adjacent to the river showed the highest chloride levels, with the concentrations decreasing with distance (EEI, 1987).

Hydraulic Conductivity

Two sources of hydraulic conductivity data were reviewed for this report. The first was published and unpublished reports of hydraulic conductivity data. The second was short term well acceptance data.

Fader and Morton, 1972, estimated hydraulic conductivity values of 130-400 ft/day for alluvial deposits and 65 - 200 ft/day for terrace deposits in Alfalfa, Grant and Kay Counties. Allison, 1974, references a series of pump tests conducted by USACOE in Alfalfa County which had hydraulic conductivities ranging from 3 to 100 ft/day. Results of pump tests conducted at the City of Medford's wellfield in Grant County indicate values ranging from

125 - 451 ft/day (RJ, 1985).

A review of drillers logs found 91 wells with short term well acceptance tests with data complete enough to be useable. Test data for wells which lacked essential information or which partially penetrated the aquifer were rejected. Data for these acceptable wells were input into the OWRB's T-O-T computer program, which calculates hydraulic conductivity and transmissivity from well acceptance test data (OWRB, 1992).

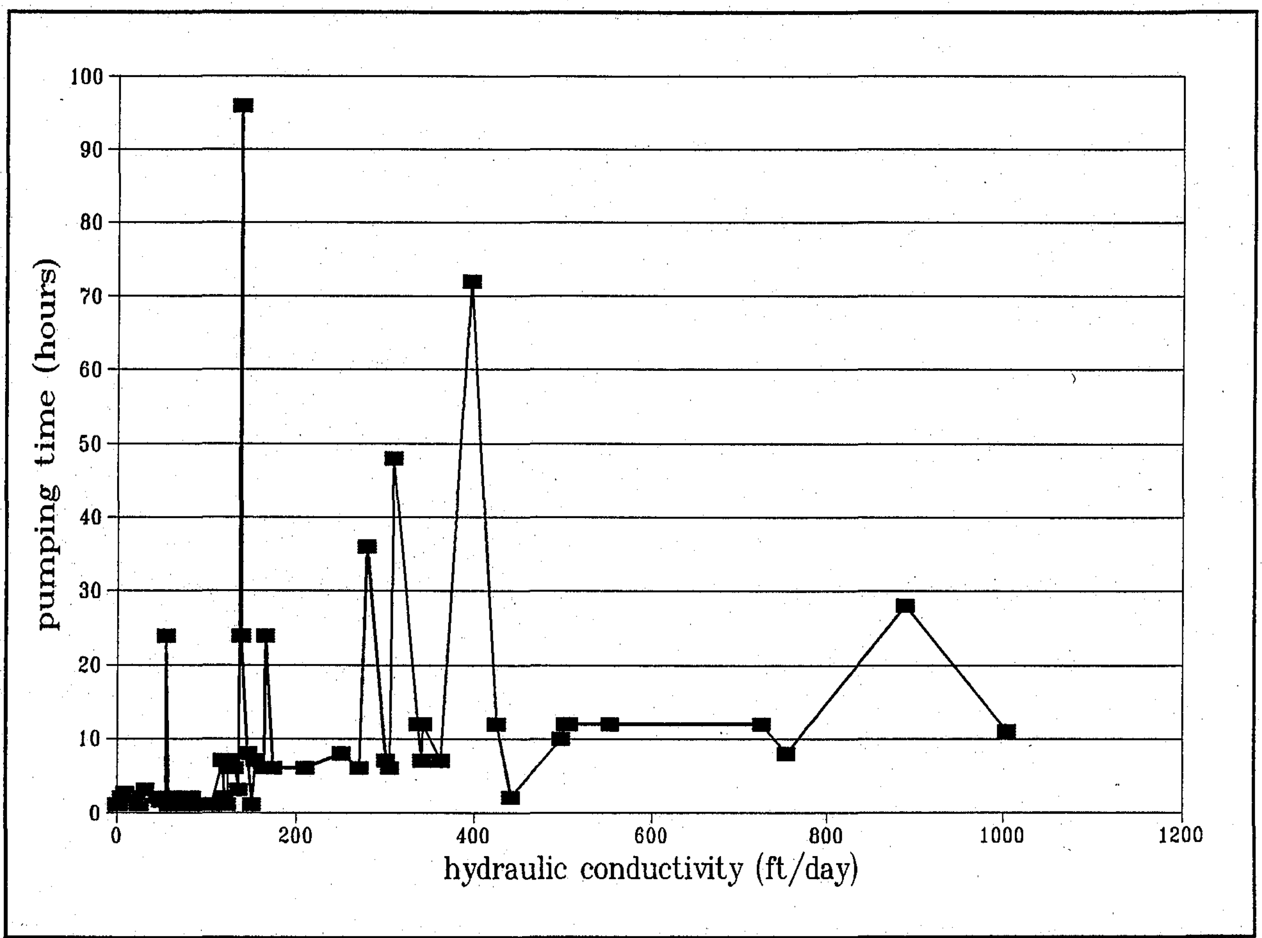

Figure 4. Graph Showing Shift in K After 5 Hours Pumping.

Hydraulic conductivities calculated by T-O-T range from 2 - 1004 ft\day with an average value of 210 ft/day. A graph of hydraulic conductivity, using the values generated by the T-O-T program, versus pumping time is shown in Figure 4. The graph shows a distinct increase in hydraulic conductivity values after pumping for 5 hours or greater. Virtually all wells with acceptance tests of less than 5 hours have a hydraulic conductivity less than 100 ft/day and all wells with a greater pumping time had conductivities over 100 ft/day. This shift indicates that a pumping time of less than 5 hours could cause underestimation of the hydraulic conductivity. Out of the original 91 wells, 36 had pumping times of 5 hours or more. These had conductivities ranging from 55 - 1,004 ft/day with an average value of 323 ft/day. Overall, values calculated from the short term well acceptance test data fall within the range of values from the published and unpublished data mentioned above. See Appendix A for further information on hydraulic conductivities.

Transmissivity Analysis

Since aquifer test and well acceptance test data were limited, saturated thickness and lithology information from 423 drillers logs were utilized to expand the number of data points. Two approaches to calculating a transmissivity (T) were considered and evaluated. The first method uses a single hydraulic conductivity (K) for the entire saturated thickness regardless of lithology changes, while the second uses grain size specific K values for different lithologies for the saturated interval in a well.

Method one was modified from Kent, et. al. (1973 & 1982) which describes a way to estimate hydraulic conductivity from a grain size envelope developed from laboratory and pump test data. This envelope can be used to estimate hydraulic conductivity from grain size descriptions found on drillers logs.

Lithology descriptions for all available logs were reviewed, and saturated lithology was broken down into 3 groups based on grain size description. Coarse sand and gravel was assigned to class 1, fine to medium sand to class 2 and silty clay and clay to class 3. Total saturated feet of each class was recorded.

Hydraulic conductivities for classes 1 and 2, were determined using the set of acceptance test data analyzed above. Wells were selected in which the entire saturated thickness was composed of class 1. The hydraulic conductivities of this set of selected wells were averaged to arrive at an average hydraulic conductivity for class 1. The same procedure was followed for class 2. Based on the averages, class 1 was assigned a K of 455 ft/day, and class 2 was assigned a K of 30 ft/day. Since no wells had only class 3, it was assigned a K of 0.5 ft/day based on the value used by Kent, et. al. (1982).

Transmissivity for each well was then calculated using the following formula:

T_{lith} = (K * total saturated feet class 1) + (K * total saturated feet class 2) + (K * total saturated feet class 3).

The second method was simply to take an average K for the aquifer and multiply it by the saturated thickness:

$T_{avg} = K_{avg}$ * saturated thickness.

The set of wells with acceptance test data which produced a known transmissivity value ($T_{acctest}$) were used as a benchmark to test against the two methods described above. A comparison of the two methods was made against the benchmark using the sum of the differences method. Two sets of calculations were made:

$$(1)\ \Sigma\ (T_{acctest} - T_{lith})$$

$$(2)\ \Sigma\ (T_{acctest} - T_{avg})$$

to determine the sum of the differences of the two methods. The closer that the difference for method 1 or 2 approached zero the closer the differences for that method come to balancing each other out. The sum of the differences for 1 and 2 were compared to each other. While the data for method 1 did not zero, it was close enough that a two percent change in transmissivity values would produce a zero. With method 2 the sum of the differences was always larger than with the first method. While the first method is not perfect it gives an overall closer match than the second.

SURFACE WATER GROUNDWATER INTERACTION

In studying groundwater-surface water interactions, base flow measurements are useful. A very wet winter prohibited the collection of this data. As mentioned above, measurements taken in 1975 by SYN-AN indicated that the Salt Fork of the Arkansas River was a gaining stream from the Great Salt Plains Reservoir to eight miles below the dam. The resolution of our water table maps is not great enough to verify this. A losing stretch on the river at this point, where it is highest in chlorides, would allow salt water to infiltrate into the aquifer and contaminate it. This could have an impact on the sensitivity distance since the chlorides in groundwater could extend well beyond the river banks. No analyses were found that could help delineate this possible groundwater contamination. This is not taken into account in the sensitivity analysis below. Operators installing wells in these areas should exercise extra caution and may want to use a distance beyond what is recommended below. Other aspects of groundwater-surface water interactions, such as the impact of saline groundwater on surface water are described in other sections of the report.

SENSITIVITY ANALYSIS

Sensitivity to Induced Infiltration.

The sensitivity of a particular well to induced infiltration is dependent on size and shape of the zone-of-contribution of the pumping well and the distance from the source. Figure 5 shows the zone-of-contribution formed by a pumping well.

In Grant and Kay Counties, it is not necessary to determine the entire capture zone of a well since the source, the river, is located downgradient to any potential wells. Only the downgradient extent is needed to establish the sensitivity. The sensitivity of wells to induced infiltration was calculated using the formula for the downgradient null point of a pumping well. The formula is:

$$X_L = -\frac{Q}{2\pi Kbi}$$

where X_L is the downgradient null or stagnation point, Q is the pumping rate, K is the hydraulic conductivity, b is the aquifer thickness and i is the hydraulic gradient (Todd, 1980). This formula assumes a stabilized cone of depression. No induced infiltration of saline waters at locations beyond the null point could occur.

Groundwater and lake water are sources of chloride in Alfalfa County. Here it is necessary to consider the entire capture zone since sources can be located upgradient or cross gradient to a potential well. The maximum distance perpendicular to the flow direction (Y_L) can be determined by the formula:

$$Y_L = \pm \frac{Q}{2KBi}$$

(Todd, 1980).

When salt water contamination is located upgradient of a well, the time of travel (TOT) must be considered since the upgradient water is moving toward the cone of depression. The time-of-travel can be calculated by the following formula:

$$TOT = (v_r)\ (t) + (v_p)\ (t)$$

where v_r is the regional velocity of groundwater, v_p is the velocity of groundwater due to pumping and t is the length of time for which the TOT is being calculated (USEPA, 1987). TOT is the distance the groundwater will have traveled for a given period of time.

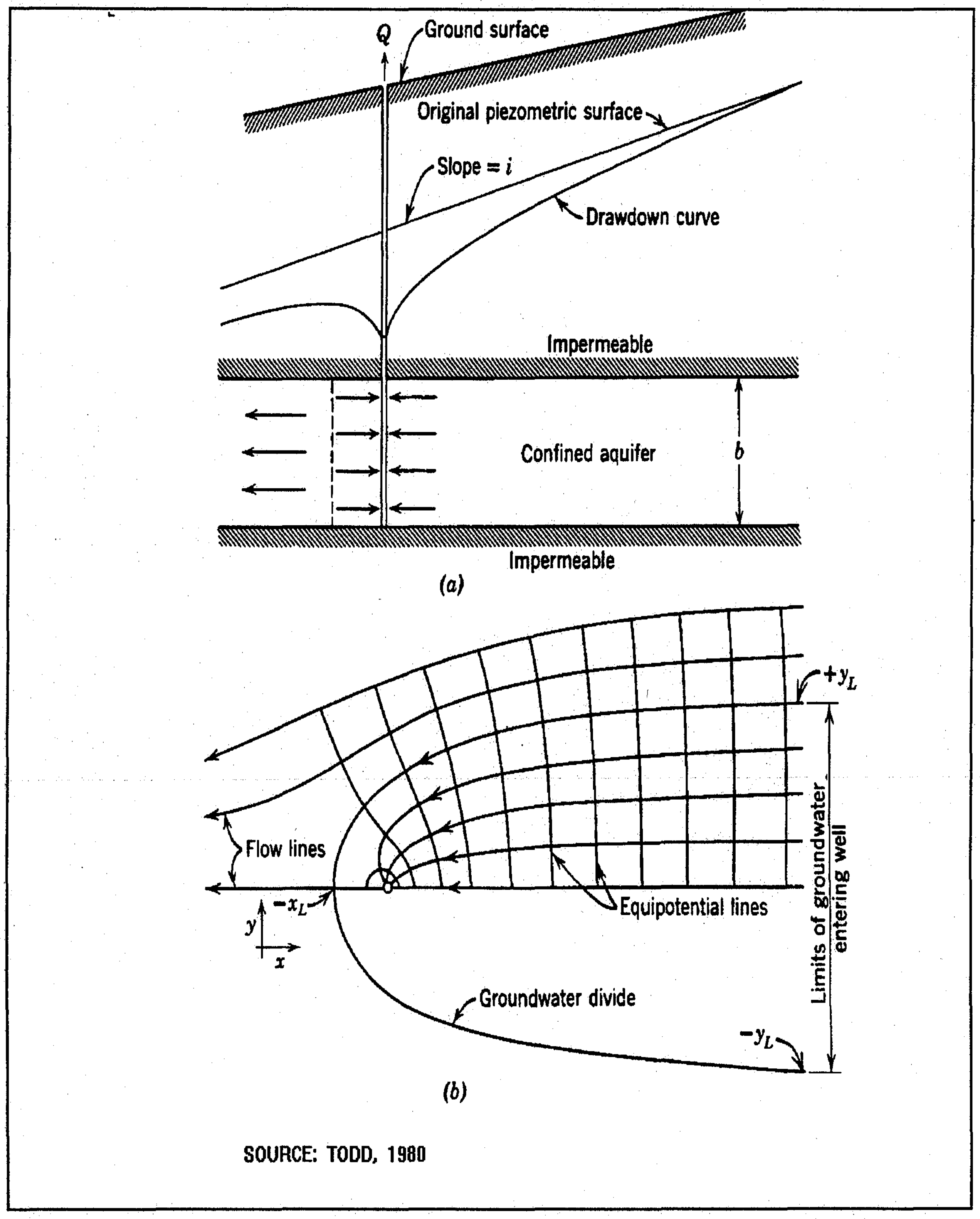

Figure 5 Diagram Showing Zone of Contribution

Preliminary sensitivity analysis indicated that the one mile distance would not be exceeded in most cases. A grid for the sensitivity map was made by utilizing the one square mile grid of the Public Land Survey System. Sections included in the grid were those which would touch on a line projected a distance of one mile from the Salt Fork of the Arkansas River in Grant and Kay Counties. In Alfalfa County, upgradient of the Great Salt Plains Dam, sections were selected which would touch on a line projected one mile from the outer edge of areas where groundwater chloride concentrations exceeded 250 mg/l (drinking water standards). The chloride concentration map for Alfalfa County was taken from USACOE 1976. Each section in a township within the selected areas was treated as a cell and a value for each variable in the formula assigned to each cell. This produces an average sensitivity for each section (one square mile).

The null point (X_L) and cross gradient extent (Y_L) were calculated for simulated pumping rates of 100, 250, 500 and 1000 gallons per minute (gpm) (Appendix C). A transmissivity (T) map was prepared using values determined as described above and an average T value assigned for each section. The minimum T value used was 500 ft^2/day unless available well data indicated a lower T. The hydraulic gradient was estimated by examining the December water table map since that month would not likely be influenced by irrigation pumping. For areas beyond the well network or in areas with limited well control, hydraulic gradient was assigned by examining the slope of the land surface and the regional hydraulic gradient.

A determination was made as to which direction, X_L, Y_L, or upgradient, would be the most sensitive in relation to the source. The sensitivity distance calculations were grouped into six classes based on the 100 gpm pumping rate That rate was chosen since it would be achievable more often than the higher pumping rates. The sensitivity classes are:

Class	Sensitivity distance:	
1.	< or = 500 feet	Least sensitive
2.	501 -1000 feet	
3.	1001-2000 feet	
4.	2001-3000 feet	
5.	3001-4000 feet	
6.	> 4000 feet	Most sensitive

A well pumping 100 gpm in a class 1 (least sensitive) area would not induce infiltration of saline water as long as it was located greater than 500 feet from the source. A class 5 well would have to be greater than 4000 feet from a saline source of water to avoid contamination. Keeping wells located beyond the minimum sensitivity distance would not only protect the water quality of the well it would also avoid degrading aquifer quality. For a given pumping rate the most sensitive areas would be those with a low hydraulic gradient and low transmissivity.

The pumping rate of a well is dependent on saturated thickness and T. For instance, a well with a transmissivity of 500 ft^2/day would, in a 100 percent efficient well, require a theoretical minimum 43 feet of saturated thickness to maintain a continuous pumping rate of 100 gpm. If that thickness were available, the null point could extend over 3000 feet downgradient from the well and the cross gradient extent could reach out to 9400 feet. If the minimum thickness was not available, then the pumping rate would have to be reduced and the calculated sensitivity distance would reduce as well.

Wells with chloride sources located upgradient to them are the most sensitive. If TOT in the upgradient direction is a consideration, then chloride contamination will move into the well at some point in time. Sections which were considered to have a source upgradient were placed into class 6 (most sensitive) for this reason.

Since this approach assumes continuous pumping and since well operators rarely pump continuously, the sensitivity distance would not often be reached.

Sensitivity Map.

The sensitivity map is based on a simulated well pumping continuously at 100 gpm (Plate 4). For ease of display the sensitivity distances were grouped into classes as mentioned above. Shown in Appendix C are the values for transmissivity and hydraulic gradient used in the analysis as well as the sensitivity distance calculated for all sections in the study at pumping rates of 100, 250, 500, 1000 gpm. Since pumping rate is proportional to the null point distance (X_L) and the crossgradient distance (Y_L), the sensitivity distance changes but not the relative sensitivity at any pumping rate selected. Also included in Appendix C is the theoretical minimum thickness necessary to pump at those rates which was calculated using the formula for specific capacity for unconfined aquifers:

$$\frac{Q}{s} = \frac{T}{1500}$$

where Q is the pumping rate, s is the drawdown, and T is the transmissivity (Driscoll, 1986). Since the average saturated thickness of the aquifer is 22 feet and is rarely greater than 50 feet, values are not shown for those cases where greater than 50 feet of saturated thickness would be necessary to obtain the simulated pumping rate.

In general, the map shows no specific pattern to the sensitivity except that class 5 and 6 sensitivities tend to be located at the edge of the aquifer where thin, low transmissivity aquifer material is expected to occur. However, a greater proportion of class 6 sensitivities occur in Alfalfa County because the position of potential wells relative to chloride plumes require that the entire zone-of-contribution be taken into account. Outside of Alfalfa County, transmissivity has the greatest effect on how classes are distributed on this map. Average transmissivity ranges from 4252 ft^2/day for class 1 to 716 ft^2/day for class 6 (Table 2). Gradient has little effect on class distribution. The average gradient ranges from 0.002 for classes 3, 4, 5 and 6 to 0.004 for class 1. This indicates that for the study area transmissivity was a more important factor in determining the distribution of classes than gradient.

Table 2 shows the total area, in square miles, and percent total of these classes by county. Also shown is the area of the aquifer outside of the area of analysis which is not considered to be sensitive due to the distance from sources. This outside area also includes the alluvium deposits of tributaries to the Salt Fork of the Arkansas River.

Noble County has the greatest percentage of areas in the least sensitive classes with 69 percent of the area in class 1 or 2. However, the county contains only a relatively small (6.5 mi^2) portion of the aquifer. No class 5 or 6 (most sensitive) are located in the county.

Kay County has the second greatest percentage of areas in the least sensitive classes. In the county, class 1 and 2 sensitivities totaled 31.5 percent of the area. Adding that to the 62.7 percent of outside areas totals 94.2 percent or 178 mi^2 of the aquifer not sensitive to slightly sensitive to induced infiltration of saline surface water. Only 0.3 percent of the area is in the two most sensitive classes.

Alfalfa County has the third largest percentage of areas in class 1 and 2 with 24 percent. When combined with the 45 percent outside areas, the area of not sensitive to slightly sensitive aquifer totals 65 percent or 182 mi^2. However this county had the greatest percentage of most sensitive areas with class 5 and 6 totaling 26.2 percent or 72.6 mi^2.

Grant County had the lowest percentage of class 1 and 2 with 14.2 percent. The outside area was 66.9 percent and when added to the class 1 and 2 totals 81.1 percent of the aquifer (269.3 mi^2) not sensitive to slightly sensitive to induced infiltration. This county had only 4.9 percent of the total area in the 5 and 6 sensitivity classes.

TABLE 2. TOTAL AREA, PERCENT AREA, TRANSMISSIVITY AND GRADIENT BY CLASS

Sensitivity Class	1	2	3	4	5	6	Outside[1]	Total Mi²/Co.
Alfalfa Co. mi²/Class	49.1	17.5	11.9	9.8	5.6	67	115.5	277[2]
Pct. of Total Area	17.7	6.3	4.3	3.5	2.0	24.2	41.7	N/A
Grant Co. mi²/Class	25.1	21.8	27.3	18.4	10.1	6.5	222.4	332
Pct. of Total Area	7.6	6.6	8.2	5.5	3.0	1.9	66.9	N/A
Kay Co. mi²/Class	30.2	29.5	7.1	3.4	0.5	0	118.6	189
Pct. of Total Area	15.9	15.6	3.8	1.8	0.3	0	62.7	N/A
Noble Co. mi²/Class	1.69	2.8	0.07	0	0	0	1.9	6.5
Pct. of Total Area	26	43.1	1.1	0	0	0	29.5	N/A
All Co.'s mi²/Class	106.1	71.6	46.4	31.6	16.2	7.35	458	804.5
Pct. of Total Area All Co.'s	13.2	8.9	5.8	3.9	2.0	0.9	56.9	N/A
Average Transmissivity	4252	2625	1820	1457	716	2096	ND	N/A
Average Gradient	.004	.003	.002	.002	.002	.002	ND	N/A

1. Outside refers to the area outside the area analyzed but within the aquifer boundaries. This area is not considered to be sensitive because of the distances from known sources.
2. Does not include area of the aquifer impacted by chloride
N/A Not Applicable.
ND Not Determined - outside of area analyzed.

SUMMARY

The Alluvium and Terrace Aquifer of the Salt Fork of the Arkansas River is a fresh water aquifer used for agricultural, municipal, and domestic purposes. Saline water from bedrock in the area of the Great Salt Plains Reservoir is moving upward and mixing with fresh groundwater and lake water. The chloride impacted groundwater discharges into streams and to the lake. Discharges from the reservoir are saline and impact the river. Water wells located close to the river or other saline surface water are sensitive to induced infiltration.

A geographic information system (GIS) was utilized in producing two water table maps, an aquifer bottom map and a map identifying areas sensitive to induced infiltration. Hydraulic gradient, transmissivity and pumping rate were used to determine the sensitivity distance using the formulas for calculating the zone of contribution of a pumping well. Although the hydraulic gradient and transmissivity have an equal effect on the sensitivity distance, hydraulic gradient did not vary enough to be a large factor in the study area. Transmissivity and position of a well relative to groundwater chloride plumes were the most important factors in determining sensitivity. The higher the transmissivity the lower the sensitivity. All other factors being equal, wells located upgradient to chloride sources are less sensitive to induced infiltration than wells located downgradient or cross gradient.

Most of the area had no or low sensitivity to induced infiltration. Of the 804.5 mi^2 of the aquifer in Alfalfa, Grant, Kay and Noble Counties, 22.1 percent are in classes 1 and 2 (least sensitive) and 2.9 percent are in classes 5 and 6 (most sensitive). Alfalfa County has the largest area (72.6 mi^2) of class 5 and 6 sensitivity classes. Large areas (635.7 mi^2) of the aquifer are of no or low sensitivity and are useable for municipal, industrial or irrigation use without concern for inducing infiltration to pumping wells or degrading aquifer water quality with salt water.

Keeping wells located beyond the minimum sensitivity distance would not only protect the water quality of the well; it would also avoid degrading aquifer quality. For a given pumping rate the most sensitive areas would be those with a low hydraulic gradient and low transmissivity.

The information contained in this report can be utilized by industry, agriculture and municipalities in maintaining water quality, aquifer management and wellhead protection.

This report should be used as a preliminary guide to locating new wells. Interpolations and assumptions were made in areas where no well data was available. Site specific results will vary and can only be determined by drilling and testing. These simulations are based on a very conservative approach. The null point formula is for a stabilized cone-of-depression. However, a stabilized cone could take weeks or months to develop and water users would rarely pump for that long. Some areas will be self limiting based on limited saturated thickness. Saturated thickness changes over time can increase or reduce the sensitivity distance. This analysis does not take into account multiple pumping wells.

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APPENDIX A

Appendix A

Hydraulic Conductivity Data

Source: Well acceptance test from drillers logs total of 91.

All 91 wells:

- Average K for all wells with acceptance test data is 210 ft/day or 1563 gpd/ft2.
- Average K for 6 wells with only Gravel is 475 ft/d or 3553 gpd/ft2
- Average K for sand from 6 tests is 30 ft/day or 224 gpd/ft2.

Wells with pumping times 5 hours or greater:

- Throwing out the high value the average K of 4 wells with pumping time of 5 hours or greater is: 455 ft/d or 3403 gpd/ft2.
- Average K for all 36 wells with pumping times of 5 hours or greater was 323 ft/day
- Average K for 13 wells with pumping times of 5 hours or greater and only sand or gravel in lithology is 336ft/day

Source: Published and Unpublished Reports.

Grant County:

1. City of Medford wells, K range from 451 ft/day (3368 gpd/ft2) to 125 ft/day (937gpd/ft2).
2. Fader and Morton p. 35 estimates hydraulic conductivity range from 130-360 ft/day (972-2692 GPD/FT2) for alluvial deposits and from 65-130 ft/day (486-972 GPD/FT2) for terrace deposits.

Kay County:

1. Fader and Morton p. 37 estimates hydraulic conductivity range from 130-400 ft/day (972-2992 GPD/FT2) for alluvial deposits.

Alfalfa County:

Source:

1. Allison 1974 p. 6, References a series of 12 pump tests made by USACOE. Tests showed permeability range from 3 to 100 ft/day (22-748 GPD/FT2). Average was 25 ft/day (187GPD/FT2).
2. Fader and Morton p. 33 estimates hydraulic conductivity range from 130-360 ft/day (972-2692 GPD/FT2) for alluvial deposits and from 65-200 ft/day (486-1496GPD/FT2) for terrace deposits.

APPENDIX B

Appendix B

SEC	TWP	RGE	DEPTH TO WATER	DATE	ELEVATION
10	25N	01EIM	9.90	22-Jul-92	959.10
10	25N	01EIM	06.73	03-Dec-92	962.27
12	25N	01EIM	22.98	22-Jul-92	944.02
12	25N	01EIM	20.08	03-Dec-92	946.92
21	25N	01EIM	20.35	22-Jul-92	944.65
21	25N	01EIM	19.16	03-Dec-92	945.84
4	25N	01WIM	15.10	03-Dec-92	962.90
7	25N	01WIM	19.55	22-Jul-92	943.45
7	25N	01WIM	18.46	03-Dec-92	944.54
9	25N	01WIM	17.02	22-Jul-92	932.98
9	25N	01WIM	18.06	03-Dec-92	931.94
1	25N	02WIM	10.50	22-Jul-92	957.50
1	25N	02WIM	10.40	03-Dec-92	957.60
14	25N	02WIM	8.92	21-Jul-92	967.08
14	25N	02WIM	5.74	03-Dec-92	970.26
18	25N	02WIM	16.10	22-Jul-92	951.90
18	25N	02WIM	16.00	03-Dec-92	952.00
6	25N	03WIM	10.27	22-Jul-92	980.73
6	25N	03WIM	10.08	03-Dec-92	980.92
1	25N	04WIM	16.83	21-Jul-92	983.17
1	25N	04WIM	17.57	03-Dec-92	982.43
13	25N	04WIM	15.55	21-Jul-92	968.45
13	25N	04WIM	15.46	03-Dec-92	968.54
6	25N	05WIM	7.17	21-Jul-92	1026.83
6	25N	05WIM	7.79	02-Dec-92	1026.21
8	25N	05WIM	9.86	21-Jul-92	1019.14
8	25N	05WIM	10.63	02-Dec-92	1018.37
32	26N	02WIM	6.27	03-Dec-92	984.73
31	26N	03WIM	10.06	22-Jul-92	989.94
31	26N	03WIM	9.03	03-Dec-92	990.97
31	26N	05WIM	16.95	21-Jul-92	1031.05
31	26N	05WIM	14.74	02-Dec-92	1033.26
32	26N	05WIM	19.10	21-Jul-92	1015.90
32	26N	05WIM	17.36	02-Dec-92	1017.64
34	26N	05WIM	20.78	21-Jul-92	1009.22
34	26N	05WIM	20.13	02-Dec-92	1009.87
22	26N	06WIM	24.72	21-Jul-92	1025.28
22	26N	06WIM	18.09	02-Dec-92	1031.91
24	26N	06WIM	11.79	21-Jul-92	1028.21
24	26N	06WIM	0.00	02-Dec-92	0.00
7	26N	07WIM	7.54	21-Jul-92	1073.46
7	26N	07WIM	5.70	02-Dec-92	1075.30
15	26N	07WIM	10.89	21-Jul-92	1062.11
15	26N	07WIM	09.93	02-Dec-92	1063.07
22	26N	07WIM	5.58	21-Jul-92	1058.42
22	26N	07WIM	5.27	02-Dec-92	1058.73
16	26N	08WIM	5.97	21-Jul-92	1097.03
16	26N	08WIM	6.90	02-Dec-92	1096.10
27	26N	08WIM	20.64	21-Jul-92	1062.36
27	26N	08WIM	20.84	02-Dec-92	1062.16
23	26N	09WIM	26.35	20-Jul-92	1154.65
23	26N	09WIM	25.61	02-Dec-92	1155.39
29	26N	09WIM	8.22	21-Jul-92	1175.78
29	26N	09WIM	6.71	02-Dec-92	1177.29
17	26N	10WIM	10.12	20-Jul-92	1142.88

Appendix B

SEC	TWP	RGE	DEPTH TO WATER	DATE	ELEVATION
17	26N	10WIM	10.43	01-Dec-92	1142.57
33	26N	10WIM	24.90	20-Jul-92	1174.10
33	26N	10WIM	24.29	01-Dec-92	1174.71
5	26N	11WIM	19.22	20-Jul-92	1184.78
5	26N	11WIM	19.05	01-Dec-92	1184.95
11	26N	11WIM	14.63	20-Jul-92	1162.37
11	26N	11WIM	14.46	01-Dec-92	1162.54
18	27N	07WIM	13.38	21-Jul-92	1105.62
12	27N	08WIM	7.83	21-Jul-92	1115.17
12	27N	08WIM	6.55	02-Dec-92	1116.45
32	27N	08WIM	6.93	21-Jul-92	1166.07
32	27N	08WIM	6.23	02-Dec-92	1166.77
8	27N	09WIM	5.52	21-Jul-92	1142.48
8	27N	09WIM	4.54	02-Dec-92	1143.46
9	27N	09WIM	3.10	21-Jul-92	1226.90
9	27N	09WIM	4.35	02-Dec-92	1225.65
16	27N	09WIM	16.65	21-Jul-92	1181.35
24	27N	09WIM	7.45	21-Jul-92	1309.55
24	27N	09WIM	6.98	02-Dec-92	1310.02
2	27N	10WIM	0.56	21-Jul-92	1144.44
18	27N	10WIM	4.53	20-Jul-92	1159.47
18	27N	10WIM	3.99	01-Dec-92	1160.01
14	27N	11WIM	6.89	20-Jul-92	1166.11
14	27N	11WIM	0.00	01-Dec-92	0.00
23	27N	11WIM	8.36	20-Jul-92	1167.64
23	27N	11WIM	0.00	01-Dec-92	0.00
31	27N	11WIM	22.65	20-Jul-92	1212.35
31	27N	11WIM	18.48	01-Dec-92	1216.52
26	27N	12WIM	18.78	20-Jul-92	1232.22
26	27N	12WIM	17.84	01-Dec-92	1233.16
11	28N	10WIM	8.45	20-Jul-92	1181.55
11	28N	10WIM	7.63	01-Dec-92	1182.37
10	28N	11WIM	8.67	20-Jul-92	1202.33
10	28N	11WIM	7.78	01-Dec-92	1203.22
19	28N	11WIM	13.40	20-Jul-92	1197.60
19	28N	11WIM	12.98	01-Dec-92	1198.02
31	28N	11WIM	4.92	20-Jul-92	1201.08
31	28N	11WIM	2.89	01-Dec-92	1203.11
29	28N	12WIM	0.00	20-Jul-92	0.00
29	28N	12WIM	0.00	01-Dec-92	0.00
18	29N	09WIM	6.27	20-Jul-92	1202.73
18	29N	09WIM	6.43	01-Dec-92	1202.57
30	29N	10WIM	22.39	20-Jul-92	1213.61
30	29N	10WIM	0.00	10-Dec-92	0.00

APPENDIX C

Explanation of Legend for Appendix C

XL - Downgradient capture zone or null point.

YL - Extent of capture zone cross gradient.

Q/S - Specific Capacity in gallons/ft of drawdown.

DD - Drawdown.

Direction - specifies the direction in relation to gradient that was considered most sensitive in determining sensitivities based on the site specific conditions based on location of the source. The three abbreviations listed below apply.

XL - As explined above.
YL - As explined above.
UG - Upgradient

Appendix C.

SEC	TWP-RGE	TRANS. Ft_2/ day	GRAD- IENT	XL@ 100 gpm	YL@ 100 gpm	XL@ 250 gpm	YL@ 250 gpm	XL@ 500 gpm	YL@ 500 gpm	XL@ 1000 gpm	YL@ 1000 gpm	Q/S	DD@ 100 gpm	DD@ 250 gpm	DD@ 500 gpm	DD@ 1000 gpm	DIREC- TION	SENS CLASS
3	24N-01E	2500	0.0025	490	1540	1225	3850	2451	7700	*	*	12.0	8	20	40	*	XL	1
4	24N-01E	2500	0.0025	490	1540	1225	3850	2451	7700	*	*	12.0	8	20	40	*	XL	1
5	24N-01E	2500	0.0025	490	1540	1225	3850	2451	7700	*	*	12.0	8	20	40	*	XL	1
3	24N-02E	1500	0.0023	888	2790	2220	6975	*	*	*	*	7.5	13	33	*	*	XL	2
4	24N-02E	1925	0.0023	692	2174	1730	5435	*	*	*	*	9.6	10	26	*	*	XL	2
5	24N-02E	2525	0.0023	528	1657	1319	4143	2638	8287	*	*	13.0	8	20	40	*	XL	2
6	24N-02E	2400	0.0023	555	1744	1388	4359	2775	8718	*	*	12.0	8	21	42	*	XL	2
8	24N-02E	2000	0.0023	666	2092	1665	5231	3330	10462	*	*	10.0	10	25	50	*	XL	2
9	24N-02E	1800	0.0023	740	2325	1850	5812	*	*	*	*	9.0	11	28	*	*	XL	2
10	24N-02E	900	0.0023	1480	4650	*	*	*	*	*	*	4.5	22	*	*	*	XL	3
7	25N-01E	2400	0.0047	272	853	679	2133	1358	4266	*	*	12.0	8	21	42	*	XL	1
17	25N-01E	1700	0.0030	601	1887	1502	4718	*	*	*	*	8.5	12	29	*	*	XL	2
18	25N-01E	1825	0.0047	357	1122	893	2805	*	*	*	*	9.1	11	27	*	*	XL	1
19	25N-01E	1900	0.0030	538	1689	1344	4222	*	*	*	*	9.5	11	26	*	*	XL	2
20	25N-01E	1800	0.0030	567	1782	1418	4456	*	*	*	*	9.0	11	28	*	*	XL	2
21	25N-01E	1675	0.0025	732	2299	1829	5746	*	*	*	*	8.4	12	30	*	*	XL	2
23	25N-01E	2800	0.0025	438	1375	1094	3438	2188	6875	*	*	14.0	7	18	36	*	XL	1
24	25N-01E	2400	0.0025	511	1604	1277	4010	2553	8021	*	*	12.0	8	21	42	*	XL	2
25	25N-01E	5500	0.0025	223	700	557	1750	1114	3500	2228	7000	27.0	4	9	18	36	XL	1
26	25N-01E	4750	0.0025	258	811	645	2026	1290	4053	2580	8105	24.0	4	11	21	42	XL	1
27	25N-01E	3600	0.0025	340	1069	851	2674	1702	5347	*	*	18.0	6	14	28	*	XL	1
28	25N-01E	2625	0.0025	467	1467	1167	3667	2334	7333	*	*	13.0	8	19	38	*	XL	1
29	25N-01E	1925	0.0025	637	2000	1592	5000	*	*	*	*	9.6	10	26	*	*	XL	2
30	25N-01E	2400	0.0025	511	1604	1277	4010	2553	8021	*	*	12.0	8	21	42	*	XL	2
31	25N-01E	2675	0.0025	458	1439	1145	3598	2291	7196	*	*	13.0	7	19	37	*	XL	1
32	25N-01E	2300	0.0025	533	1674	1332	4185	2664	8370	*	*	11.0	9	22	44	*	XL	2
33	25N-01E	2225	0.0025	551	1730	1377	4326	2754	8652	*	*	11.0	9	23	45	*	XL	2
34	25N-01E	2975	0.0025	412	1294	1030	3235	2060	6471	*	*	15.0	7	17	34	*	XL	1
35	25N-01E	4000	0.0025	306	963	766	2406	1532	4813	3064	9625	20.0	5	13	25	50	XL	1
36	25N-01E	4330	0.0025	283	889	708	2223	1415	4446	2830	8892	22.0	5	12	23	46	XL	1
3	25N-01W	1600	0.0015	1277	4010	3191	10026	*	*	*	*	8.0	13	31	*	*	XL	3
4	25N-01W	1875	0.0015	1089	3422	2723	8556	*	*	*	*	9.4	11	27	*	*	XL	3
5	25N-01W	2550	0.0015	801	2516	2002	6291	4005	12582	*	*	13.0	8	20	39	*	XL	2
6	25N-01W	2625	0.0015	778	2444	1945	6111	3890	12222	*	*	13.0	8	19	38	*	XL	2
7	25N-01W	2575	0.0015	793	2492	1983	6230	3966	12460	*	*	13.0	8	19	39	*	XL	2
8	25N-01W	2350	0.0015	869	2731	2173	6826	4346	13652	*	*	12.0	9	21	43	*	XL	2
9	25N-01W	1400	0.0035	625	1964	1563	4911	*	*	*	*	7.0	14	36	*	*	XL	2
10	25N-01W	2275	0.0035	385	1209	962	3022	1924	6044	*	*	11.0	9	22	44	*	XL	1
11	25N-01W	3250	0.0035	269	846	673	2115	1347	4231	*	*	16.0	6	15	31	*	XL	1
12	25N-01W	1750	0.0047	373	1170	931	2926	*	*	*	*	8.7	11	29	*	*	XL	1
13	25N-01W	1450	0.0047	450	1412	1124	3531	*	*	*	*	7.2	14	35	*	*	XL	1
14	25N-01W	3450	0.0035	254	797	634	1993	1269	3986	*	*	17.0	6	15	29	*	XL	1
15	25N-01W	4200	0.0035	208	655	521	1637	1042	3274	2084	6548	21.0	5	12	24	48	XL	1
16	25N-01W	1650	0.0035	531	1667	1326	4167	*	*	*	*	8.2	12	30	*	*	XL	2
17	25N-01W	750	0.0020	2042	6417	*	*	*	*	*	*	3.7	27	*	*	*	XL	4
18	25N-01W	1250	0.0020	1225	3850	3064	9625	*	*	*	*	6.2	16	40	*	*	XL	3
20	25N-01W	500	0.0025	2451	7700	*	*	*	*	*	*	2.5	40	*	*	*	XL	4
21	25N-01W	1325	0.0025	925	2906	2312	7264	*	*	*	*	6.6	15	38	*	*	XL	2
22	25N-01W	1750	0.0025	700	2200	1751	5500	*	*	*	*	8.7	11	29	*	*	XL	2
23	25N-01W	2200	0.0025	557	1750	1393	4375	2785	8750	*	*	11.0	9	23	46	*	XL	2
24	25N-01W	3650	0.0025	336	1055	839	2637	1679	5274	*	*	18.0	5	14	27	*	XL	1
25	25N-01W	6250	0.0025	196	616	490	1540	980	3080	1961	6160	31.0	3	8	16	32	XL	1
36	25N-01W	2725	0.0025	450	1413	1124	3532	2249	7064	*	*	14.0	7	18	37	*	XL	1

Appendix C.

SEC	TWP-RGE	TRANS. Ft_2/ day	GRAD-IENT	XL@ 100 gpm	YL@ 100 gpm	XL@ 250 gpm	YL@ 250 gpm	XL@ 500 gpm	YL@ 500 gpm	XL@ 1000 gpm	YL@ 1000 gpm	Q/S	DD@ 100 gpm	DD@ 250 gpm	DD@ 500 gpm	DD@ 1000 gpm	DIREC-TION	SENS CLASS
15	25N-02E	2105	0.0023	633	1988	1582	4970	3164	9940	*	*	10.0	10	24	48	*	XL	2
16	25N-02E	1075	0.0023	1239	3893	3098	9732	*	*	*	*	5.4	19	47	*	*	XL	3
17	25N-02E	1275	0.0023	1045	3282	2612	8206	*	*	*	*	6.4	16	39	*	*	XL	3
18	25N-02E	1100	0.0023	1211	3804	3027	9511	*	*	*	*	5.5	18	46	*	*	XL	3
19	25N-02E	2875	0.0023	463	1456	1158	3639	2317	7278	*	*	14.0	7	17	35	*	XL	1
20	25N-02E	3225	0.0023	413	1298	1033	3244	2065	6488	*	*	16.0	6	16	31	*	XL	1
21	25N-02E	1325	0.0023	1005	3158	2513	7896	*	*	*	*	6.6	15	38	*	*	XL	3
22	25N-02E	1550	0.0023	859	2700	2148	6750	*	*	*	*	7.7	13	32	*	*	XL	2
27	25N-02E	2550	0.0023	522	1641	1306	4103	2612	8206	*	*	13.0	8	20	39	*	XL	2
28	25N-02E	3425	0.0023	389	1222	972	3055	1945	6109	*	*	17.0	6	15	29	*	XL	1
29	25N-02E	5300	0.0023	251	790	628	1974	1257	3948	2513	7896	26.0	4	9	19	38	XL	1
30	25N-02E	3875	0.0023	344	1080	859	2700	1719	5400	*	*	19.0	5	13	26	*	XL	1
31	25N-02E	4150	0.0023	321	1008	802	2521	1605	5042	3210	10084	21.0	5	12	24	48	XL	1
32	25N-02E	4400	0.0023	303	951	757	2378	1514	4755	3027	9511	22.0	5	11	23	46	XL	1
33	25N-02E	4900	0.0023	272	854	680	2135	1359	4270	2719	8540	24.0	4	10	20	41	XL	1
34	25N-02E	1895	0.0023	703	2208	1757	5521	*	*	*	*	9.4	11	26	*	*	XL	2
1	25N-02W	5250	0.0020	292	917	730	2292	1459	4583	2918	9167	26.0	4	10	19	38	XL	1
2	25N-02W	1875	0.0020	817	2567	2042	6417	*	*	*	*	9.4	11	27	*	*	XL	2
3	25N-02W	1625	0.0020	943	2962	2357	7404	*	*	*	*	8.1	12	31	*	*	XL	2
4	25N-02W	2850	0.0020	538	1689	1344	4222	2687	8443	*	*	14.0	7	18	35	*	XL	2
5	25N-02W	1575	0.0020	973	3056	2432	7639	*	*	*	*	7.9	13	32	*	*	XL	2
7	25N-02W	2100	0.0020	730	2292	1824	5729	3647	11458	*	*	10.0	10	24	48	*	XL	2
8	25N-02W	1750	0.0020	875	2750	2188	6875	*	*	*	*	8.7	11	29	*	*	XL	2
9	25N-02W	4825	0.0020	318	997	794	2494	1587	4987	3175	9974	24.0	4	10	21	42	XL	1
10	25N-02W	4000	0.0020	383	1203	957	3008	1915	6016	3830	12031	20.0	5	13	25	50	XL	1
11	25N-02W	2700	0.0020	567	1782	1418	4456	2837	8912	*	*	13.0	7	19	37	*	XL	2
12	25N-02W	2200	0.0020	696	2188	1741	5469	3482	10938	*	*	11.0	9	23	46	*	XL	2
13	25N-02W	1500	0.0020	1021	3208	2553	8021	*	*	*	*	7.5	13	33	*	*	XL	3
17	25N-02W	1500	0.0020	1021	3208	2553	8021	*	*	*	*	7.5	13	33	*	*	XL	3
18	25N-02W	670	0.0020	2286	7183	*	*	*	*	*	*	3.3	30	*	*	*	XL	4
19	25N-02W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
1	25N-03W	3000	0.0020	511	1604	1277	4010	2553	8021	*	*	15.0	7	17	33	*	XL	2
2	25N-03W	1500	0.0020	1021	3208	2553	8021	*	*	*	*	7.5	13	33	*	*	XL	3
3	25N-03W	2500	0.0020	613	1925	1532	4813	3064	9625	*	*	12.0	8	20	40	*	XL	2
4	25N-03W	1825	0.0020	839	2637	2098	6593	*	*	*	*	9.1	11	27	*	*	XL	2
5	25N-03W	2450	0.0020	625	1964	1563	4911	3126	9821	*	*	12.0	8	20	41	*	XL	2
6	25N-03W	4750	0.0020	323	1013	806	2533	1612	5066	3225	10132	24.0	4	11	21	42	XL	1
7	25N-03W	3300	0.0020	464	1458	1161	3646	2321	7292	*	*	16.0	6	15	30	*	XL	1
8	25N-03W	1430	0.0020	1071	3365	2678	8414	*	*	*	*	7.1	14	35	*	*	XL	3
9	25N-03W	1350	0.0020	1135	3565	2837	8912	*	*	*	*	6.7	15	37	*	*	XL	3
10	25N-03W	1350	0.0020	1135	3565	2837	8912	*	*	*	*	6.7	15	37	*	*	XL	3
11	25N-03W	2000	0.0020	766	2406	1915	6016	3830	12031	*	*	10.0	10	25	50	*	XL	2
12	25N-03W	4175	0.0020	367	1153	917	2882	1835	5764	3669	11527	21.0	5	12	24	48	XL	1
13	25N-03W	5000	0.0020	306	963	766	2406	1532	4813	3064	9625	25.0	4	10	20	40	XL	1
14	25N-03W	2400	0.0020	638	2005	1596	5013	3191	10026	*	*	12.0	8	21	42	*	XL	2
15	25N-03W	1000	0.0020	1532	4813	3830	12031	*	*	*	*	5.0	20	50	*	*	XL	3
16	25N-03W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
17	25N-03W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
18	25N-03W	1000	0.0020	1532	4813	3830	12031	*	*	*	*	5.0	20	50	*	*	XL	3
22	25N-03W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
24	25N-03W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
1	25N-04W	4500	0.0015	454	1426	1135	3565	2269	7130	4539	14259	22.0	4	11	22	45	XL	1
2	25N-04W	1725	0.0015	1184	3720	2960	9300	*	*	*	*	8.6	12	29	*	*	XL	3

Appendix C.

SEC	TWP-RGE	TRANS. Ft_2/ day	GRAD- IENT	XL@ 100 gpm	YL@ 100 gpm	XL@ 250 gpm	YL@ 250 gpm	XL@ 500 gpm	YL@ 500 gpm	XL@ 1000 gpm	YL@ 1000 gpm	Q/S	DD@ 100 gpm	DD@ 250 gpm	DD@ 500 gpm	DD@ 1000 gpm	DIREC- TION	SENS CLASS
3	25N-04W	3250	0.0015	629	1974	1571	4936	3142	9872	*	*	16.0	6	15	31	*	XL	2
4	25N-04W	3025	0.0015	675	2121	1688	5303	3376	10606	*	*	15.0	7	17	33	*	XL	2
7	25N-04W	1000	0.0015	2042	6417	5106	16042	*	*	*	*	5.0	20	50	*	*	XL	4
8	25N-04W	1500	0.0015	1362	4278	3404	10694	*	*	*	*	7.5	13	33	*	*	XL	3
9	25N-04W	3550	0.0015	575	1808	1438	4519	2877	9038	*	*	18.0	6	14	28	*	XL	2
10	25N-04W	3000	0.0015	681	2139	1702	5347	3404	10694	*	*	15.0	7	17	33	*	XL	2
11	25N-04W	2300	0.0015	888	2790	2220	6975	4440	13949	*	*	11.0	9	22	44	*	XL	2
12	25N-04W	6875	0.0015	297	933	743	2333	1485	4667	2971	9333	34.0	3	7	15	29	XL	1
13	25N-04W	2300	0.0015	888	2790	2220	6975	4440	13949	*	*	11.0	9	22	44	*	XL	2
14	25N-04W	1400	0.0015	1459	4583	3647	11458	*	*	*	*	7.0	14	36	*	*	XL	3
15	25N-04W	1500	0.0015	1362	4278	3404	10694	*	*	*	*	7.5	13	33	*	*	XL	3
16	25N-04W	1600	0.0013	1473	4627	3682	11569	*	*	*	*	8.0	13	31	*	*	XL	3
17	25N-04W	1000	0.0013	2357	7404	5892	18510	*	*	*	*	5.0	20	50	*	*	XL	4
18	25N-04W	500	0.0013	4713	14808	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
20	25N-04W	500	0.0013	4713	14808	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
21	25N-04W	500	0.0013	4713	14808	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
23	25N-04W	500	0.0013	4713	14808	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
24	25N-04W	500	0.0013	4713	14808	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
1	25N-05W	500	0.0015	4085	12833	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
2	25N-05W	875	0.0015	2334	7333	*	*	*	*	*	*	4.4	23	*	*	*	XL	4
3	25N-05W	1725	0.0015	1184	3720	2960	9300	*	*	*	*	8.6	12	29	*	*	XL	3
4	25N-05W	1600	0.0015	1277	4010	3191	10026	*	*	*	*	8.0	13	31	*	*	XL	3
5	25N-05W	1600	0.0015	1277	4010	3191	10026	*	*	*	*	8.0	13	31	*	*	XL	3
6	25N-05W	1575	0.0015	1297	4074	3242	10185	*	*	*	*	7.9	13	32	*	*	XL	3
7	25N-05W	500	0.0015	4085	12833	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
8	25N-05W	700	0.0015	2918	9167	*	*	*	*	*	*	3.5	29	*	*	*	XL	4
9	25N-05W	900	0.0015	2269	7130	*	*	*	*	*	*	4.5	22	*	*	*	XL	4
10	25N-05W	900	0.0015	2269	7130	*	*	*	*	*	*	4.5	22	*	*	*	XL	4
11	25N-05W	700	0.0015	2918	9167	*	*	*	*	*	*	3.5	29	*	*	*	XL	4
12	25N-05W	500	0.0015	4085	12833	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
13	25N-05W	500	0.0015	4085	12833	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
15	25N-05W	600	0.0015	3404	10694	*	*	*	*	*	*	3.0	33	*	*	*	XL	5
16	25N-05W	600	0.0015	3404	10694	*	*	*	*	*	*	3.0	33	*	*	*	XL	5
17	25N-05W	500	0.0015	4085	12833	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
18	25N-05W	500	0.0015	4085	12833	*	*	*	*	*	*	2.5	40	*	*	*	XL	6
1	25N-06W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
12	25N-06W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
13	25N-06W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
4	25N-09W	1225	0.0125	200	629	500	1571	*	*	*	*	6.1	16	41	*	*	XL	1
5	25N-09W	1650	0.0150	124	389	310	972	*	*	*	*	8.2	12	30	*	*	XL	1
6	25N-09W	1500	0.0100	204	642	511	1604	*	*	*	*	7.5	13	33	*	*	XL	1
7	25N-09W	500	0.0100	613	1925	*	*	*	*	*	*	2.5	40	*	*	*	XL	2
8	25N-09W	900	0.0150	227	713	*	*	*	*	*	*	4.5	22	*	*	*	XL	1
9	25N-09W	750	0.0075	545	1711	*	*	*	*	*	*	3.7	27	*	*	*	XL	2
16	25N-09W	500	0.0075	817	2567	*	*	*	*	*	*	2.5	40	*	*	*	XL	2
17	25N-09W	500	0.0150	409	1283	*	*	*	*	*	*	2.5	40	*	*	*	XL	1
18	25N-09W	500	0.0075	817	2567	*	*	*	*	*	*	2.5	40	*	*	*	XL	2
1	25N-10W	675	0.0100	454	1426	*	*	*	*	*	*	3.4	30	*	*	*	YL	3
4	25N-10W	3000	0.0070	146	458	365	1146	730	2292	*	*	15.0	7	17	33	*	YL	1
5	25N-10W	4050	0.0050	151	475	378	1188	757	2377	1513	4753	20.0	5	12	25	50	XL	1
6	25N-10W	3000	0.0050	204	642	511	1604	1021	3208	*	*	15.0	7	17	33	*	YL	2
12	25N-10W	500	0.0050	1225	3850	*	*	*	*	*	*	2.5	40	*	*	*	XL	3
1	25N-11W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	YL	6

Appendix C.

SEC	TWP-RGE	TRANS. Ft_2/ day	GRAD- IENT	XL@ 100 gpm	YL@ 100 gpm	XL@ 250 gpm	YL@ 250 gpm	XL@ 500 gpm	YL@ 500 gpm	XL@ 1000 gpm	YL@ 1000 gpm	Q/S	DD@ 100 gpm	DD@ 250 gpm	DD@ 500 gpm	DD@ 1000 gpm	DIREC- TION	SENS CLASS
2	25N-11W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	UG	6
3	25N-11W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
4	25N-11W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
5	25N-11W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
10	25N-11W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
11	25N-11W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
12	25N-11W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
31	26N-01W	6025	0.0035	145	456	363	1141	726	2282	1453	4564	30.0	3	8	17	33	XL	1
32	26N-01W	2850	0.0035	307	965	768	2412	1536	4825	*	*	14.0	7	18	35	*	XL	1
33	26N-01W	3150	0.0035	278	873	695	2183	1389	4365	*	*	16.0	6	16	32	*	XL	1
25	26N-02W	3325	0.0020	461	1447	1152	3618	2304	7237	*	*	17.0	6	15	30	*	XL	1
26	26N-02W	1600	0.0020	957	3008	2394	7520	*	*	*	*	8.0	13	31	*	*	XL	2
34	26N-02W	650	0.0020	2357	7404	*	*	*	*	*	*	3.2	31	*	*	*	XL	4
35	26N-02W	1525	0.0020	1005	3156	2511	7889	*	*	*	*	7.6	13	33	*	*	XL	3
36	26N-02W	4500	0.0020	340	1069	851	2674	1702	5347	3404	10694	22.0	4	11	22	45	XL	1
31	26N-03W	1750	0.0013	1347	4231	3367	10577	*	*	*	*	8.7	11	29	*	*	XL	3
32	26N-03W	1625	0.0013	1450	4556	3626	11391	*	*	*	*	8.1	12	31	*	*	XL	3
33	26N-03W	2100	0.0013	1122	3526	2806	8814	5611	17628	*	*	10.0	10	24	48	*	XL	3
34	26N-03W	4175	0.0013	565	1773	1411	4433	2822	8867	5645	17734	21.0	5	12	24	48	XL	2
35	26N-03W	1150	0.0013	2049	6438	5123	16095	*	*	*	*	5.7	17	44	*	*	XL	4
36	26N-03W	1175	0.0013	2006	6301	5014	15753	*	*	*	*	5.9	17	43	*	*	XL	4
30	26N-05W	3125	0.0015	654	2053	1634	5133	3268	10267	*	*	16.0	6	16	32	*	XL	2
31	26N-05W	5000	0.0015	409	1283	1021	3208	2042	6417	4085	12833	25.0	4	10	20	40	XL	1
33	26N-05W	8750	0.0015	233	733	584	1833	1167	3667	2334	7333	44.0	2	6	11	23	XL	1
34	26N-05W	7250	0.0015	282	885	704	2213	1409	4425	2817	8851	36.0	3	7	14	28	XL	1
35	26N-05W	3075	0.0015	664	2087	1661	5217	3321	10434	*	*	15.0	7	16	33	*	XL	2
36	26N-05W	950	0.0015	2150	6754	*	*	*	*	*	*	4.7	21	*	*	*	XL	4
7	26N-06W	750	0.0020	2042	6417	*	*	*	*	*	*	3.7	27	*	*	*	XL	4
8	26N-06W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
17	26N-06W	1400	0.0020	1094	3438	2735	8594	*	*	*	*	7.0	14	36	*	*	XL	3
18	26N-06W	3050	0.0020	502	1578	1256	3945	2511	7889	*	*	15.0	7	16	33	*	XL	2
19	26N-06W	1875	0.0020	817	2567	2042	6417	*	*	*	*	9.4	11	27	*	*	XL	2
20	26N-06W	550	0.0020	2785	8750	*	*	*	*	*	*	2.7	36	*	*	*	XL	4
21	26N-06W	1500	0.0020	1021	3208	2553	8021	*	*	*	*	7.5	13	33	*	*	XL	3
22	26N-06W	8000	0.0020	192	602	479	1504	957	3008	1915	6016	40.0	3	6	13	25	XL	1
23	26N-06W	8500	0.0020	180	566	451	1415	901	2831	1802	5662	42.0	2	6	12	24	XL	1
25	26N-06W	2750	0.0020	557	1750	1393	4375	2785	8750	*	*	14.0	7	18	36	*	XL	2
26	26N-06W	3450	0.0020	444	1395	1110	3487	2220	6975	*	*	17.0	6	15	29	*	XL	1
27	26N-06W	1375	0.0020	1114	3500	2785	8750	*	*	*	*	6.9	15	36	*	*	XL	3
28	26N-06W	1000	0.0020	1532	4813	3830	12031	*	*	*	*	5.0	20	50	*	*	XL	3
29	26N-06W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
30	26N-06W	875	0.0020	1751	5500	*	*	*	*	*	*	4.4	23	*	*	*	XL	3
32	26N-06W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
33	26N-06W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
34	26N-06W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
35	26N-06W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
36	26N-06W	750	0.0020	2042	6417	*	*	*	*	*	*	3.7	27	*	*	*	XL	4
12	26N-07W	3000	0.0020	511	1604	1277	4010	2553	8021	*	*	15.0	7	17	33	*	XL	2
13	26N-07W	5250	0.0020	292	917	730	2292	1459	4583	2918	9167	26.0	4	10	19	38	XL	1
14	26N-07W	6250	0.0020	245	770	613	1925	1225	3850	2451	7700	31.0	3	8	16	32	XL	1
15	26N-07W	1525	0.0020	1005	3156	2511	7889	*	*	*	*	7.6	13	33	*	*	XL	3
16	26N-07W	1425	0.0020	1075	3377	2687	8443	*	*	*	*	7.1	14	35	*	*	XL	3
17	26N-07W	525	0.0020	2918	9167	*	*	*	*	*	*	2.6	38	*	*	*	XL	4

Appendix C.

SEC	TWP-RGE	TRANS. Ft_2/ day	GRAD-IENT	XL@ 100 gpm	YL@ 100 gpm	XL@ 250 gpm	YL@ 250 gpm	XL@ 500 gpm	YL@ 500 gpm	XL@ 1000 gpm	YL@ 1000 gpm	Q/S	DD@ 100 gpm	DD@ 250 gpm	DD@ 500 gpm	DD@ 1000 gpm	DIREC-TION	SENS CLASS
18	26N-07W	3600	0.0020	426	1337	1064	3342	2128	6684	*	*	18.0	6	14	28	*	XL	1
19	26N-07W	4200	0.0020	365	1146	912	2865	1824	5729	3647	11458	21.0	5	12	24	48	XL	1
20	26N-07W	1100	0.0020	1393	4375	3482	10938	*	*	*	*	5.5	18	46	*	*	XL	3
21	26N-07W	975	0.0020	1571	4936	*	*	*	*	*	*	4.9	21	*	*	*	XL	3
22	26N-07W	1750	0.0020	875	2750	2188	6875	*	*	*	*	8.7	11	29	*	*	XL	2
23	26N-07W	5000	0.0020	306	963	766	2406	1532	4813	3064	9625	25.0	4	10	20	40	XL	1
24	26N-07W	4750	0.0020	323	1013	806	2533	1612	5066	3225	10132	24.0	4	11	21	42	XL	1
25	26N-07W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
26	26N-07W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
27	26N-07W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
28	26N-07W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
29	26N-07W	700	0.0020	2188	6875	*	*	*	*	*	*	3.5	29	*	*	*	XL	4
30	26N-07W	1250	0.0020	1225	3850	3064	9625	*	*	*	*	6.2	16	40	*	*	XL	3
31	26N-07W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
5	26N-08W	9000	0.0045	76	238	189	594	378	1188	756	2377	45.0	2	6	11	22	XL	1
6	26N-08W	7000	0.0014	308	968	771	2421	1541	4842	3082	9683	35.0	3	7	14	29	XL	1
7	26N-08W	5000	0.0070	88	275	219	688	438	1375	875	2750	25.0	4	10	20	40	XL	1
8	26N-08W	5250	0.0035	167	524	417	1310	834	2619	1667	5238	26.0	4	10	19	38	XL	1
17	26N-08W	1500	0.0035	584	1833	1459	4583	*	*	*	*	7.5	13	33	*	*	XL	2
18	26N-08W	1250	0.0035	700	2200	1751	5500	*	*	*	*	6.2	16	40	*	*	XL	2
19	26N-08W	500	0.0035	1751	5500	*	*	*	*	*	*	2.5	40	*	*	*	XL	3
20	26N-08W	500	0.0030	2042	6417	*	*	*	*	*	*	2.5	40	*	*	*	XL	4
21	26N-08W	1200	0.0030	851	2674	2128	6684	*	*	*	*	6.0	17	42	*	*	XL	2
22	26N-08W	4750	0.0048	134	422	336	1055	672	2111	1344	4222	24.0	4	11	21	42	XL	1
23	26N-08W	4500	0.0040	170	535	426	1337	851	2674	1702	5347	22.0	4	11	22	45	XL	1
24	26N-08W	4400	0.0020	348	1094	870	2734	1741	5469	3482	10938	22.0	5	11	23	46	XL	1
25	26N-08W	1500	0.0020	1021	3208	2553	8021	*	*	*	*	7.5	13	33	*	*	XL	3
26	26N-08W	600	0.0020	2553	8021	*	*	*	*	*	*	3.0	33	*	*	*	XL	4
27	26N-08W	900	0.0020	1702	5347	*	*	*	*	*	*	4.5	22	*	*	*	XL	3
28	26N-08W	1000	0.0020	1532	4813	3830	12031	*	*	*	*	5.0	20	50	*	*	XL	3
29	26N-08W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
30	26N-08W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
35	26N-08W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
36	26N-08W	500	0.0020	3064	9625	*	*	*	*	*	*	2.5	40	*	*	*	XL	5
1	26N-09W	5600	0.0028	195	614	489	1535	977	3069	1954	6138	28.0	4	9	18	36	XL	1
2	26N-09W	5500	0.0023	242	761	606	1902	1211	3804	2422	7609	27.0	4	9	18	36	XL	1
3	26N-09W	3750	0.0063	130	407	324	1019	648	2037	*	*	19.0	5	13	27	*	XL	1
11	26N-09W	750	0.0030	1362	4278	*	*	*	*	*	*	3.7	27	*	*	*	XL	3
12	26N-09W	450	0.0030	2269	7130	*	*	*	*	*	*	2.2	45	*	*	*	XL	4
13	26N-09W	400	0.0074	1035	3252	*	*	*	*	*	*	2.0	50	*	*	*	XL	3
14	26N-09W	300	0.0030	*	*	*	*	*	*	*	*	1.5	*	*	*	*	XL	5
15	26N-09W	1700	0.0050	360	1132	901	2831	*	*	*	*	8.5	12	29	*	*	XL	1
21	26N-09W	2700	0.0070	162	509	405	1273	811	2546	*	*	13.0	7	19	37	*	XL	1
22	26N-09W	2150	0.0050	285	895	713	2238	1425	4477	*	*	11.0	9	23	47	*	XL	1
23	26N-09W	300	0.0050	*	*	*	*	*	*	*	*	1.5	*	*	*	*	XL	4
27	26N-09W	1900	0.0030	538	1689	1344	4222	*	*	*	*	9.5	11	26	*	*	XL	2
28	26N-09W	3000	0.0050	204	642	511	1604	1021	3208	*	*	15.0	7	17	33	*	XL	1
29	26N-09W	1375	0.0070	318	1000	796	2500	*	*	*	*	6.9	15	36	*	*	XL	1
31	26N-09W	2000	0.0030	511	1604	1277	4010	2553	8021	*	*	10.0	10	25	50	*	XL	2
32	26N-09W	2000	0.0030	511	1604	1277	4010	2553	8021	*	*	10.0	10	25	50	*	XL	2
33	26N-09W	3000	0.0030	340	1069	851	2674	1702	5347	*	*	15.0	7	17	33	*	XL	1
6	26N-10W	1050	0.0016	1824	5729	4559	14323	*	*	*	*	5.2	19	48	*	*	YL	6
7	26N-10W	3375	0.0018	504	1584	1261	3961	2522	7922	*	*	17.0	6	15	30	*	UG	6

Appendix C.

SEC	TWP-RGE	TRANS. Ft_2/ day	GRAD-IENT	XL@ 100 gpm	YL@ 100 gpm	XL@ 250 gpm	YL@ 250 gpm	XL@ 500 gpm	YL@ 500 gpm	XL@ 1000 gpm	YL@ 1000 gpm	Q/S	DD@ 100 gpm	DD@ 250 gpm	DD@ 500 gpm	DD@ 1000 gpm	DIREC-TION	SENS CLASS
20	26N-10W	1200	0.0022	1161	3645	2901	9114	*	*	*	*	6.0	17	42	*	*	YL	5
21	26N-10W	1200	0.0022	1161	3645	2901	9114	*	*	*	*	6.0	17	42	*	*	YL	5
27	26N-10W	1925	0.0022	723	2273	1809	5682	*	*	*	*	9.6	10	26	*	*	XL	2
28	26N-10W	2450	0.0022	568	1786	1421	4464	2842	8929	*	*	12.0	8	20	41	*	YL	3
29	26N-10W	1700	0.0022	819	2574	2048	6434	*	*	*	*	8.5	12	29	*	*	YL	4
30	26N-10W	1500	0.0022	928	2917	2321	7292	*	*	*	*	7.5	13	33	*	*	YL	4
31	26N-10W	1500	0.0032	638	2005	1596	5013	*	*	*	*	7.5	13	33	*	*	XL	2
32	26N-10W	3000	0.0027	378	1188	946	2971	1891	5941	*	*	15.0	7	17	33	*	XL	1
33	26N-10W	4025	0.0022	346	1087	865	2717	1730	5435	3460	10870	20.0	5	12	25	50	XL	1
34	26N-10W	2575	0.0024	496	1557	1239	3894	2479	7787	*	*	13.0	8	19	39	*	XL	1
1	26N-11W	1125	0.0014	1945	6111	4863	15278	*	*	*	*	5.6	18	45	*	*	YL	6
2	26N-11W	750	0.0014	2918	9167	*	*	*	*	*	*	3.7	27	*	*	*	YL	6
3	26N-11W	825	0.0014	2653	8333	*	*	*	*	*	*	4.1	24	*	*	*	YL	6
4	26N-11W	1850	0.0022	753	2365	1882	5912	*	*	*	*	9.2	11	27	*	*	YL	4
5	26N-11W	875	0.0022	1592	5000	*	*	*	*	*	*	4.4	23	*	*	*	YL	6
6	26N-11W	300	0.0031	*	*	*	*	*	*	*	*	1.5	*	*	*	*	YL	6
7	26N-11W	100	0.0031	*	*	*	*	*	*	*	*	0.5	*	*	*	*	YL	6
8	26N-11W	100	0.0019	*	*	*	*	*	*	*	*	0.5	*	*	*	*	YL	6
9	26N-11W	150	0.0020	*	*	*	*	*	*	*	*	0.7	*	*	*	*	YL	6
10	26N-11W	200	0.0018	*	*	*	*	*	*	*	*	1.0	*	*	*	*	YL	6
11	26N-11W	1250	0.0018	1362	4278	3404	10694	*	*	*	*	6.2	16	40	*	*	YL	6
12	26N-11W	2900	0.0018	587	1844	1467	4610	2935	9219	*	*	14.0	7	17	35	*	UG	6
15	26N-11W	650	0.0018	2619	8227	*	*	*	*	*	*	3.2	31	*	*	*	YL	6
16	26N-11W	125	0.0019	*	*	*	*	*	*	*	*	0.6	*	*	*	*	YL	6
17	26N-11W	100	0.0023	*	*	*	*	*	*	*	*	0.5	*	*	*	*	YL	6
18	26N-11W	100	0.0031	*	*	*	*	*	*	*	*	0.5	*	*	*	*	YL	6
19	26N-11W	100	0.0031	*	*	*	*	*	*	*	*	0.5	*	*	*	*	YL	6
30	26N-11W	100	0.0025	*	*	*	*	*	*	*	*	0.5	*	*	*	*	XL	6
31	26N-11W	100	0.0025	*	*	*	*	*	*	*	*	0.5	*	*	*	*	XL	6
32	26N-11W	100	0.0025	*	*	*	*	*	*	*	*	0.5	*	*	*	*	XL	6
35	26N-11W	500	0.0025	2451	7700	*	*	*	*	*	*	2.5	40	*	*	*	YL	6
36	26N-11W	1000	0.0025	1225	3850	3064	9625	*	*	*	*	5.0	20	50	*	*	UG	6
1	26N-12W	90	0.0031	*	*	*	*	*	*	*	*	0.4	*	*	*	*	YL	6
2	26N-12W	100	0.0031	*	*	*	*	*	*	*	*	0.5	*	*	*	*	YL	6
12	26N-12W	100	0.0031	*	*	*	*	*	*	*	*	0.5	*	*	*	*	YL	6
13	26N-12W	100	0.0031	*	*	*	*	*	*	*	*	0.5	*	*	*	*	XL	6
24	26N-12W	100	0.0031	*	*	*	*	*	*	*	*	0.5	*	*	*	*	XL	6
25	26N-12W	100	0.0025	*	*	*	*	*	*	*	*	0.5	*	*	*	*	XL	6
36	26N-12W	100	0.0025	*	*	*	*	*	*	*	*	0.5	*	*	*	*	XL	6
31	27N-08W	2300	0.0075	178	558	444	1395	888	2790	*	*	11.0	9	22	44	*	XL	1
32	27N-08W	6625	0.0075	62	194	154	484	308	969	617	1937	33.0	3	8	15	30	XL	1
4	27N-09W	6825	0.0095	47	148	118	371	236	742	473	1485	34.0	3	7	15	29	XL	1
5	27N-09W	5325	0.0095	61	190	151	476	303	951	606	1903	27.0	4	9	19	38	UG	6
6	27N-09W	5325	0.0020	288	904	719	2259	1438	4519	2877	9038	27.0	4	9	19	38	UG	6
7	27N-09W	2175	0.0050	282	885	704	2213	1409	4425	*	*	11.0	9	23	46	*	XL	1
8	27N-09W	2175	0.0095	148	466	371	1165	741	2329	*	*	11.0	9	23	46	*	YL	1
9	27N-09W	4475	0.0095	72	226	180	566	360	1132	721	2264	22.0	4	11	22	45	XL	1
16	27N-09W	5250	0.0090	65	204	162	509	324	1019	648	2037	26.0	4	10	19	38	XL	1
17	27N-09W	600	0.0090	567	1782	*	*	*	*	*	*	3.0	33	*	*	*	XL	2
18	27N-09W	500	0.0090	681	2139	*	*	*	*	*	*	2.5	40	*	*	*	XL	2
20	27N-09W	6400	0.0085	56	177	141	442	282	885	563	1769	32.0	3	8	16	31	XL	1
21	27N-09W	5500	0.0085	66	206	164	515	328	1029	655	2059	27.0	4	9	18	36	XL	1
27	27N-09W	3400	0.0080	104	325	259	813	518	1626	*	*	18.0	5	14	27	*	XL	1

Appendix C.

SEC	TWP-RGE	TRANS. Ft_2/ day	GRAD- IENT	XL@ 100 gpm	YL@ 100 gpm	XL@ 250 gpm	YL@ 250 gpm	XL@ 500 gpm	YL@ 500 gpm	XL@ 1000 gpm	YL@ 1000 gpm	Q/S	DD@ 100 gpm	DD@ 250 gpm	DD@ 500 gpm	DD@ 1000 gpm	DIREC- TION	SENS CLASS
28	27N-09W	3700	0.0080	104	325	259	813	518	1626	*	*	18.0	5	14	27	*	XL	1
29	27N-09W	6500	0.0080	59	185	147	463	295	925	589	1851	32.0	3	8	15	31	XL	1
33	27N-09W	900	0.0074	460	1445	*	*	*	*	*	*	4.5	22	*	*	*	XL	1
34	27N-09W	2175	0.0074	190	598	476	1495	952	2990	*	*	11.0	9	23	46	*	XL	1
35	27N-09W	5875	0.0074	70	221	176	553	352	1107	705	2214	29.0	3	9	17	34	XL	1
36	27N-09W	4975	0.0070	88	276	220	691	440	1382	880	2764	25.0	4	10	20	40	XL	1
1	27N-10W	3000	0.0015	681	2139	1702	5347	3404	10694	*	*	15.0	7	17	33	*	UG	6
2	27N-10W	1900	0.0015	1075	3377	2687	8443	*	*	*	*	9.5	11	26	*	*	UG	6
6	27N-10W	6000	0.0009	567	1782	1418	4456	2837	8912	5674	17824	30.0	3	8	17	33	UG	6
1	27N-11W	11250	0.0009	303	951	757	2377	1513	4753	3026	9506	56.0	2	4	9	18	UG	6
2	27N-11W	5750	0.0009	592	1860	1480	4650	2960	9300	5920	18599	29.0	3	9	17	35	YL	3
3	27N-11W	1800	0.0009	1891	5941	4728	14853	*	*	*	*	9.0	11	28	*	*	YL	6
4	27N-11W	3225	0.0016	594	1865	1484	4663	2969	9327	*	*	16.0	6	16	31	*	YL	3
5	27N-11W	4250	0.0016	451	1415	1126	3539	2253	7077	4506	14154	21.0	5	12	24	47	YL	3
6	27N-11W	2200	0.0016	870	2734	2176	6836	4352	13672	*	*	11.0	9	23	46	*	YL	4
9	27N-11W	4075	0.0010	752	2362	1880	5905	3759	11810	7518	23620	20.0	5	12	25	49	YL	4
10	27N-11W	1500	0.0010	2042	6417	5106	16042	*	*	*	*	7.5	13	33	*	*	YL	6
11	27N-11W	5875	0.0010	522	1638	1304	4096	2607	8192	5215	16383	29.0	3	9	17	34	YL	3
12	27N-11W	10500	0.0010	292	917	730	2292	1459	4583	2918	9167	52.0	2	5	10	19	UG	6
15	27N-11W	1275	0.0011	2184	6863	5461	17157	*	*	*	*	6.4	16	39	*	*	YL	6
16	27N-11W	2500	0.0018	681	2139	1702	5347	3404	10694	*	*	12.0	8	20	40	*	YL	4
17	27N-11W	3550	0.0018	480	1506	1199	3766	2397	7531	*	*	18.0	6	14	28	*	YL	3
18	27N-11W	3750	0.0018	454	1426	1135	3565	2269	7130	*	*	19.0	5	13	27	*	XL	1
19	27N-11W	4350	0.0028	252	790	629	1976	1258	3951	2515	7902	22.0	5	12	23	46	UG	6
20	27N-11W	4625	0.0020	331	1041	828	2601	1656	5203	3312	10405	23.0	4	11	22	43	UG	6
21	27N-11W	4125	0.0020	371	1167	928	2917	1857	5833	3714	11667	21.0	5	12	24	49	UG	6
22	27N-11W	1800	0.0012	1418	4456	3546	11140	*	*	*	*	9.0	11	28	*	*	UG	6
27	27N-11W	1000	0.0012	2553	8021	6383	20052	*	*	*	*	5.0	20	50	*	*	UG	6
28	27N-11W	3050	0.0024	419	1315	1046	3287	2093	6575	*	*	15.0	7	16	33	*	UG	6
29	27N-11W	3050	0.0024	419	1315	1046	3287	2093	6575	*	*	15.0	7	16	33	*	UG	6
30	27N-11W	3150	0.0031	314	986	784	2464	1569	4928	*	*	16.0	6	16	32	*	UG	6
31	27N-11W	250	0.0031	*	*	*	*	*	*	*	*	1.2	*	*	*	*	YL	6
32	27N-11W	1175	0.0024	1086	3413	2716	8533	*	*	*	*	5.9	17	43	*	*	UG	6
33	27N-11W	1900	0.0024	672	2111	1680	5277	*	*	*	*	9.5	11	26	*	*	UG	6
34	27N-11W	1000	0.0014	2188	6875	5471	17188	*	*	*	*	5.0	20	50	*	*	UG	6
35	27N-11W	1150	0.0014	1903	5978	4757	14946	*	*	*	*	5.7	17	44	*	*	UG	6
13	27N-12W	5750	0.0031	172	540	430	1350	859	2700	1719	5400	29.0	3	9	17	35	XL	1
14	27N-12W	6500	0.0031	152	478	380	1194	760	2388	1521	4777	32.0	3	8	15	31	XL	1
15	27N-12W	6100	0.0031	162	509	405	1273	810	2545	1620	5090	30.0	3	8	16	33	XL	1
16	27N-12W	3000	0.0031	329	1035	824	2587	1647	5175	*	*	15.0	7	17	33	*	XL	1
21	27N-12W	3000	0.0031	329	1035	824	2587	1647	5175	*	*	15.0	7	17	33	*	XL	1
22	27N-12W	5750	0.0031	172	540	430	1350	859	2700	1719	5400	29.0	3	9	17	35	YL	2
23	27N-12W	6250	0.0031	158	497	395	1242	791	2484	1581	4968	31.0	3	8	16	32	YL	1
24	27N-12W	6450	0.0031	153	481	383	1203	766	2407	1532	4814	32.0	3	8	16	31	UG	6
25	27N-12W	4000	0.0031	247	776	618	1941	1235	3881	2471	7762	20.0	5	13	25	50	UG	6
26	27N-12W	3750	0.0031	264	828	659	2070	1318	4140	*	*	19.0	5	13	27	*	YL	2
27	27N-12W	3700	0.0031	267	839	668	2098	1336	4196	*	*	18.0	5	14	27	*	XL	1
28	27N-12W	1875	0.0031	527	1656	1318	4140	*	*	*	*	9.4	11	27	*	*	XL	2
34	27N-12W	1500	0.0031	659	2070	1647	5175	*	*	*	*	7.5	13	33	*	*	XL	2
35	27N-12W	530	0.0031	1865	5858	*	*	*	*	*	*	2.6	38	*	*	*	YL	6
36	27N-12W	90	0.0031	*	*	*	*	*	*	*	*	0.4	*	*	*	*	YL	6
16	28N-09W	1500	0.0095	215	675	538	1689	*	*	*	*	7.5	13	33	*	*	XL	1
17	28N-09W	1275	0.0062	388	1218	969	3044	*	*	*	*	6.4	16	39	*	*	XL	1

Appendix C.

SEC	TWP-RGE	TRANS. Ft_2/ day	GRAD- IENT	XL@ 100 gpm	YL@ 100 gpm	XL@ 250 gpm	YL@ 250 gpm	XL@ 500 gpm	YL@ 500 gpm	XL@ 1000 gpm	YL@ 1000 gpm	Q/S	DD@ 100 gpm	DD@ 250 gpm	DD@ 500 gpm	DD@ 1000 gpm	DIREC- TION	SENS CLASS
18	28N-09W	4625	0.0028	237	743	592	1858	1183	3716	2366	7432	23.0	4	11	22	43	YL	2
19	28N-09W	1300	0.0020	1178	3702	2946	9255	*	*	*	*	6.5	15	39	*	*	YL	5
20	28N-09W	1625	0.0047	401	1260	1003	3151	*	*	*	*	8.1	12	31	*	*	XL	1
21	28N-09W	7500	0.0095	43	135	108	338	215	675	430	1351	37.0	3	7	13	27	XL	1
22	28N-09W	14250	0.0095	23	71	57	178	113	355	226	711	71.0	1	4	7	14	XL	1
28	28N-09W	10000	0.0095	32	101	81	253	161	507	323	1013	50.0	2	5	10	20	XL	1
29	28N-09W	3875	0.0050	158	497	395	1242	791	2484	*	*	19.0	5	13	26	*	XL	1
31	28N-09W	4750	0.0020	323	1013	806	2533	1612	5066	3225	10132	24.0	4	11	21	42	UG	6
32	28N-09W	6750	0.0015	303	951	757	2377	1513	4753	3026	9506	34.0	3	7	15	30	YL	2
33	28N-09W	9750	0.0095	33	104	83	260	165	520	331	1039	49.0	2	5	10	21	XL	1
1	28N-10W	8325	0.0018	205	642	511	1606	1022	3212	2045	6423	42.0	2	6	12	24	XL	1
2	28N-10W	5875	0.0018	290	910	724	2275	1449	4551	2897	9102	29.0	3	9	17	34	XL	1
3	28N-10W	3200	0.0020	479	1504	1197	3760	2394	7520	*	*	16.0	6	16	31	*	YL	3
4	28N-10W	2800	0.0024	456	1432	1140	3581	2280	7162	*	*	14.0	7	18	36	*	UG	6
5	28N-10W	4950	0.0024	258	810	645	2026	1289	4051	2579	8102	25.0	4	10	20	41	YL	2
6	28N-10W	4175	0.0024	306	961	764	2401	1529	4803	3058	9606	21.0	5	12	24	48	YL	2
7	28N-10W	5350	0.0024	239	750	597	1874	1193	3748	2386	7496	27.0	4	9	19	37	YL	2
8	28N-10W	6250	0.0024	204	642	511	1604	1021	3208	2043	6417	31.0	3	8	16	32	YL	2
9	28N-10W	5325	0.0024	240	753	599	1883	1199	3766	2397	7531	27.0	4	9	19	38	UG	6
10	28N-10W	4050	0.0024	315	990	788	2476	1576	4951	3152	9902	20.0	5	12	25	50	YL	2
11	28N-10W	4675	0.0018	364	1144	910	2860	1820	5719	3641	11438	23.0	4	11	21	43	XL	1
12	28N-10W	6475	0.0018	263	826	657	2065	1314	4129	2629	8258	32.0	3	8	15	31	XL	1
13	28N-10W	4600	0.0021	317	996	793	2491	1586	4982	3172	9964	23.0	4	11	22	44	YL	2
14	28N-10W	2750	0.0020	557	1750	1393	4375	2785	8750	*	*	14.0	7	18	36	*	UG	6
15	28N-10W	3150	0.0022	442	1389	1105	3472	2210	6944	*	*	16.0	6	16	32	*	UG	6
16	28N-10W	6500	0.0023	205	644	512	1610	1025	3219	2049	6438	32.0	3	8	15	31	YL	2
17	28N-10W	6825	0.0025	180	564	449	1410	898	2821	1796	5641	34.0	3	7	15	29	YL	2
18	28N-10W	6600	0.0025	186	583	464	1458	928	2917	1857	5833	33.0	3	8	15	30	YL	2
19	28N-10W	6850	0.0019	235	740	589	1849	1177	3698	2354	7395	34.0	3	7	15	29	UG	6
20	28N-10W	7800	0.0024	164	514	409	1285	818	2571	1637	5142	39.0	3	6	13	26	YL	2
22	28N-10W	4675	0.0022	298	936	745	2340	1489	4679	2979	9358	23.0	4	11	21	43	UG	6
23	28N-10W	3225	0.0022	432	1357	1080	3392	2159	6783	*	*	16.0	6	16	31	*	UG	6
24	28N-10W	3050	0.0018	558	1753	1395	4383	2790	8766	*	*	15.0	7	16	33	*	YL	3
25	28N-10W	1700	0.0013	1386	4355	3466	10888	*	*	*	*	8.5	12	29	*	*	UG	6
26	28N-10W	2000	0.0022	696	2188	1741	5469	3482	10937	*	*	10.0	10	25	50	*	UG	6
27	28N-10W	1850	0.0020	828	2601	2070	6503	*	*	*	*	9.2	11	27	*	*	UG	6
28	28N-10W	3325	0.0020	461	1447	1152	3618	2304	7237	*	*	17.0	6	15	30	*	UG	6
29	28N-10W	4800	0.0020	319	1003	798	2507	1596	5013	3191	10026	24.0	4	10	21	42	YL	3
30	28N-10W	7200	0.0015	284	891	709	2228	1418	4456	2837	8912	36.0	3	7	14	28	UG	6
31	28N-10W	6900	0.0012	370	1162	925	2906	1850	5812	3700	11624	34.0	3	7	15	29	UG	6
32	28N-10W	3350	0.0012	762	2394	1905	5986	3811	11971	*	*	17.0	6	15	30	*	UG	6
33	28N-10W	1500	0.0012	1702	5347	4255	13368	*	*	*	*	7.5	13	33	*	*	UG	6
34	28N-10W	1325	0.0018	1285	4036	3211	10089	*	*	*	*	6.6	15	38	*	*	UG	6
35	28N-10W	1650	0.0013	1428	4487	3571	11218	*	*	*	*	8.2	12	30	*	*	UG	6
36	28N-10W	2825	0.0013	834	2621	2086	6552	4171	13104	*	*	14.0	7	18	35	*	UG	6
1	28N-11W	3450	0.0010	888	2790	2220	6975	4440	13949	*	*	17.0	6	15	29	*	YL	4
2	28N-11W	3400	0.0010	901	2831	2253	7077	4505	14154	*	*	17.0	6	15	29	*	YL	4
3	28N-11W	3050	0.0010	1005	3156	2511	7889	5023	15779	*	*	15.0	7	16	33	*	YL	5
4	28N-11W	2675	0.0010	1145	3598	2863	8995	5727	17991	*	*	13.0	7	19	37	*	YL	5
6	28N-11W	4000	0.0010	766	2406	1915	6016	3830	12031	7659	24063	20.0	5	13	25	50	UG	6
7	28N-11W	500	0.0050	1225	3850	*	*	*	*	*	*	2.5	40	*	*	*	UG	6
8	28N-11W	6300	0.0100	49	153	122	382	243	764	486	1528	31.0	3	8	16	32	UG	6
9	28N-11W	5350	0.0160	36	112	89	281	179	562	358	1124	27.0	4	9	19	37	UG	6

Appendix C.

SEC	TWP-RGE	TRANS. Ft_2/ day	GRAD-IENT	XL@ 100 gpm	YL@ 100 gpm	XL@ 250 gpm	YL@ 250 gpm	XL@ 500 gpm	YL@ 500 gpm	XL@ 1000 gpm	YL@ 1000 gpm	Q/S	DD@ 100 gpm	DD@ 250 gpm	DD@ 500 gpm	DD@ 1000 gpm	DIREC-TION	SENS CLASS
10	28N-11W	3550	0.0160	54	169	135	424	270	847	*	*	18.0	6	14	28	*	UG	6
11	28N-11W	4650	0.0010	659	2070	1647	5175	3294	10349	6589	20699	23.0	4	11	22	43	XL	2
15	28N-11W	5875	0.0016	326	1024	815	2560	1630	5120	3259	10239	29.0	3	9	17	34	UG	6
16	28N-11W	5100	0.0016	376	1180	939	2949	1877	5898	3755	11795	25.0	4	10	20	39	UG	6
17	28N-11W	2250	0.0016	851	2674	2128	6684	4255	13368	*	*	11.0	9	22	45	*	XL	2
18	28N-11W	500	0.0016	3830	12031	*	*	*	*	*	*	2.5	40	*	*	*	YL	6
19	28N-11W	500	0.0010	6127	19250	*	*	*	*	*	*	2.5	40	*	*	*	YL	6
20	28N-11W	1600	0.0014	1368	4297	3419	10742	*	*	*	*	8.0	13	31	*	*	YL	6
21	28N-11W	2750	0.0014	796	2500	1989	6250	3979	12500	*	*	14.0	7	18	36	*	UG	6
22	28N-11W	3850	0.0014	568	1786	1421	4464	2842	8929	*	*	19.0	5	13	26	*	UG	6
24	28N-11W	3800	0.0014	576	1809	1440	4523	2879	9046	*	*	19.0	5	13	26	*	UG	6
25	28N-11W	3875	0.0014	565	1774	1412	4436	2824	8871	*	*	19.0	5	13	26	*	UG	6
26	28N-11W	3325	0.0014	658	2068	1645	5169	3291	10338	*	*	17.0	6	15	30	*	UG	6
27	28N-11W	2325	0.0014	941	2957	2353	7393	4706	14785	*	*	12.0	9	22	43	*	UG	6
28	28N-11W	1450	0.0014	1509	4741	3773	11853	*	*	*	*	7.2	14	35	*	*	UG	6
29	28N-11W	1400	0.0014	1563	4911	3908	12277	*	*	*	*	7.0	14	36	*	*	YL	6
30	28N-11W	825	0.0014	2653	8333	*	*	*	*	*	*	4.1	24	*	*	*	YL	6
31	28N-11W	1850	0.0014	1183	3716	2957	9291	*	*	*	*	9.2	11	27	*	*	YL	5
32	28N-11W	3500	0.0014	625	1964	1563	4911	3126	9821	*	*	17.0	6	14	29	*	UG	6
33	28N-11W	1775	0.0014	1233	3873	3082	9683	*	*	*	*	8.9	11	28	*	*	UG	6
34	28N-11W	1825	0.0014	1199	3767	2998	9418	*	*	*	*	9.1	11	27	*	*	UG	6
35	28N-11W	3750	0.0014	584	1833	1459	4583	2918	9167	*	*	19.0	5	13	27	*	UG	6
36	28N-11W	7450	0.0014	294	923	734	2307	1469	4614	2937	9228	37.0	3	7	13	27	UG	6
1	28N-12W	500	0.0010	6127	19250	*	*	*	*	*	*	2.5	40	*	*	*	YL	6
2	28N-12W	400	0.0010	7659	24063	*	*	*	*	*	*	2.0	50	*	*	*	YL	6
13	28N-12W	500	0.0010	6127	19250	*	*	*	*	*	*	2.5	40	*	*	*	YL	6
14	28N-12W	500	0.0030	2042	6417	*	*	*	*	*	*	2.5	40	*	*	*	YL	6
24	28N-12W	250	0.0030	*	*	*	*	*	*	*	*	1.2	*	*	*	*	YL	6
25	28N-12W	400	0.0030	2553	8021	*	*	*	*	*	*	2.0	50	*	*	*	YL	6
36	28N-12W	700	0.0030	1459	4583	*	*	*	*	*	*	3.5	29	*	*	*	YL	6
15	29N-10W	2900	0.0015	704	2213	1761	5532	3522	11063	*	*	14.0	7	17	35	*	XL	2
16	29N-10W	1500	0.0015	1362	4278	3404	10694	*	*	*	*	7.5	13	33	*	*	YL	6
17	29N-10W	1500	0.0015	1362	4278	3404	10694	*	*	*	*	7.5	13	33	*	*	XL	3
18	29N-10W	3000	0.0015	681	2139	1702	5347	3404	10694	*	*	15.0	7	17	33	*	YL	4
19	29N-10W	3000	0.0015	681	2139	1702	5347	3404	10694	*	*	15.0	7	17	33	*	YL	4
21	29N-10W	1500	0.0015	1362	4278	3404	10694	*	*	*	*	7.5	13	33	*	*	YL	6
22	29N-10W	2950	0.0015	692	2175	1731	5438	3462	10876	*	*	15.0	7	17	34	*	YL	4
27	29N-10W	3650	0.0015	560	1758	1399	4395	2798	8790	*	*	18.0	5	14	27	*	YL	3
28	29N-10W	1650	0.0015	1238	3889	3095	9722	*	*	*	*	8.2	12	30	*	*	YL	5
29	29N-10W	2800	0.0015	730	2292	1824	5729	3647	11458	*	*	14.0	7	18	36	*	YL	4
30	29N-10W	4300	0.0015	475	1492	1187	3731	2375	7461	4750	14922	21.0	5	12	23	47	YL	3
31	29N-10W	5300	0.0015	385	1211	963	3027	1927	6054	3854	12107	26.0	4	9	19	38	YL	3
32	29N-10W	3400	0.0015	601	1887	1502	4718	3004	9436	*	*	17.0	6	15	29	*	YL	3
33	29N-10W	1500	0.0015	1362	4278	3404	10694	*	*	*	*	7.5	13	33	*	*	YL	6
34	29N-10W	3000	0.0015	681	2139	1702	5347	3404	10694	*	*	15.0	7	17	33	*	YL	4
22	29N-11W	1500	0.0045	454	1426	1135	3565	*	*	*	*	7.5	13	33	*	*	XL	1
23	29N-11W	1500	0.0045	454	1426	1135	3565	*	*	*	*	7.5	13	33	*	*	XL	1
24	29N-11W	1000	0.0045	681	2139	1702	5347	*	*	*	*	5.0	20	50	*	*	XL	2
25	29N-11W	5075	0.0045	134	421	335	1054	671	2107	1342	4215	25.0	4	10	20	40	XL	1
26	29N-11W	3050	0.0045	223	701	558	1753	1116	3506	*	*	15.0	7	16	33	*	XL	1
27	29N-11W	1800	0.0045	378	1188	946	2971	*	*	*	*	9.0	11	28	*	*	XL	1
28	29N-11W	400	0.0045	1702	5347	*	*	*	*	*	*	2.0	50	*	*	*	XL	3
30	29N-11W	400	0.0040	1915	6016	*	*	*	*	*	*	2.0	50	*	*	*	XL	3

Appendix C.

SEC	TWP-RGE	TRANS. Ft$_2$/ day	GRAD- IENT	XL@ 100 gpm	YL@ 100 gpm	XL@ 250 gpm	YL@ 250 gpm	XL@ 500 gpm	YL@ 500 gpm	XL@ 1000 gpm	YL@ 1000 gpm	Q/S	DD@ 100 gpm	DD@ 250 gpm	DD@ 500 gpm	DD@ 1000 gpm	DIREC- TION	SENS CLASS
31	29N-11W	500	0.0040	1532	4813	*	*	*	*	*	*	2.5	40	*	*	*	XL	3
32	29N-11W	1325	0.0060	385	1211	963	3027	*	*	*	*	6.6	15	38	*	*	XL	1
33	29N-11W	2000	0.0060	255	802	638	2005	1277	4010	*	*	10.0	10	25	50	*	YL	2
35	29N-11W	3300	0.0035	265	833	663	2083	1326	4167	*	*	16.0	6	15	30	*	YL	2
36	29N-11W	8500	0.0035	103	324	258	809	515	1618	1030	3235	42.0	2	6	12	24	YL	1
25	29N-12W	400	0.0030	2553	8021	*	*	*	*	*	*	2.0	50	*	*	*	YL	6
26	29N-12W	400	0.0030	2553	8021	*	*	*	*	*	*	2.0	50	*	*	*	YL	6
35	29N-12W	400	0.0030	2553	8021	*	*	*	*	*	*	2.0	50	*	*	*	YL	6
36	29N-12W	400	0.0030	2553	8021	*	*	*	*	*	*	2.0	50	*	*	*	YL	6

PLATE 1

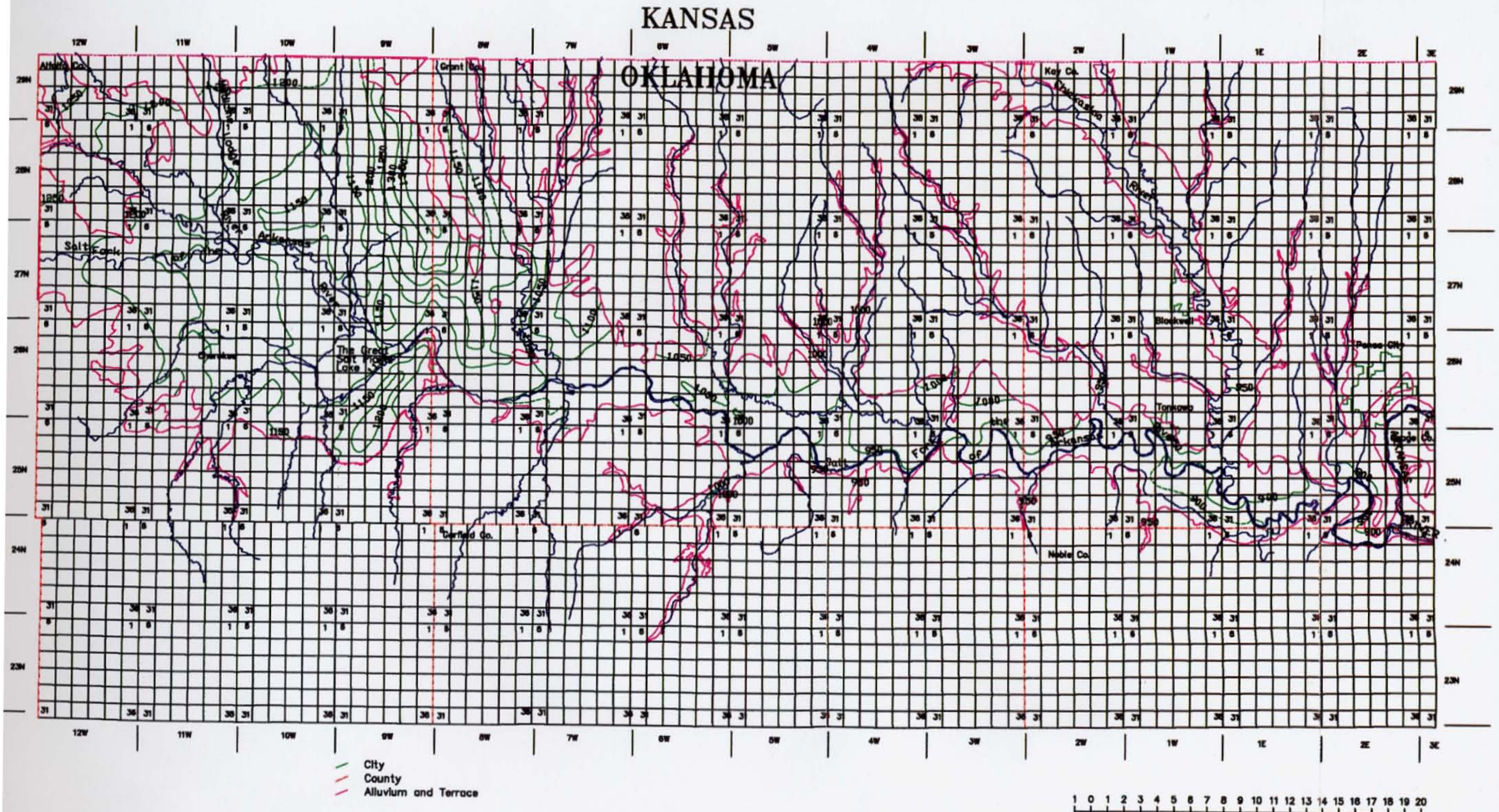


PLATE 1. Aquifer Bottom Map.

contour interval = 50 feet

Map by The Oklahoma Water Resources Board

PLATE 2

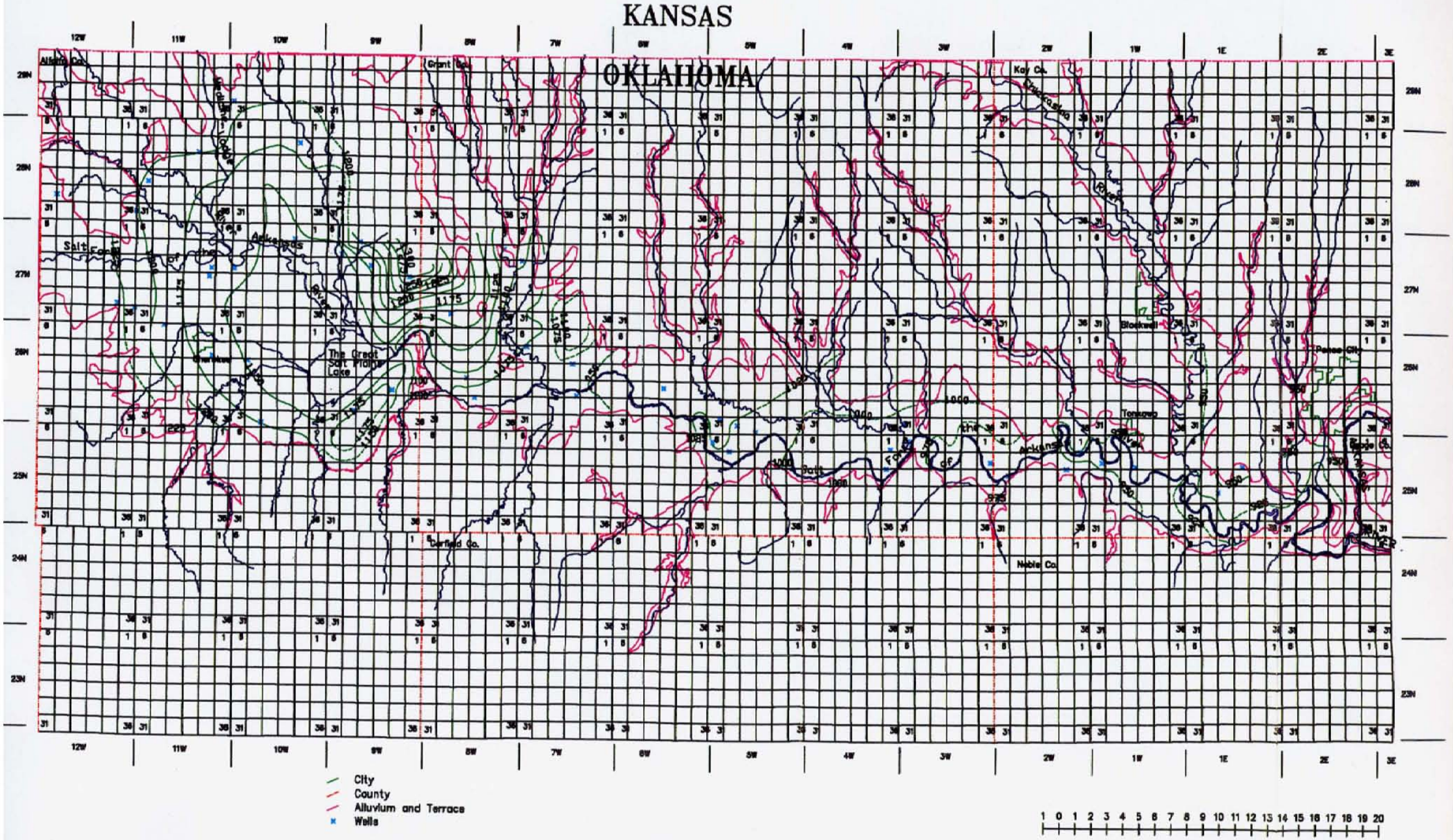
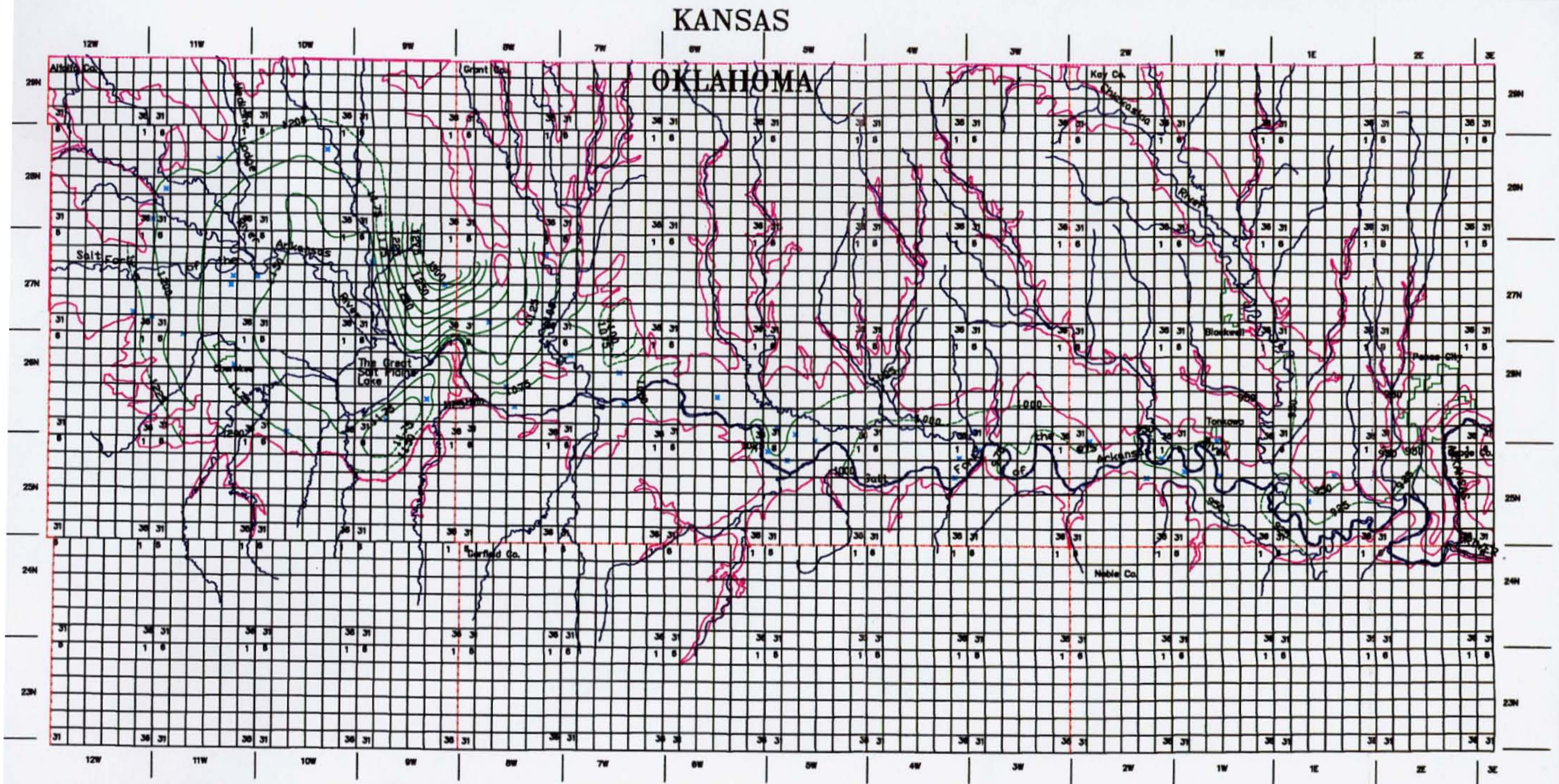


PLATE 2. Contour Map Top of Water Table July 1992.

contour interval = 25 feet

Map by The Oklahoma Water Resources Board

PLATE 3



City
County
Alluvium and Terrace
Wells

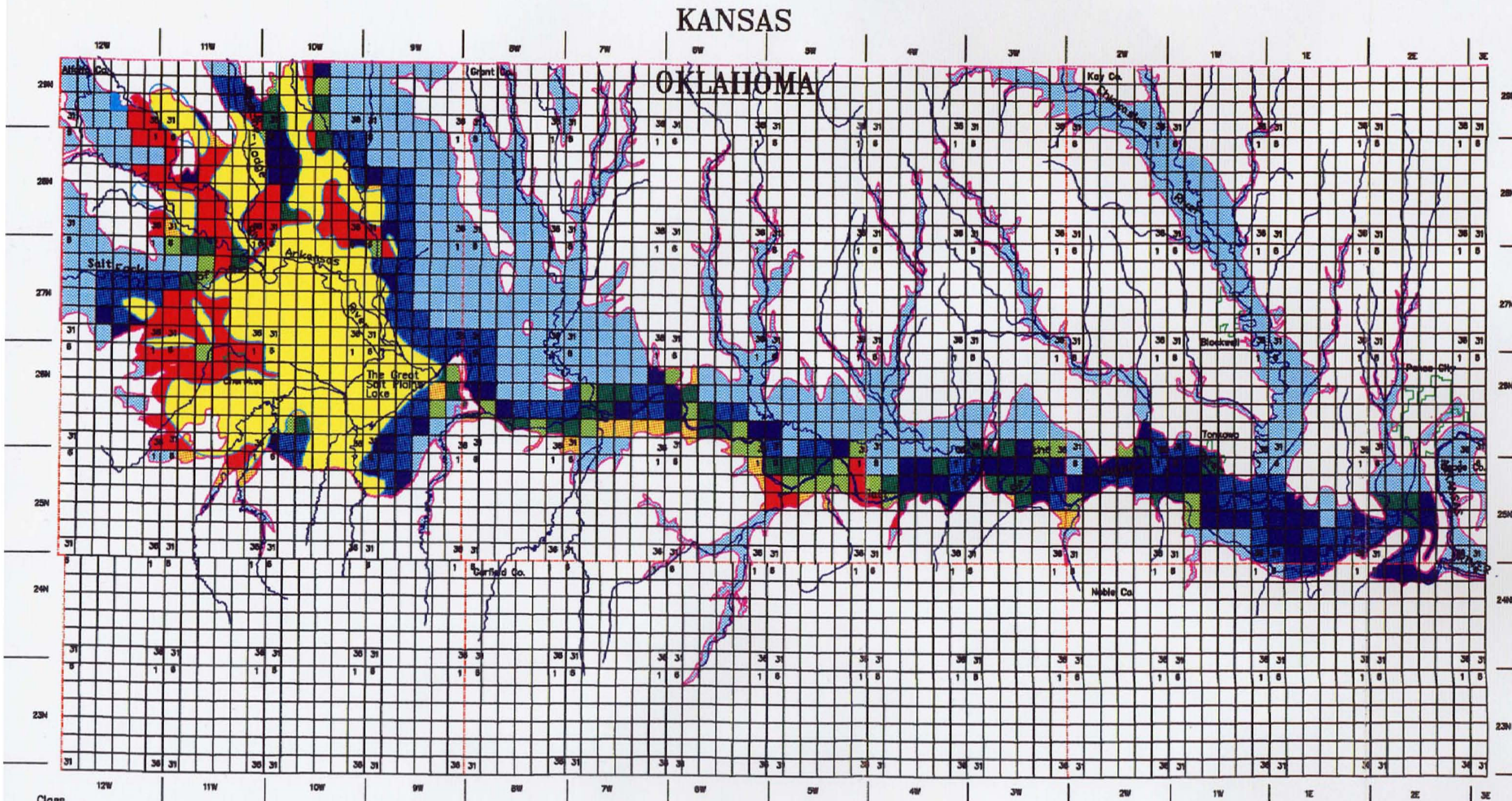
1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Scale of Miles

PLATE 3. Contour Map Top of Water Table December 1992.

contour interval = 25 feet

Map by The Oklahoma Water Resources Board

PLATE 4



Class

1 < or = 500 feet Least Sensitive
2 501 – 1000 feet
3 1001 – 2000 feet
4 2001 – 3000 feet
5 3001 – 4000 feet
6 > 4000 feet Most Sensitive
Chloride concentration > 250 mg/l
Beyond Sensitive Area

City
County
Alluvium and Terrace
250 mg/l

1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Scale of Miles

PLATE 4. Aquifer Sensitivity Map.

Map by The Oklahoma Water Resources Board