Report on Hydrologically Connected Ground Water and Surface Water in the Upper Niobrara-White Natural Resources District

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Purpose

This report reviews the background information that was used to assist the Department of Natural Resources (DNR) in making its determination of which basins, subbasins or reaches in the Upper Niobrara-White Natural Resources District (UNWNRD) are fully appropriated in accordance with Neb. Rev. Stat. Chapter 46, Article 7. The report describes: 1) the availability of stream flow to meet current surface water rights in the UNWNRD; 2) the hydrologic connection between ground water and these surface water supplies; and 3) how uses of one source of water may affect availability of the other source.

Background

On January 10, 2003, the UNWNRD sent a letter (Figure 1, Appendix I) requesting that the DNR consult with the UNWNRD. The requested consultation concerned studies and a hearing on the preparation of a joint action plan for the integrated management of hydrologically connected ground water and surface water under the Nebraska Ground Water Management and Protection Act.

The DNR responded on February 26, 2003 (Figure 2, Appendix I) with a preliminary decision according to then current law (Neb. Rev. Stat. 46-656.28(2)1998). In that decision the DNR found reason to believe that the use of hydrologically connected ground water and surface water resources in the UNWNRD was contributing to, or was in the reasonably foreseeable future likely to contribute to, conflicts between ground water users and surface water appropriators. The decision was made based on information found in the UNWNRD's ground water management plan, various United States Geological Survey (USGS) reports, various DNR records, and other reports and records. Based upon the preliminary determination, the DNR initiated a more detailed study to determine the cause of such conflicts, disputes, or difficulties and the extent of the area affected.

On July 16, 2004 LB 962 became effective, replacing portions of the Ground water Management and Protection Act pertaining to the integrated management planning process. The new law provided a transition process for natural resources districts that were in the process of determining whether they needed to develop an integrated management plan (Neb. Rev. Stat. 46-720). Under the new law an integrated management plan must be developed if the DNR determines that a basin, subbasin, or reach within the district is fully appropriated (Neb. Rev. Stat. 46-715). This new legislation provides the following standard to determine whether a basin is "fully appropriated":

"A river basin, subbasin, or reach shall be deemed fully appropriated if the department determines that then-current uses of hydrologically connected surface water and ground water in the river basin, subbasin, or reach cause or will in the reasonably foreseeable future cause (a) the surface water supply to be insufficient to sustain over the long term the beneficial or useful purposes for which existing natural flow or storage appropriations were granted and the beneficial or useful purposes for which, at the time of approval, any existing instream appropriation was granted, (b) the streamflow to be insufficient to sustain over the long term the beneficial uses from wells constructed in aquifers dependent on recharge from the river or stream involved, or (c) reduction in the flow of a river or stream sufficient to cause noncompliance by Nebraska with an interstate compact or decree, other formal state contract or agreement, or applicable state or federal laws." (Neb. Rev. Stat. 46-713(3))

Under the provisions DNR must hold a hearing by November 14, 2004 (Neb. Rev. Stat. 46-714 (4)) and make a final determination designating which river basins/reaches in the UNWNRD are fully appropriated within thirty days of the hearing (Neb. Rev. Stat. 46-714 (5)).

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Basic Principles of Ground Water - Surface Water Interactions

1) Where there is a hydrological connection between surface water flow and ground water aquifers, a consumptive use of one depletes the supply in the other.

2) In such areas a decrease in recharge to the aquifer from surface water supplies, precipitation, canal seepage or seepage from irrigated fields, will decrease the amount of water infiltrating from the land surface to recharge the ground water aquifer. A decrease in recharge will also decrease the ground water supplies available for use.

3) Stream flows are supplied by surface water runoff and by water seeping from the ground water aquifer to the stream as baseflow. Surface water runoff tends to be sporadic, depending on precipitation events. Baseflow from ground water is more constant.

4) Changes in baseflow to a stream result from any factor that either changes the water pressure or the water table elevation in any aquifer hydrologically connected to the stream. Consumptive

use of the aquifer by wells or vegetation affects both the aquifer pressure and water table elevation.

5) If a ground water aquifer is closely connected to a surface water stream, decreases in aquifer water pressure or elevation caused by a pumping well will either decrease the movement of water to the stream or induce the movement of water from the stream to the aquifer. In either case, the first noticeable impact of increased consumptive use from an aquifer hydrologically connected to a stream is often a change in the quantity of stream flow rather than a change in the water table elevation of the aquifer. In many cases, changes in water table elevations are detected only when stream flows decline to the point they are no longer able to recharge the aquifer. Thus, in addition to declines in water table elevation, any steady decline in stream flow that cannot be explained by a change in precipitation or other factors is a good indication that the current level of consumptive use of the hydrologically connected surface water and ground water cannot be sustained in the long term.

6) Aquifer Properties:

(a) *Hydraulic Conductivity* (K) – the volume of water that will flow through a unit cross-sectional area of aquifer in unit time, under a unit hydraulic gradient and at a specified temperature. Basically, K is a measure of how easily water flows through the aquifer. For instance, water flows more easily through a sand and gravel aquifer than an aquifer composed of silts and clays;

(b) *Transmissivity* (T) is the hydraulic conductivity multiplied by the full thickness of saturated aquifer. The more the saturated thickness; the higher the value of T. Saturated thickness is the thickness of the aquifer where all available pore space is filled with water.

River Basins in the UNWNRD

This report focuses on five river basins and sub-basins within the UNWNRD: the Niobrara River Basin, Box Butte Creek Basin, Snake River Basin, White River Basin, and Hat Creek Basin. The following sections of this report present a general description of the following topics for those basins: *1) general description/precipitation/land cover, 2)characterization of surface water flows, 3) surface water appropriations/administration, 4) hydrogeology, 5) ground water wells/development, and 6) analysis/conclusions.* In addition to examining each basin, there will be a brief discussion of where ground water use in the river basin might affect surface water availability outside of the river basin. One separate map deals with all of the basins and is included as a separate insert at the back of the report. That map, developed by the UNWNRD, shows streams that currently have no stream flow according to local residents of the UNWNRD and hydrographers from the DNR. All of the remaining figures for the report are found in Appendix II.

Niobrara River Basin

General Description / Precipitation / Landcover

The Niobrara is the largest river basin in the UNWNRD. *For purposes of this report, Snake Creek and Box Butte Creek, which are part of the basin, are primarily treated in separate sections.* Including Snake Creek and Box Butte Creek, the Niobrara River basin within UNWNRD occupies 2,730,000 acres of land, and runs the full length of the NRD from west to east. Figure 1, Appendix II depicts surface water diversions and surface water basin boundaries in the UNWNRD.

Figure 2, Appendix II presents annual precipitation by year for several UNWNRD weather stations. Overall precipitation for the stations exhibited no statistically significant trends in the fifty to seventy five year periods of record. For the longer period of 1896 to 2003, annual precipitation at the Alliance station in the Niobrara basin has minimum, maximum, and average annual values of 8.67, 25.57 and 16.18 inches respectively.

Land cover in this report has been aggregated for the overall district, rather than by sub-basin. Land cover in the UNWNRD consists primarily of rangeland with dryland crops, forest, and irrigated crops comprising most of the balance (Figure 3). There are also small areas of badlands, lakes, wetlands and urban development. In 1997, irrigated harvested cropland accounted for about 39% of total harvested cropland and 5.4 % of the total land area in the four counties that have land area in the UNWNRD. The primary crops grown in the area are corn, wheat, beans, alfalfa, and sugar beets. In general there are relatively few crops grown in the southeastern and southwestern portions of the district. Box Butte County and areas to the north and east of Box Butte County have more cropped area.

Figure 4 presents U.S. Census of Agriculture information regarding changes in cropland acres, and bushels of production in the four-county UNWNRD area between 1969 and 1997. Harvested irrigated cropland acres increased about 150% while total cropland harvested increased by only about 5% during the period. However, of the two major crops; bushels of corn for grain increased tenfold, while wheat production increased by 181%. These changes are far more significant than those experienced by the state overall, which had a 143% increase in corn production and a nearly 13% decrease in wheat production during the same period.

Characterization of Surface Water Flows

The Niobrara is a perennial stream throughout the study area. Figure 5 depicts the stream and canal network and irrigation wells within the UNWNRD. Figure 6 provides average annual flows on the Niobrara at each gage. The average annual flow leaving the UNWNRD is over 31 times greater the flow entering the UNWNRD at the state line. At the Wyoming State line the Niobrara's flow averaged 2,615 acre-feet per year in the 1956-2002 time period. Above Box Butte Reservoir it averaged 20,334 acre-feet per year (1947-2002) and below the reservoir (after evaporation) it averaged 17,018 acre-feet per year (1947-2002). Approximately seven miles downstream of Box Butte Reservoir the Mirage Flats Canal, the Potmesil Canal, and the Lichte Canal diverted an annual combined average of 16,758 acre-feet from the river in the 1956 to

2002 time period. (Note: these figures are somewhat deceptive because they are long-term averages and flows and diversions by these canals have been decreasing through time). In eastern Sheridan County, south of Gordon, the Niobrara's flow averaged 82,489 acre-feet per year between 1946 and 1994.

Annual average streamflows at the four gaged Niobrara River sites have declined significantly since initiation of measurements between 1946 and 1956 (Figures 7 through 14). One interesting side note is that, for the state line gage only, the maximum decline in streamflow at the state line gage seems to have occurred in the mid- 1970s with levels actually rising since that time.

Surface Water Appropriations/Administration

The Niobrara River in the UNWNRD can be subdivided into two reaches, the reach above the Mirage Flats Canal headgate and the reach below the headgate. There has been an order granting a moratorium on the issuance of new surface water appropriations from the Nebraska-Wyoming state line to the headgate of the Mirage Flats Canal (seven miles below Box Butte Reservoir)in the SENW of Section 26, Township 29 North, Range 48 West of the 6th P.M. in Dawes County since November 30, 1990.

Sixty three of the 144 surface water rights in the Niobrara Basin in the UNWNRD are for the portion of the basin upstream of the Mirage Flats canal diversion. The oldest surface water right in the Niobrara Basin dates to 1883 and there are a total of 81 surface water rights downstream of the Mirage Flats Diversion, including those in the Box Butte and Snake Creek Basins.

Some rights are administered in almost all years to supply water for the Mirage Flats diversion's 1937 water right. The Department of Water Resources order *(November 30, 1990)* granting a moratorium in the Niobrara Basin above the Mirage Flats headgate noted: *"Department records show that Box Butte Reservoir has completely filled only once in the last 25 years. For the benefit of Box Butte Reservoir and Mirage Flats Canal, water administration of upstream junior appropriators occurs every year. The hydrologic experience since Box Butte Reservoir was completed in 1945 gives no indication that greater flows can be expected. Public interest is not well served by granting 'paper water rights'."* Downstream of Box Butte Reservoir, administration has not been required on the mainstem of the Niobrara.

Diversions to the Mirage Flats Canal averaged 17,497 acre-feet per year during the 1948 to1975 time period and 14,172 acre-feet per year during the 1976 to 2003 time period; a 19% decrease (Figure 15). Diversions to other canals in the basin have also decreased (Figures 16 and 17).

There are eight surface water rights along the Niobrara itself between the Mirage Flats canal diversion and the confluence of Box Butte Creek. One of these is for a storage right immediately downstream of the Mirage Flats diversion. The other seven rights are natural flow irrigation rights with four of them being held by one party. The irrigation rights total 13.58 cfs and 950.8 acres with priority dates from 1953 to 2003. There has been no water administration in this reach. Neither have there been calls for administration to the east of Box Butte Creek.

Hydrogeology of the River Basin

(Note: This section also contains general regional geologic/hydrologic information relevant to the Box Butte Creek and Snake Creek Basins)

The principal aquifer units include the Arikaree group and the Ogallala group. In some areas the Sandhills overlie the Ogallala group. Figure 18 provides a geologic map of the district. Figure 19 provides a ground water regions map. The source of water in the study area is primarily local precipitation and underflow of ground water from the west.

The Arikaree Group, which is at the surface in the western and northern portion of the basin, consists mostly of very fine to medium grained sand, sandstone and silt. It also underlies the Ogallala to the east. The Arikaree is a major aquifer in the UNWNRD supplying water to large capacity irrigation wells as well as other depletive water wells in the UNWNRD. Wenzel et. al. (1946) stated that "On the table lands of Sioux and Box Butte counties the sandstones of the Arikaree group yield moderately large amounts of water to wells that penetrate a great thickness". Bradley (1956) indicated that the Arikaree is only moderately permeable. Many irrigation wells have been drilled into the Arikaree since that time.

The Ogallala Group is at the surface and thickens toward the eastern part of the study area. The Ogallala Group includes the Box Butte, Sheep Creek and Runningwater Units. The thickness of the aquifer reaches over 800 feet in the eastern part of Sheridan County. The Ogallala Group consists of gravelly sand, sand, siltstones, and clay. Quaternary sands overlie the formation and absorb precipitation and transmit it downward to the underlying Ogallala deposits. This Group is also a major aquifer in the UNWNRD supplying water to large capacity irrigation and other types of water wells. The Ogallala will yield water to wells more readily than an equivalent thickness of Arikaree or Brule. Depth to water varies greatly in the Sandhills because of the dunes. In many areas it reaches or approaches the surface as lakes, wetlands or subirrigated areas. However, in other areas it may be 300 feet or more to water from the top of a dune.

Geologic cross-section E-E', figure 20, shows the predominant aquifer trends from the Arikaree Group to the Ogallala Group, west to east across the southern portion of the UNWNRD. This cross-section also shows that these two groups are in contact, meaning ground water can move between the two geologic groups. Cross-Sections A-A', B-B' and C-C', figures 21 to 23, depict the geology from south to north at 3 separate locations moving from west to east across the UNWNRD. A-A' shows the Arikaree to be the aquifer in contact with the Niobrara River in the west of the UNWNRD. B-B' is in the zone where the Arikaree and Ogallala aquifers are both present and the Ogallala is in contact with the Niobrara River. C-C' is located in the easternmost part of the UNWNRD and shows the Ogallala with the Quaternary Sandhills deposits overlying it, in contact with the Niobrara River. These two major aquifers, the Arikaree and Ogallala, which supply ground water to numerous irrigation wells in the UNWNRD are also the aquifers in hydrologic contact with the Niobrara River and supply the Niobrara and other perennial streams in the basin with baseflow.

The Brown Siltstone unit, also referred to as the "Beaver Wall" siltstone beds, is in hydrologic contact with the Niobrara River alluvium along an area from the western to central Box Butte County (Souders, 1981). Although the permeability of this Brown Siltstone unit is low; the unit does contain water and is a source of water supply for stock and domestic wells in the northern part of the county (Souders et. al. (1980). According to Souders "Irrigation wells could probably be developed in the unit if a considerable thickness, about 300 ft. (91 m), is penetrated and the wells are developed over a long period of time by surging, back-flushing, and over-pumping. On the whole, the unit is not attractive as a source of water supply if a well yield greater than a few hundred gallons per minute is required". Souders, et. al., also indicated that water moves through this Brown Siltstone unit at the edge of the tableland to the Niobrara Valley. Underflow may be on the magnitude of 1,500 acre-feet (1.85 x 10(6) m(3)) per year. From west to east across northern Box Butte County the major hydrologic unit in contact with the Niobrara River Valley alluvium transitions from the Brown Siltstone to more permeable formations or units of the Ogallala Group that have a higher hydraulic conductivity (Cross-sections A-A' through D-D', Figures 24-27).

Saturated thickness in the study area ranges from the previously mentioned 800 feet in part of Sheridan County to an area where the principal aquifer, as defined by the Conservation and Survey Division (CSD), which does not include the Brown Siltstone Unit, is absent or very thin along the Niobrara in the western portion of the Dawes-Box Butte County line. Aquifer thicknesses in some of the heavily developed areas of Box Butte County are in the 200 to 400 foot range. Saturated thickness is presented in Figure 28. Transmissivity in the study area also varies greatly with the highest transmissivities occurring in southern Sheridan, southern Box Butte, and far west central Sioux counties.

A 1956 U.S. Geological Survey report (Bradley) on the Upper Niobrara Basin indicated that ground water moves in an easterly direction and toward the perennial streams, probably at a rate of less than 1 foot per day (pg. 1). The generalized direction of flow is more varied at the detailed level within the study area. A ground water mound in southeast Sheridan County shows ground water flow moving in all directions away from the top of the ground water mound, north toward the Niobrara River, south to the North Platte Basin, east through the Loup Basin and even west prior to eventually turning north (Figures 29, 30, and 31).

According to water table contour maps and other publications ground water discharge in the Niobrara River Basin occurs through the Niobrara River and its tributaries, lakes, subirrigated areas (ET), and ground water pumping/irrigation (Souders, 1981; Souders et al, 1980). In Box Butte County Souders et. al. estimated that total ground water underflow exiting Box Butte County was 21,000 acre-feet per year, with another 1,500 acre-feet being discharged to springs, seeps, the Niobrara River, Box Butte Creek, and Snake Creek. Of the 21,000 acre-feet of ground water underflow leaving Box Butte County, the majority of that water, about 13,000 acre-feet per year, went north and east to Dawes County, toward the Niobrara River. Also approximately 4,000 acre-feet of ground water was estimated to move northeast into Sheridan County, toward the Niobrara River and Box Butte Creek.

Understanding the total water balance of a basin helps determine the major stresses on the system and how those stressors interact. This in turn helps in understanding how changes to these stressors ultimately impact the total available ground water supply and the resultant baseflow to streams. Significant factors in determining the water balance of the region are precipitation, evaporation, transpiration and recharge. Average annual precipitation in the Upper Niobrara White NRD ranges from 14.9 inches in southern Sioux County to 18.38 inches in eastern Sheridan County. Most precipitation is received during May, June and July and precipitation is highly variable from year to year. Alliance receives over 79% percent of its annual rainfall from April to September. Thus a great deal of the precipitation arrives at times when it is more subject to evapotranspiration.

Evapotranspiration in areas of shallow water table can significantly influence the water balance of a region. Souders, et. al. (1980), indicated large areas of shallow water table in Box Butte County as of 1938.

Estimates of recharge vary and are dependent upon many factors including “the time of year precipitation occurs, the duration and intensity of rainstorms, the freezing and thawing of the soil column, the wetting and drying of the soil column, the slope of the land, the vegetative cover, cultural practices on the land, biological activities of plants and animals in the soil, the texture and permeability of the soil columns, and the vertical hydraulic conductivity of subsoil strata in the unsaturated zone as well as the hydrologic unit occurring at the surface” (Souders et. al., 1980).

Pettijohn and Chen (1984) provided mapped average annual recharge estimates for Box Butte County that ranged from less than .05 inches to 2.5 to 3.0 inches. The Revised Ground Water Management Plan for the Upper Niobrara-White Natural Resources District (Jacobson Helgoth Consultants 1994) indicated that additional information was needed to prepare more meaningful recharge estimates for the entire UNWNRD so that a better water budget model could be created for the district.

Additionally, increases in crop production would suggest that crop evapotranspiration in the district has probably increased. Significant unknown factors in the water balance of the basin include changes in crop water use efficiency (especially for dryland crops), changes in evapotranspiration salvage, and changes in total crop production on ground water irrigated acres versus all other acres.

Ground Water Wells/Development

The Niobrara Basin has about 2,057 active irrigation wells and 49 high capacity wells (500 gallons per minute or more) used for non-irrigation purposes. Irrigation wells in the UNWNRD portion of the Niobrara Basin increased from 1,161 at the beginning of 1980 to 1,536 at the beginning of 1990 to 2,057 by February 29, 2004. There are approximately 115 irrigation wells within a seven mile buffer of the Niobrara River above the Mirage Flats diversion and approximately 125 irrigation wells in the Niobrara River surface water basin above the Mirage Flats Diversion. Figure 32 provides a map of irrigation well locations as well as information on water level changes since predevelopment. Figure 33 supplies the information at a larger scale for the eastern part of the district. Excluding the Box Butte Creek and Snake Creek Basins there are approximately 990 active irrigation wells downstream of the Mirage Flats diversion in the Niobrara River Basin. As of March 20, 2003 the UNWNRD placed a moratorium on the construction of new wells with a capacity of more than 50 gpm.

Figures 34 through 39 provide cumulative depletive and irrigation well numbers through time as well as cumulative surface water appropriation acres through time for the UNWNRD. Of the 49 high capacity non-irrigation wells in the Niobrara River Basin, 22 were for public water suppliers, 13 were for livestock and 9 were for commercial/ industrial purposes. It should be noted that while surface water irrigated acres in the Niobrara River Basin portion of the UNWNRD have been at a near plateau since 1960, the number of ground water irrigation wells in the same region have grown from 302 to 2013 and the associated ground water acres have grown from 53,000 to 317,000 since 1960.

Figure 32 indicates that substantial ground water level declines have occurred in Box Butte County since 1946, in places reaching more than 50 feet. Figure 40 shows readings from an Alliance recorder well within the area of declines that indicate the depth to water had increased by approximately 40 feet between June 1968 and June 2002. Based on the 2003 CSD decline map the edges of the area of decline have reached within 1 mile of the Niobrara River.

Figure 41 provides evidence of water level changes from a recorder well in the Mirage Flats area. The recorder well shows an initial rise in ground water levels following initiation of observation in the early 1950s through the early to mid 1970s, followed by falling levels since that time. Other recorder wells in the area with measurements beginning in the 1970s also show declines. Figure 32 indicates portions of the area have now experienced substantial water level declines from predevelopment. Figures 42, 43 and 44 indicate averages from some observation wells in the southern and northern portions of the Mirage Flats Area. They indicate a steeper decline in the northern portion of the district, with more modest declines to the south, nearer the river.

Niobrara River Upstream of the Mirage Flats Diversion

<u>Analysis</u>

In recent history the Niobrara River has been administered every year to meet the 1937 water right for the Mirage Flats Canal.

The amount of surface water available for diversion from the Niobrara River upstream of the Mirage Flats canal diversion has significantly decreased. At the state line the five-year average flow decreased by 567 acre-feet between the 1956-1960 time period and the 1996-2000 time period. The average flow for the same time periods above Box Butte Reservoir decreased by 4,332 acre-feet. This indicates that although there are significant decreases in average flow at the state line, there are considerably larger decreases after the river enters the state. Records also show that diversions to the Mirage Flats Canal averaged 19% less per year during the 1976 to 2003 time period than during the 1948 to 1975 time period.

River reach gains during the 1956 to 2002 time period were also analyzed for the reach of the Niobrara between the Wyoming-Nebraska State line gage and the gage above Box Butte Reservoir (Figure 45)[1]. Reach gains declined significantly even though during the same period the precipitation at the nearest station, Agate, showed no significant decreasing trend. During this

[1] The analysis involved examining flow at both gages, subtracting gaged diversions (gaged diversions have rights to approximately 84% of the acres irrigated with surface water rights in the reach), and holding remaining water rights constant through time for purposes of analysis.

same period there was a significant increase in the number of wells in the reach. Regression analysis determined that precipitation has a significant positive contribution toward explaining the variance of the gain while the number of irrigation wells has a negative contribution. Almost 79% of the variations in the gains can be explained by these two factors, with numbers of irrigation wells and local precipitation accounting for 62% and 17% of the variation respectively.

Wells in aquifers that are in hydrologic connection with the Niobrara River have increased significantly over time as have their associated irrigated acres. Within a seven mile buffer of the river reach, the number of active irrigation wells has increased from 24 in 1960 to 115 at present. Significant ground water level declines are currently occurring in the aquifer to the south of the Niobrara River in Box Butte County and the edges of the decline area are approaching the river. Based upon the CSD 2003 decline map, it appears that a portion of that decline is affecting the ground water that flows toward the reach of the Niobrara.

The hydrogeology of the Niobrara Basin in the UNWNRD indicates that these declines are in aquifers that are in hydrologic connection to the Niobrara River. Even in western Box Butte County where the low permeable Brown Siltstone Unit lies between the alluvial aquifer of the Niobrara River and the Arikaree and Ogallala aquifers to the south, the presence of sufficient water to supply domestic wells indicates that there is a hydrologic connection between all these formations and the Niobrara River.

Conclusions

In summary, for the reach of the Niobrara upstream of the Mirage Flats diversion: there has been a moratorium on new surface water appropriations since 1990, flows have diminished, surface water diversion amounts have diminished, average precipitation amounts have not significantly changed, and the number of irrigation wells hydrologically connected to the stream reach have increased. Water table declines are evident in Box Butte County in aquifers that are in hydrologic connection with the surface waters of the river reach.

The level of surface water supplies is insufficient to sustain the beneficial purposes for which surface water rights on the reach were granted. Based upon hydrogeologic information the aquifers along the Niobrara River above the Mirage Flats Diversion are hydrologically connected to the river reach. Ground water use is depleting the ground water supply in the aquifers. Where wells are depleting aquifers in hydrological connection to a river, the wells will cause depletions to streamflow in the river. Impacts of the wells closest to the river would be expected to cause relatively more significant and quicker impacts to flows. Where present the low permeability of the Brown Siltstone decreases the impacts of declining ground water levels to the south on the Niobrara River; however, without further information, the potential for these impacts on streamflow in the Niobrara River cannot be discounted. Further study of the impact of the Brown Siltstone unit on the potential of wells in aquifers to the south to impact the river should be a component of any integrated surface water/ ground water plan for the basin.

Mirage Flats Area / Niobrara River from Mirage Flats Diversion to Confluence of Box Butte Creek

<u>Analysis</u>

There appears to be a sizeable reach gain above the Mirage Flats Diversion Dam. In the 1995 to 2003 time period the annual flow of the Niobrara River below Box Butte Reservoir was 13,500 acre-feet and 13,800 acre-feet was removed seven miles further downstream at the Mirage Flats diversion. Since more is being diverted downstream than is being released at the reservoir, the river must be gaining baseflow through this reach in the summer. Additionally, measurements taken by the DNR during the non-irrigation season indicate a monthly reach gain of around 720 acre-feet between the reservoir and the Mirage Flats diversion. It is reasonable to expect some of this reach gain is present during the irrigation season, but the exact amount is unknown.

In an effort to determine more about the current status of this reach of the river DNR staff made spot measurements of streamflow on September 16, 2004 and interviewed several appropriators along the reach. Flow levels found were as follows:

Location	Name	CFS
Nio. Riv. Below Box Butte Reservoir		0.79 cfs
Sec 26-29-48	Nio. Riv below Mirage Flats Div Dam	9.33 cfs
Sec 19-29-45	Nio. Riv. Above Box Butte Cr	12.20 cfs
Sec 29-29-45	Box Butte Cr where it discharges into Nio. Riv	.30 cfs
Sec 20-29-45	Nio. Riv. Below Box Butte Cr	13.80 cfs

All the tributaries located between the Mirage Flats Diversion Dam and Box Butte Creek were dry.

Although there are no long-term flow data, the presence of a reach gain above the diversion dam and between the Box Butte Reservoir and the gage at Gordon, Nebraska, along with the September 2004 DNR measurements suggest that this section of the river is a gaining reach.

There are eight irrigation rights for a total of 13.58 cfs along the reach, most in the lower end of the reach. Comments from interviews with irrigators in this area indicated that currently appropriations in this reach were being satisfied but that flows had decreased in recent years and that some subirrigated wet meadows were no longer wet. One appropriator also indicated that during the summer the river would flow at about half the level it was flowing at the time he was interviewed. There is no record of any administration for the surface water rights in this reach.

This reach of the river is near the irrigated lands of the Mirage Flats Irrigation District and in its downstream end is subject to the impacts of the irrigation district on surface water return flows and baseflow to the river. Figure 15 shows long-term declines in surface water diversions to the Mirage Flats Canal. The data show an overall long term downward trend. Since irrigation wells in the Mirage Flats area are dependent upon recharge from that project, the total supply available to wells is also affected. Because of surface water recharge from the project, water table levels in the area rose until the early to mid-1970s and then began to fall. A USGS report indicated that in 1962, prior to the time when the ground water levels began falling, about 3,000 acre-feet of ground water was pumped in the Mirage Flats project area, which was probably less than the average annual amount of seepage from the project to the zone of saturation (Keech, 1964).

NDNR records indicate that in 1962 there were 51 active irrigation wells in a broadly delineated area that encompasses the Mirage Flats District. As of July 2004 there were 217 active irrigation wells in that area (Figure 46). Most of the wells in the Mirage Flats District are located several miles from this river reach. There are 77 irrigation wells within 2 miles of the river throughout this reach. Eighteen of the irrigation wells are on the south side of the river and, of the 59 on the north, 50 are also in the broadly delineated Mirage Flats region included on the map (Figure 47). It is likely that the additional consumptive use of the ground water wells is now greater than the average annual seepage from the surface water irrigation project and is causing the ground water level declines.

The saturated thickness of the principal aquifer in the Mirage Flats area is estimated to be between 200 and 300 feet with higher levels generally being to the south and east. Figure 26 shows direction of ground water flow to be toward the river and indicates ground water from the southern portions of the Mirage Flats project area is reaching the Niobrara River upstream of the confluence of Box Butte Creek. There have been water level declines in wells along the southern portion of the Mirage Flats area near the river, although not as significant as the declines in the northern portion of the Mirage Flats area (Figure 43). Based upon the reach gain estimates it seems likely that despite ground water level declines in part of the project area, ground water continues to provide baseflow to the river in this reach. It is also important to note that this river reach is hydrologically connected to the aquifer in Box Butte County where there are significant ground water level declines. At this time there are insufficient data available to know the exact amount and timing of any baseflow reaching this river reach or how the ground water level declines might be affecting the baseflow. The installation of a stream gage station and monitoring wells along with other studies to gather data would help answer these questions.

Conclusions

In summary, at the current time this reach of the river has received no calls for administration. There is little historic stream flow data to show trends in stream flow. Ground water contour maps and stream flow observations show that this reach of the Niobrara River gains baseflow. Water well hydrographs and the CSD decline map show significant ground water level declines in aquifers that are hydrologically connected to this river reach. These gains currently appear to be sufficient to satisfy the surface water rights in the reach but there is some anecdotal information that the flows are declining and that administration could be required in the near future. Long term ground water declines associated with ground water pumping in the Mirage

Flats area are affecting the river, but the magnitude and timing of such effects and whether such effects will adversely impact surface water rights in the reach in the near or distant future cannot be determined without further study.

Confluence of Box Butte Creek to the Eastern Boundary of the Natural Resources District

Downstream of the confluence of Box Butte Creek there are no records of calls for surface water administration and it appears that there is sufficient streamflow to satisfy all downstream rights. This reach would be impacted by any changes in base flow due to development in the Mirage Flats Irrigation District, which could adversely affect the surface water rights immediately downstream.

Box Butte Creek Basin

General Description

Box Butte Creek is a tributary of the Niobrara River that enters the river below the Mirage Flats Canal headgate and drains approximately 247 square miles. The Creek originates east of Hemingford, flows toward the southeast for about 10 miles, and then turns towards the northeast and Sheridan County. After entering Sheridan County it turns north toward the Niobrara River.

Cady et. al. (1946) noted that in the 1930's in Box Butte County, Box Butte Creek was a perennial stream except near the eastern portion of the county near the Sheridan County line and that in certain moist years even this reach may have been perennial. There are no continuous gaging records for Box Butte Creek. According to numerous observations west of the Sheridan County line, Box Butte Creek is no longer a perennial stream but east of the Sheridan County line the creek still has constant flow. Spot gaging on the creek in 1986 and again in December 2002, a very dry year, found flow near the mouth of the creek with the creek becoming dry about ½ mile further upstream. In 2002 there was also ponded water at a point a number of miles upstream and cattails at points along the stream. For further general information relevant to the Box Butte basin, including information on precipitation, land cover, and aquifers see the Niobrara River Basin section of this report.

Surface Water Appropriations/Administration/Characterization of Surface Water Flows

Six of the seven surface water rights in the Box Butte Creek basin, with priority dates from 1950 to 1989, are on the mainstem; two are storage rights. In a 1979 adjudication of surface water rights, a number of rights in Box Butte basin were cancelled. Nebraska Department of Natural Resources personnel at one time received calls for surface water rights administration along Box Butte Creek but are no longer asked to administer. It is possible that the lack of calls for administration in recent years is due to a recognition on the part of water right holders that no water is available.

Hydrogeology
(Note: for general geology and hydrology, see the corresponding section on the Niobrara Basin).

Cady (1946) reported that ground water in the northern third of the Box Butte County drained into the lowlands of the Niobrara, either directly, or through Box Butte Creek. In the western area of the Box Butte Creek basin the Box Butte Unit, a thin very clayey silt layer, acts as a confining layer and causes a perched water table where present (Souders et al, 1980). The Sheep Creek Unit mantles the Box Butte Unit in much of the basin. This unit is not a major aquifer; however, it has been reported that some shallow stock and domestic wells obtain their water supply from this unit where it is saturated due to the perched water table caused by the Box Butte Unit (Souders et al, 1980). It is likely that the perched water table in the Sheep Creek Unit is the source of baseflow for Box Butte Creek in its upper reaches. At the Box Butte – Sheridan County line the Box Butte Unit is at considerable depth, 200+ feet, and overlain by the Runningwater Unit. Additionally, Testhole 7-B-79 from Souders (1981) indicates that the Box Butte Unit is either no longer present or no longer contains as high of a percentage of clay east of the Box Butte – Sheridan County line near Box Butte Creek, meaning it is no longer an effective confining layer.

The Runningwater Unit has a saturated thickness of more than 100 feet where Box Butte Creek crosses the Box Butte – Sheridan County line. The Runningwater, which is composed of sand and gravel stream deposits, is estimated to be able to yield enough water to develop 400 to 800 gpm irrigation wells (Souders et al, 1980). The water table contours indicate Box Butte Creek gains water from this unit from the Box Butte – Sheridan County line to its confluence with the Niobrara River. The Box Butte, Sheep Creek and Runningwater Units are considered to be part of the Ogallala Group, which is what is shown on the geology map (Figure 18).

Ground Water Wells/Development

The surface water basin of Box Butte Creek includes 155 active registered irrigation wells. Figure 32 indicates both the location of irrigation wells in the district and the substantial ground water declines that have occurred in much of the subbasin. These declines are in aquifers that are hydrologically connected to Box Butte Creek.

Conclusions

Stream flow in Box Butte Creek has declined since the 1930’s. Wells in the basin are contributing to changes in ground water levels in aquifers that are hydrologically connected to Box Butte Creek. The consumptive use from ground water wells has caused or will cause depletions in Box Butte Creek and has adversely affected surface water rights in the basin.

Snake Creek Basin

General Description

In the 1930’s and 40’s Snake Creek was a perennial stream with a small discharge, except during floods, that arose in eastern Sioux County and ran in an easterly direction across the southern portion of Box Butte County before losing itself in a broad lowland 3 or 4 miles wide near Alliance (Cady, et. al. (1946). In a 1980 report Souders, et. al. (1980) stated that Snake Creek flowed year round from west of the Box Butte County line to east of Kilpatrick Lake and that east of there it was an ephemeral stream. Other information in that report indicates that at that time Snake Creek had areas of shallow water table along its lower reach and that to some degree the lowering of the water table by pumping had salvaged evapotranspiration in some of that area. Today Snake Creek only flows west of Kilpatrick Lake.

The watershed is a part of the Niobrara Basin, although the Creek did not have any surface water connection to the Niobrara River. There are other similar streams in this area including Point of Rocks Creek (a Snake Creek tributary) and nearby Hemingford Creek and Berea Creek, which dead-end into the western portion of the Sandhills. Souders et. al. (1980) identified these three streams as being ephemeral. These creeks flow generally northwest to southeast, ultimately dead-ending on the western portion of the Sandhills. For further information relevant to the Snake Creek Basin and precipitation and land cover in the basin, see the section on the Niobrara River Basin.

Surface Water Appropriations/Administration/Characterization of Surface Water Flows

There are currently five surface water rights associated with the Snake Creek Basin. Two of those are associated with Kilpatrick Reservoir, one with Kilpatrick Canals and two with Snake Creek tributaries. Two rights are for storage, two for irrigation, and one for supplemental irrigation. Priority dates range from 1894 for the Kilpatrick canals and 1911 for Kilpatrick Reservoir to 1970 and 1973 for the water rights on the tributaries.

Administration has not occurred in the Snake Creek Basin since the early 1970s. This may be in part because the three rights on Snake Creek proper are all for Kilpatrick Reservoir and canals and the other two rights have no rights upstream of them. Thus there are no other rights to call on.

There are no gages on Snake Creek. Spot measurements showed flow above Kilpatrick reservoir in 1983, although not in 1986 or 1987. There are also reports of wetlands in the area. Thirty years ago it was not unusual to measure 4 to 6 cfs of inflow to the reservoir compared to current measurements of 1 to two cfs range (Hayden, 2002). At one time the basin also contained Bronco Lake, which has been dry for some time. In 2004 it was reported for the first time that Kilpatrick Reservoir was dry. Snake Creek has ceased to flow below the Kilpatrick Reservoir. For all practical purposes, only above Kilpatrick Reservoir can Snake Creek be called a live stream.

Hydrogeology

Details on the hydrogeology near these creeks can be found in the hydrogeology discussion within the Niobrara River Basin. In short, the Arikaree and Ogallala groups are hydrologically connected to Snake Creek and are capable of producing water for large capacity irrigation wells. The configuration of the water table continues to show ground water flow moving toward the stream as it approaches the area of the stream.

Ground Water Wells/Development

Snake Creek basin currently has 780 active registered irrigation wells. Approximately 767 of these wells are within a five-mile distance of the creek. Figure 5 indicates the location of irrigation wells in the district along with the stream network. Heavy pumping of ground water wells in the area has resulted in ground water levels falling by about 30+ feet in northern portions of the Snake Creek Basin, averaging 1 foot of decline per year since 1960. The edges of the decline area now reach beyond the Snake Creek subbasin and into the Niobrara River Basin as well as out of the UNWNRD and into northern Morrill County in the North Platte Natural Resources District (Figure 32).

Conclusions

Ground water pumping in the basin has contributed to declines in streamflow in Snake Creek to the degree that the only portion of Snake Creek that exists as a live stream is above Kilpatrick Reservoir.

White River Basin and Hat Creek Basin

General Description

The White River Basin and Hat Creek Basin include 247 square miles in the northern portion of the Upper-Niobrara White NRD. Figure 3 presents land cover for the overall UNWNRD. Precipitation information for Chadron is provided in Figure 2. Annual precipitation at the Chadron station has minimum, maximum, and average annual values of 8.45, 23.16, and 15.92 inches respectively for the period of 1949 to 2003. There have been no significant long-term trends for precipitation in the basin. Information on precipitation and land use in the basin can be found in the discussion on the Niobrara River Basin.

Surface Water Appropriations/Administration/Characterization of Surface Water Flows

The oldest surface water right in the White and Hat basins dates to 1880 and there are a total of 527 surface water irrigation rights in the area. Of those, 296 rights are for the White River Basin, and 231 rights are for the Hat Creek Basin. About 25% of the rights in the basin are storage rights. Many small dams have been built on tributaries for the purpose of watering livestock. Figure 1 provides a map of surface water diversions throughout the UNWNRD. Figure 48 provides cumulative surface water appropriations in the basin, and Figure 49 provides surface water appropriation acres by use. The White River Basin contains 1,620 square miles in Nebraska and the Hat Creek Basin contains 474 square miles.

The basins support one surface water irrigation district and a large number of individual irrigation rights. Whitney Reservoir diverts water from the White River downstream from Crawford and provides water to the Whitney Irrigation District. Surface waters in the study area also support other uses. The upper reaches of the White River, Hat Creek and their tributaries support one of Nebraska's best cold-water fisheries. Crawford's municipal water supply comes from wells in the White River alluvium. Although they have wells, both Crawford and Chadron also have surface water rights associated with their municipal water systems.

Surface water rights in both the Hat Creek and White River basins are administered in most years. There has been an informal moratorium and new surface water rights have been denied in both basins since 1995 due to insufficient flow.

Sando (1991) estimated and characterized what would have been natural streamflow without irrigation depletions on the White River near the Nebraska state line and found there would have been flow in every month in the 1976 to 1989 time period with average annual flows ranging from 14,654 acre-feet to 69,173 acre-feet (pg. 18). Sando indicated that the White River in Nebraska generally flows year round. However, some locations in some years experience periods of no flow. He also noted that streamflow generally was not sufficient to fully satisfy the net irrigation requirement for all irrigators during the later part of the irrigation season (pg. 11).

The White River does have continuous flow at a gage at Crawford and its gaged annual flows average 14,719 acre-feet and have remained fairly constant through time. There is a gage on the White River at Crawford that shows no significant trend on flows since 1931 (Figure 50). This may be a reflection of the commitment of flows at Crawford to downstream water rights.

While there is no Nebraska gage on Hat Creek, there is a gage on Hat Creek some distance into South Dakota near Edgemont. No significant flow trend is apparent for that gage during the 1951 to 2002 time period.

Hydrogeology

The aquifers in these basins are nearly nonexistent. Geologic cross-sections A-A’ and B-B’ (Figures 21 & 22) show the Arikaree Group as the primary unit in the western upper reaches (southern area of the basins) of the river basins. This is the same Arikaree Group aquifer that is found in the Niobrara River Basin and whose geologic properties were discussed in the earlier section of this report on the Niobrara River Basin. The Pine Ridge forms the surface water divide between waters that flow to the Niobrara to the south, and the White and Hat Creek basins to the north. While a ground water divide is also found along the Pine Ridge it is important to remember that a ground water divide is not permanent and that the direction of ground water flow can be influenced by stresses to the system.

Looking at the same cross-sections mentioned above, moving north from the Pine Ridge, lower geologic units are found at the surface, the Arikaree is literally cut off in these basins where it has eroded away and relatively impermeable materials are at the surface. The geologic units below the Arikaree and that outcrop progressively to the north are, in order, the Brule, the Chadron, and the Pierre Shale. None of these geologic units are considered major sources of ground water. The Brule is a tight formation composed primarily of silts and clays and has a minimal hydraulic conductivity of less than 25 feet per day (Olsson Associates, 1993). In some areas there may be a significant saturated thickness that contains a great deal of water; however, the hydraulic conductivity of unfractured Brule is very low (Wenzel, et al., 1946).

The Chadron consists mostly of massive silty claystones, light brownish to pink in color. These rocks owe their origin in large part to extensive deposits of volcanic ash, now mostly devitrified into clays. Occasionally discrete beds of volcanic ash can be found in the Chadron. Some channel sandstones may be present. A coarse sandy unit is often found at the base of the Chadron. The Chadron is similar to the Brule, it is tight and has a low hydraulic conductivity except in fractures or in the sand beds which are limited in areal extent. The Chadron rests on the Pierre throughout most of northwestern Nebraska.

The Pierre Shale is predominantly a dark gray or brownish-gray shale, but also contains thin beds of bentonite, zones of calcareous concretions, and some shaly limestones. The Pierre, which crops out over most of the northern part of the Hat and White Basins, is considered impermeable. It is found at the surface in the west and is overlain again by younger, more permeable formations in the far eastern areas of the Hat and White Basins. This unit is very tight and is not considered to hold any extractable ground water except where there are extensive fractures in contact with a source of water such as an alluvial valley.

The principal aquifer, the Arikaree, is recharged by precipitation and inflow from the western edge of the UNWNRD. Streams and tributaries that begin in this relatively permeable material on the Pine Ridge have perennial flow maintained by ground water baseflow in the upper reaches but ground water contribution effectively ceases once the streams flow over other geologic units. Bentall and Hamer (1980) in reference to Hat Creek, the White River, White Clay Creek, and their tributaries indicated that it was unknown whether any of these streams in their natural state flowed continuously as far as the South Dakota state line. They noted that they now become dry before they reach the state line because many impoundments reduce inflow from tributaries and diversions for irrigation consume all the remaining flow.

Fractures in the otherwise relatively impermeable Brule formation supply water for some stock and domestic wells as do the Chadron sands. At a few specific sites, where fracture systems intersect faults, this formation contributes up to 600 gallons per minute from springs (Jacobson-Helgoth Consultants, 1994). There are also some river deposited sediments along the major drainages. In their lower reaches the streams may be in hydrologic connection with small amounts of alluvial material, Chadron sands or fractures in the Pierre Shale or Brule Formation, but overall there is little ground water available for high capacity uses outside the upper reaches of the basin.

Based upon geologic cross-sections A-A' and B-B' (Figures 21 & 22), water table contour maps and other evidence, Hat Creek, White River and some of their tributaries are hydrologically connected to ground water in their upper reaches. The ground water source is the same Arikaree Group aquifer that is hydrologically connected to the Niobrara River; therefore, changes in stressors in either river basin could affect the baseflow to streams in the other basins. Outside the extent of the Arikaree, there is an absence of aquifers. However, where the other geologic formations provide water to small capacity wells, it is likely the formation through fractures is in hydrologic connection with a stream and/or alluvial aquifer.

Ground Water Wells/Development

There are only 24 registered irrigation wells in the White River and Hat Creek basins and 14 of these were in place prior to 1970. Only three new registered irrigation wells have been completed since 1980. Over 720 other types of depletive wells have been installed in the basin since 1989, but generally the amounts of depletion per well are low in comparison to irrigation wells. There are only 3 large capacity wells pumping more than 500 gallons per minute that are not irrigation wells. Figure 5 provides a map of irrigation wells throughout the district along with the stream network.

There are very few large capacity wells in these basins. This is mainly due to the topography and hydrogeology in the area. The alluvial areas are very small and lie on Pierre Shale and the Brule Formation, both of which are very tight and do not yield water to wells unless a fracture system is tapped.

Conclusions

Due to the nature of the geologic formations in the area the ground water supply in the White and Hat basins is limited. It seems likely that most wells have a hydrologic connection to surface water and would affect surface water appropriations; however, some may be in fractures that have little or no known connection to surface water. Given that the study area has insufficient surface water to grant new appropriations, some monitoring of ground water development trends will be needed to be certain that increased well development does not further deplete already insufficient streamflows.

Because the baseflow for streams in this area originates in the southern margins of the basin along the Pine Ridge, it is possible that ground water development just outside the physical surface water basin could affect baseflow in the headwaters of some streams such as Larabee Creek and possibly Beaver Creek and White Clay Creek, all of which have active surface water rights. The impact of well development outside the surface watershed boundary on the flow of these creeks should be monitored.

Potential Out of Basin Effects of Water Use In the UNWNRD

To what extent could the ground water declines in Box Butte County affect the North Platte River or its tributaries? A very small portion of the North Platte Basin surface water drainage reaches into the UNWNRD in the southern margins of Box Butte, Sioux, and Sheridan counties. Ground water subflow for a very small portion of Southern Sheridan County is hydrologically connected to the North Platte Basin. Ground water table contours indicate that this area provides baseflow to Blue Creek. However, this is an area where there is not a high gradient and there are many lakes and wetlands that influence ground water flow via evapotranspiration. With these localized complications, the direction of subflow can be difficult to determine.

Based on water table contour maps, the far southwest corner of the UNWNRD also appears to have ground water subflow towards the North Platte Basin, but there is only one irrigation well in that area. Between this area and the North Platte River lies the Brule Formation, an area of low transmissivity and hydraulic conductivity. The magnitude and timing of any declines originating from development in this area would be long term.

An additional potential impact that could occur due to ground water pumping in the Niobrara Basin/Sandhills area might involve the alkali lakes in the southeast portion of the UNWNRD. Should water table declines in eastern Box Butte County become marked enough, they might influence water table levels further east in the area of the Sandhills lakes.

Water table contours indicate the direction of subflow for ground water in a portion of southeast Sheridan County is towards the Loup River Basin. This area is very far from any stream headwaters and the Loup surface water drainage basin within the UNWNRD contains only five irrigation wells. While there is a hydrologic connection, impacts to surface water appropriators, if any, would be very small, and would likely not be felt for many years.

Parameters Considered in Delineating the Areas Where Ground Water is Considered to be Hydrologically Connected to the Surface Water Reaches

Drawing lines delineating the area of ground water hydrologically connected to a specific reach of a river is a technically complex task. Aquifer boundaries are relatively easy to define where impermeable geological formations outcrop near the surface or a stream that penetrates the full thickness of the aquifer. In absence of such boundaries, ground water table divides or ground water flow lines from the endpoint of the fully appropriated river reach could also be used. However, a ground water well on one side of a ground water table divide can still impact a stream on the other side of the divide and if the ground water table declines significantly, the location of the ground water table divide itself will change. Surface water boundaries generally are not useful for determining ground water flow, but in some instances the surface water divide does provide a major influence on ground water flows and mimics the location of the ground water divide.

As defined in this report the river reaches that are recommended to be designated as fully appropriated are the full reaches of the White River and Hat Creek, the Niobrara above the Mirage Flats diversion, Box Butte Creek and Snake Creek.

In the White River and Hat Creek, the live sections of the streams are in the headwaters and are in hydrologic connection with the Arikaree aquifer, which continues into the Niobrara River Surface Water Basin. Possible boundaries in this area include the ground water and surface water divides. However, the situation exists where ground water well development outside of these boundaries could affect baseflow in the stream reaches of concern. Hydrologically speaking, there is a continuous aquifer from the Niobrara River to the headwaters of the White River and Hat Creek. However, as distance increases away from the headwaters the degree of connection decreases.

One way to measure the degree of connection is to use a stream depletion calculation (Jenkins, 1977). Based upon existing data concerning transmissivity and specific yield the following stream depletion lines were calculated: 28% over 40 years - 2.5 to 5 miles from the upper reaches of the streams, over 80 years the range is 3 to 7 miles and over 120 years the range is 4 to 8 miles. Some value of stream depletion could be chosen as the boundary for the area in which ground water is hydrologically connected to the stream reach.

In the Niobrara River basin near the Mirage Flats diversion point there is a stream (Cottonwood/Pebble Creek) located on the north side of the River; however, there is no reason to believe that this stream fully penetrates the aquifer. Another option is this area would be to follow a ground water flow line north from the diversion point to where it intersects the boundary with the White River. The ground water flow line would be even less of a hydrologic boundary than the stream.

To the south of the Niobrara River the situation is more complex. The question raised above, of the effects of ground water declines across a ground water divide is applicable. According to the ground water level decline maps developed by the CSD in Box Butte County, a 20’ to 30’ decline has occurred at the ground water divide between the Niobrara Basin and the Snake and Box Butte Creek basins. Moving from the ground water divide north toward the Niobrara River the 5’ to 10’ decline zone reaches to within a mile of the Niobrara River. There is question as to the degree of hydrologic connection between the decline area and the Niobrara River due to the presence of low permeability geologic materials. However, as was mentioned previously, Souders et al (1980) stated that this material does contain enough water to produce wells of 600+ gallons per minute and that a possible 1,500 acre feet per year of ground water flow reaches the river above Box Butte Reservoir. Given the evidence and the severity of the ground water level declines any possible effect on the fully appropriated river reach must be considered.

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Appendix I

February 26, 2003

John Burke, Chairperson
Upper Niobrara White NRD
430 East 2nd Street
Chadron, NE 69337

Dear Mr. Burke:

This letter is to notify your district that in accordance with the requirements of section 46-656.28 (2), R.R.S., 1998, I have made a preliminary determination in response to your written request of January 10, 2003. My determination is that there is reason to believe that the use of hydrologically connected ground water and surface water resources in the Upper Niobrara White Natural Resources District is contributing to or is in the reasonably foreseeable future likely to contribute to conflicts between ground water users and surface water appropriators.

In order to make this preliminary determination Department staff reviewed the records of the Department; the District's ground water management plan, rules and regulations; ground water monitoring records; the Department's "Hydrographic Reports"; the USGS "Water Resources Data – Nebraska" showing stream flow, canal diversions and ground water levels; the Department's "Biennial Reports" showing surface water appropriations; and the ground water well registration data. Other resources reviewed include the following: Geology and Ground-Water Resources of Box Butte County, Nebraska, USGS Water-Supply Paper 969; Ground-Water Resources of Mirage Flats, Nebraska, USGS Water-Supply Paper 1779-BB; Geology and Groundwater Supplies of Box Butte County, Nebraska, Nebraska Water Survey Paper Number 47. On January 23, 2003, Tom Hayden wrote a memo documenting the decline in the surface water flow of Box Butte Creek, Snake Creek, and Antelope Creek from the time he started working for the Department until current day.

Based on this review we determine that:

1. There have been concerns about declining surface water flows resulting from the increased ground water pumping throughout the District, most notably in the Niobrara River Valley. A letter to the Governor dated October 19, 2002, echoed these concerns. The District also provided a list of concerns the public has regarding declining surface and ground water levels. These events have prompted the District to take action on conjunctive use to try to avoid further conflicts.

2. The Department published notice and issued a formal order declaring a moratorium on new surface water rights along the Niobrara River above Box Butte Reservoir. The Department has also denied applications in the White River and Hat Creek Basins since approximately 1993 on the basis that there is insufficient unappropriated water; effectively placing a moratorium on the White River and Hat Creek Basins.

3. The Department's database on water well registrations show that the number of new irrigation water wells constructed annually within the Upper Niobrara White NRD hit a peak in 1976 then declined until 1988 and rebounded to an average of 30 new wells completed per year until 2003. As of February 5, 2003, the total number of completed irrigation wells in the District was 2,038. (Figures 6 – 8)

4. The District is underlain by unconsolidated to consolidated, very fine to coarse-grained sediments which were deposited primarily in alluvial and eolian environments. These sediments comprise the different aquifers found throughout the District. Ground water from these sediments is the primary source of flow for the Niobrara River and other streams in the District. The relationship between the aquifers and surface water is most readily apparent in the Mirage Flats area and in Box Butte County. Within the Mirage Flats area, a locally significant rise in the water table corresponds to the delivery of surface water through the canals. The resultant ground water mound has been declining in recent years most likely due to the increased pumping in the area. In Box Butte County, heavy pumping of ground water for the past several decades has resulted in a significant decrease in the water table. This decrease appears to correspond with the declining flows in several of the streams that drain the county. Prior to the extensive development of ground water pumping, Snake Creek was identified as a perennial stream fed primarily by ground water. It is now an intermittent stream.

5. Monitoring wells reported by the USGS on their online database show ground water declines in various wells in the District. (Figures 1 – 5)

The above findings support a preliminary determination that there is reason to believe that the use of hydrologically connected ground water and surface water resources is contributing to or is in the reasonably foreseeable future likely to contribute to a conflict between ground water users and surface water appropriators. Accordingly, Ann Bleed is authorized to work with the District to conduct studies to determine the extent and precise cause of the conflict.

Sincerely,

Roger K. Patterson
Director

tk
Enclosures

Upper Niobrara-White
Natural Resources District

430 East 2nd Street
Chadron, Nebraska 69337

Telephone (308) 432-6190 http://dbdec.nrc.state.ne.us/unwnrd/ Fax (308) 432-6187

January 10, 2003

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JAN 13 2003

DEPARTMENT OF ... URCES

Mr. Roger Patterson, Director
Department of Natural Resources
P.O. Box 94676
Lincoln NE 68509

Dear Mr. Patterson,

Ground water levels within the Upper Niobrara White Natural Resources District have steadily declined for over 30 years. Declines in ground water levels have subsequently affected surface water; streams where there used to be surface water appropriations no longer carry water to appropriate. For example, Bronco Lake located west of Alliance is completely dry.

Surface water that is transported via canal to the Mirage Flats Irrigation District in Sheridan County is affecting the ground water in the area. Monitoring and observation well information from Mirage Flats indicate the effect in variable water levels and water temperature.

Therefore, we believe it would be in the best interest of the public to establish an integrated management area to manage these waters. With this letter, the Upper Niobrara White Natural Resources District requests, under the Nebraska Ground Water Management and Protection Act (section 46-656.28), that the Department of Natural Resources consult with the Upper Niobrara White NRD; and that studies and a hearing be held on the preparation of a joint action plan for the integrated management of hydrologically connected ground water and surface water.

Sincerely,

John Burke, Chairman

Surface Water Rights in the Upper Niobrara White Natural Resources District

Application	Annotation	Carrier	Priority Date	Use[1]	Grant[2]	Rate[3]	Sec	Twn	Rng	County
A Jordan Lower Reservoir										
A 3446	A-3446	Lower Jordan Canal	2 28 1941	6	0		16	34	55 W	Sioux
A 5212	A-5212	Allen Jordan Pump	2 28 1941	6	0		16	34	55 W	Sioux
A Jordan Reservoir										
A 5212		Jordan Canal No. 1	8 23 1940	5	0		16	34	55 W	Sioux
A 3446		Jordan Canal	8 23 1940	5	0		9	34	55 W	Sioux
Alkali Creek										
A 9889		Ormesher Corner Reservoir	2 17 1961	2	36 AF		22	35	48 W	Dawes
Anderson Reservoir										
A 4976		Pump	4 18 1950	5	0		26	31	47 W	Dawes
A 3396		Anderson Canal	10 16 1940	5	0		2	29	47 W	Dawes
A 4861		Anderson Canal 1-2	8 19 1949	5	0		2	34	56 W	Sioux
Andrews Reservoir										
A 9815		Pump	3 26 1935	5	0		5	32	55 W	Sioux
A 4464		Andrews Canal	3 26 1935	5	0		5	32	55 W	Sioux
A 2558		Andrews Canal	3 26 1935	5	0		5	32	55 W	Sioux
Antelope Creek										
A 5124		Hull Canal No. 4	1 5 1953	1	1.14	70	22	33	42 W	Sheridan
A 3239		A Jordan Reservoir	8 23 1940	2	776 AF		9	34	55 W	Sioux
A 10551		Antelope Creek Res. 40-B	3 3 1965	2	774 AF		24	33	42 W	Sheridan
A 5168		Hull Canal No. 1	2 17 1953	1	0.04	70	22	33	42 W	Sheridan
A 5172		Hull Reservoir	2 17 1953	2	2.3 AF		22	33	42 W	Sheridan
A 5170		Hull Canal No. 5	2 17 1953	1	0.17	70	20	33	42 W	Sheridan
A 5169		Hull Canal No. 6	2 17 1953	1	0.94	70	20	33	42 W	Sheridan
A 5171		Hull Canal No. 2	2 17 1953	1	0.47	70	22	33	42 W	Sheridan
Antelope Creek, North										
A 1509		Story Canal	3 26 1918	1	6.43	70	9	34	56 W	Sioux
A 168		Story Canal	11 11 1895	1	2		8	34	56 W	Sioux
Antelope Creek, South										
A 17252		Eitel Reservoir No. 1	2 24 1993	2	14.9 AF		33	34	57 W	Sioux
A 14743		Pumps 1-3	2 18 1977	1	0.34	70	15	34	56 W	Sioux
D 537		Turner Canal	10 31 1894	1	0.86	70	26	34	57 W	Sioux
A 1675		Turner Reservoir	7 3 1922	2	250 AF		26	34	57 W	Sioux
A 338		Ellis Canal	5 17 1896	1	0.29	70	9	33	57 W	Sioux

Application	Annotation	Carrier	Priority Date	Use [1]	Grant [2]	Rate [3]	Sec	Twn	Rng	County
Antelope Creek, South, Trib. To										
A 3775		Schnurr Reservoir No. 2	10 10 1944	2	123 AF		23	34	57 W	Sioux
A 10151		Story Canal No. 3	2 27 1963	1	3.74	70	19	34	56 W	Sioux
A 4907		Dunlap Reservoir No. 1	9 18 1951	2	16 AF		15	34	56 W	Sioux
A 6415		Dunlap Reservoir No. 2	7 8 1954	2	20 AF		15	34	56 W	Sioux
Antelope Creek, Trib. To										
A 10550		Antelope Creek Res. 60-A	3 3 1965	2	446 AF		28	33	42 W	Sheridan
A 4502		Anderson Reservoir	8 19 1949	2	65 AF		2	34	56 W	Sioux
A 8942		Holzberger Reservoir	10 30 1956	2	43 AF		29	34	42 W	Sheridan
A 3405		A Jordan Lower Reservoir	2 28 1941	2	137 AF		16	34	55 W	Sioux
Ash Creek										
A 5281		Pump	4 24 1953	1	0.29	70	1	32	51 W	Dawes
Ash Creek, East										
A 2024		Barron Canal	8 15 1928	1	0.89	70	32	32	50 W	Dawes
D 438		Barron Canal	7 1 1888	1	1.14	70	32	32	50 W	Dawes
A 2057		Thomas Canal	12 17 1928	1	1	70	19	32	50 W	Dawes
A 1953		Norman Reservoir	8 22 1927	2	776 AF		32	32	50 W	Dawes
A 16376		Barron Canal	5 6 1985	1	1.68	70	32	32	50 W	Dawes
A 2205		Stumph-Ox Yoke Canal	6 6 1931	1	0.26	70	32	32	50 W	Dawes
D 1023	R	Stumph Canal	9 5 1892	1	0.22	70	32	32	50 W	Dawes
D 447	R P-160	Stumph Canal	5 31 1880	1	0.16	70	32	32	50 W	Dawes
Ash Creek, East, Trib. To										
A 17013		Hollibaughs Fish Ponds	8 17 1990	2	8.28 AF		29	31	50 W	Dawes
A 11803		Ham Fish Pond	9 23 1969	2	2.2 AF		8	31	50 W	Dawes
A 4760		Ivins Reservoir	10 30 1950	2	25 AF		30	32	50 W	Dawes
Ash Creek, West										
A 16042		Pump	12 24 1981	1	0.09	70	14	31	51 W	Dawes
A 12905		Pump	7 17 1973	1	0.19	70	11	31	51 W	Dawes
D 452	R P-NONE	West Ash Creek Canal	7 4 1893	1	0.8	70	35	32	51 W	Dawes
A 434	R P-350	West Ash Creek Canal	2 3 1898	1	0.57	70	35	32	51 W	Dawes
A 5973	R	West Ash Creek Canal	2 18 1954	1	3.26	70	35	32	51 W	Dawes
A 12744		Pump	9 22 1972	1	0.06	70	31	31	50 W	Dawes
A 17417		Soester Reservoir	11 8 1994	2	67.7 AF		2	31	51 W	Dawes
A 3362	R P-349	West Ash Creek Canal	1 6 1941	1	1.31	70	35	32	51 W	Dawes
Badland Reservoir										
A 8704	A-5986	Badland Canal	7 23 1952	6	0		7	33	56 W	Sioux
A 8704		Badland Canal	7 23 1952	5	0		7	33	56 W	Sioux

Application	Annotation	Carrier	Priority Date			Use [1]	Grant [2]	Rate [3]	Sec	Twn	Rng	County
Bauer's Lone Tree Reservoir												
A 6916		Bauer's Lone Tree Canal	9	23	1953	5	0		22	34	51 W	Dawes
Beaver Creek												
A 5081		Isham Reservoir	11	24	1952	2	435 AF		18	34	46 W	Sheridan
A 15795		Pump	3	20	1981	1	3.19	70	20	34	46 W	Sheridan
A 2034		Lockler Canal	9	19	1928	1	0.49	70	34	35	47 W	Sheridan
D 1017		Lockler Canal	9	15	1892	1	1.83		34	35	47 W	Dawes
A 6400		Kadlecek Reservoir	6	30	1954	2	70 AF		34	33	46 W	Sheridan
A 4932		Pumps	1	15	1952	1	0.14	70	28	34	46 W	Sheridan
A 16118		Pump	6	4	1982	4	0.02		32	34	46 W	Sheridan
Beaver Creek, Little												
A 16117		Pump	6	3	1982	4	0.03		28	34	46 W	Sheridan
A 4608		Lundy Reservoir	2	27	1950	2	222 AF		33	34	46 W	Sheridan
A 4933		Pump	1	15	1952	1	0.03	70	28	34	46 W	Sheridan
A 6686	A-4608	Lundy Reservoir	9	13	1954	8	47 AF		33	34	46 W	Sheridan
A 5154		Reeves Reservoir	2	9	1953	2	0.5 AF		28	34	46 W	Sheridan
Bodarc Springs												
A 4765		Zimmerman Reservoir	11	9	1950	2	26 AF		27	33	55 W	Sioux
Boggy Creek												
A 2182		Wickersham Reservoir	12	24	1930	2	250 AF		31	33	54 W	Sioux
A 2204		Wickersham Canal	5	15	1931	1	0.96	70	31	33	54 W	Sioux
A 701		Wickersham Canal	2	28	1903	1	3	70	31	33	54 W	Sioux
A 4918		Wickersham Res. No. 2	11	7	1951	2	42 AF		31	33	54 W	Sioux
Boggy Creek, Middle												
A 342		Marten Canal	5	19	1896	1	0.36	70	18	32	54 W	Sioux
Boggy Creek, West												
A 886		Hill Canal	1	20	1908	1	0.86	70	11	32	55 W	Sioux
A 4639		Holmgren Reservoir	4	11	1950	2	43.1 AF		2	32	55 W	Sioux
Bordeaux Creek, Big												
A 1748	R P-323	Pump	9	12	1924	1	0.16	70	34	34	48 W	Dawes
A 2036	R P-286	O'donnell Canal	9	22	1928	1	0.63	70	9	34	48 W	Dawes
A 432	R P-285	O'donnell Canal	1	17	1898	1	0.14	70	9	34	48 W	Dawes
A 5202		Pump	3	10	1953	1	3.55	70	9	34	48 W	Dawes
A 2151		Pump	7	24	1930	1	0.1	70	14	33	48 W	Dawes
A 2801		Pump	11	16	1937	1	0.21	70	16	34	48 W	Dawes
A 9428		Pump	4	4	1957	1	1.71	70	21	34	48 W	Dawes
A 15796		Pump	3	23	1981	1	1.62	70	28	34	48 W	Dawes
A 5447		Pump	8	4	1953	1	0.43	70	34	34	48 W	Dawes

Application	Annotation	Carrier	Priority Date			Use [1]	Grant [2]	Rate [3]	Sec	Twn	Rng	County
A 7648		Pump	6	10	1955	1	0.39	70	34	34	48 W	Dawes
A 2328		Pump No. 2	7	7	1933	1	0.03	70	14	33	48 W	Dawes
A 5008		Pump	8	11	1952	1	1.72	70	15	33	48 W	Dawes
A 3891		Bass Nursery Canal	4	11	1946	1	0.99	70	23	33	48 W	Dawes
A 17281		Pump	4	29	1993	1	0.23	70	10	33	48 W	Dawes
A 5631		Pump	10	7	1953	1	1.4	70	10	33	48 W	Dawes
A 5129		Pump	1	13	1953	1	2.7	70	3	33	48 W	Dawes
A 7043		Pump	1	25	1955	1	0.02	70	24	33	48 W	Dawes
A 15835		Pump	4	8	1981	1	0.33	70	10	33	48 W	Dawes
Bordeaux Creek, Big, Trib. To												
A 4761		Pine Springs Reservoir	11	3	1950	2	2 AF		23	32	48 W	Dawes
Bordeaux Creek, Little												
A 15836		Pump	4	8	1981	1	0.85	70	11	33	48 W	Dawes
A 8984		Pump	11	19	1956	1	2.01	70	30	33	47 W	Dawes
A 8345		Pump	2	3	1956	1	2.27	70	11	33	48 W	Dawes
A 16931		Pump	2	26	1990	4	0.33		11	33	48 W	Dawes
BOX Butte Creek												
A 7710		Pump	6	15	1955	1	0.71	70	30	29	45 W	Sheridan
A 15619		Pump	2	19	1980	1	0.71	70	34	27	47 W	Box Butte
A 4690		Pump	6	5	1950	1	0.9	70	30	29	45 W	Sheridan
A 4692		Heaton Reservoir	6	6	1950	2	44 AF		36	29	46 W	Sheridan
A 16830		Reservoir No. 1	6	19	1989	2	5.3 AF		17	28	46 W	Sheridan
A 12126		Pump	12	16	1970	1	2.03	70	35	27	47 W	Box Butte
BOX Butte Creek, Trib. To												
A 12098		Pump	10	9	1970	1	2.28	70	11	27	49 W	Box Butte
BOX Butte Reservoir												
A 6565	A-2683	Mirage Flats Canal	8	5	1954	6	0		26	29	48 W	Dawes
A 6565	A-3729	Mirage Flats Canal	8	5	1954	6	0		26	29	48 W	Dawes
Caladonia Reservoir												
A 1681		Caladonia Canal	7	20	1922	5	0		13	33	57 W	Sioux
A 1683		Caladonia Canal	7	20	1922	5	0		13	33	57 W	Sioux
A 1683	D-543	Caladonia Canal	7	20	1922	6	0		13	33	57 W	Sioux
Carter P Johnson Reservoir												
A 16114		Pump	6	2	1982	5	0		2	31	53 W	Sioux
Cedar Creek												
A 9775		Little Red Reservoir	10	6	1959	2	48 AF		26	33	56 W	Sioux
D 507		Schilt-Cedar Creek Canal	5	15	1885	1	0.57	70	35	33	56 W	Sioux
A 3172		Grote Reservoir	6	4	1940	2	19 AF		3	32	56 W	Sioux

Application	Annotation	Carrier	Priority Date			Use[1]	Grant[2]	Rate[3]	Sec	Twn	Rng	County
D 976		Valdez Canal	4	5	1886	1	0.5	70	10	32	56 W	Sioux
Chadron Creek												
A 17349		Pfister Res. No. 1	2	2	1994	2	1.53 AF		1	32	49 W	Dawes
A 2007		Chadron State Park Lake	4	17	1928	2	10 AF		31	32	48 W	Dawes
A 9842		Chadron Reservoir No. 2	7	19	1960	2	143 AF		18	32	48 W	Dawes
D 1022		Chadron Water Works	12	31	1888	4	1		18	32	48 W	Dawes
A 1583		Chadron Water Works	4	8	1920	35	4.5		18	32	48 W	Dawes
A 14076		Pump	3	3	1976	1	0.77	70	13	32	49 W	Dawes
A 9975		Pump	9	7	1961	1	1.11	70	1	32	49 W	Dawes
A 11626		Pump	1	28	1969	1	0.3	70	2	32	49 W	Dawes
A 10970		Pump	10	14	1966	1	0.02	70	31	33	48 W	Dawes
A 16932		Pump	2	26	1990	4	0.09		15	33	49 W	Dawes
A 13094		Pump	7	23	1974	1	4.26	70	22	33	49 W	Dawes
A 17343		O Rourke Res. No. 1	12	22	1993	2	1 AF		13	32	49 W	Dawes
A 17350		Pipeline	2	2	1994	7	1		1	32	49 W	Dawes
A 17342		Pipeline	12	22	1993	7	1		13	32	49 W	Dawes
A 13815		Pump	9	18	1975	1	1.56	70	15	33	49 W	Dawes
Chadron Creek, Trib. To												
A 4526		Mayfield Reservoir	10	19	1949	2	73 AF		23	33	49 W	Dawes
Charcoal Creek												
A 11393		Pump	4	15	1968	1	0.05	70	33	31	53 W	Sioux
A 3130		Charcoal Canal	4	2	1940	1	0.13	70	33	31	53 W	Sioux
Cherry Creek												
A 3909		Merlo Reservoir	5	21	1946	2	15 AF		29	33	54 W	Sioux
D 549		Cherry Creek Canal	5	1	1893	1	0.03	70	29	33	54 W	Sioux
Cherry Creek, Trib. To												
A 3844		Serres Reservoir No. 2	6	18	1945	2	54 AF		29	33	54 W	Sioux
A 3843		Serres Reservoir No. 1	6	18	1945	2	27 AF		30	33	54 W	Sioux
Coffee Reservoir No. 1												
A 4937		Lickett Canal	7	17	1951	5	0		27	33	54 W	Sioux
A 4937	A-549	Lickett Canal	7	17	1951	6	0		27	33	54 W	Sioux
Cornelius Jordan Reservoir												
A 1469	A-841	Cornelius Jordan Canal	1	14	1915	6	0		13	33	56 W	Sioux
A 841	A-841	Cornelius Jordan Canal	11	12	1906	6	0		13	33	56 W	Sioux
A 1470	A-1375	Kite (neil) Canal	1	14	1915	6	0		13	33	56 W	Sioux
Cottonwood Creek												
A 8721		Pump	8	6	1956	1	2.3	70	17	29	48 W	Dawes

Application	Annotation	Carrier	Priority Date			Use [1]	Grant [2]	Rate [3]	Sec	Twn	Rng	County
Cottonwood Creek, Big												
A 15759		Moody Reservoir No. 1	1	29	1981	2	265 AF		31	34	52 W	Dawes
A 14395		Pump	8	13	1976	1	3.53	70	20	33	51 W	Dawes
Cottonwood Creek, Big, Trib. To												
A 9689		Norman Reservoir No. 3	2	16	1959	2	170 AF		10	33	53 W	Sioux
A 4930		Norman Reservoir No. 2	1	8	1952	2	935 AF		2	33	53 W	Sioux
A 5037		Moody Reservoir	9	26	1952	2	143 AF		29	34	52 W	Dawes
A 3580		Norman Reservoir No. 1	7	6	1942	2	150 AF		35	34	53 W	Sioux
Cottonwood Creek, Little												
A 1276		Dodd-Mcdowell Reservoir And Pipeline	4	15	1913	2	480 AF		13	32	53 W	Sioux
D 425	R P-NONE	Stuart Bros. South Canal	12	21	1890	1	0.36	70	18	32	52 W	Dawes
A 8	R P-220	Stuart Bros. South Canal	6	10	1895	1	1.43	70	18	32	52 W	Dawes
A 2363		Simons Canal	2	12	1934	1	0.77	70	9	32	51 W	Dawes
A 17323		Dodd-Mcdowell Canal	10	13	1993	1	2.65	70	13	32	53 W	Sioux
A 8	R P-NONE	Stuart Bros. North Canal	6	10	1895	1	1.43	70	18	32	52 W	Dawes
A 649		Dunn Canal	1	14	1902	1	1.43	105	4	32	52 W	Dawes
Cottonwood Creek, Little, Trib. To												
A 4905		Speas Reservoir	9	8	1951	2	14 AF		8	32	53 W	Sioux
A 10307		Pump	2	13	1964	1	1.04	70	9	32	52 W	Dawes
A 10306		Pump	2	13	1964	1	0.64	70	9	32	52 W	Dawes
Coyote Springs												
A 2572		Coyote Springs Reservoir	4	1	1936	2	15 AF		16	27	54 W	Sioux
A 2418		Watson Canal	7	7	1934	1	1.41	70	16	27	54 W	Sioux
Coyote Springs Reservoir												
A 2579	A-2418	Coyote Springs Canal	4	1	1936	6	0		16	27	54 W	Sioux
A 2579		Coyote Springs Canal	4	1	1936	5	0		16	27	54 W	Sioux
Crystal Lake Reservoir												
A 8035		Crystal Lake Canal No. 2	8	26	1955	5	0		6	32	55 W	Sioux
A 2286		Crystal Lake Canal	8	22	1927	5	0		6	32	55 W	Sioux
Dan Jordan Reservoir												
A 2072		Dan Jordan Canal	2	20	1929	5	0		32	33	55 W	Sioux
Dawes-Sheridan Creek												
A 12876		Mirage Flats Reservoir	5	30	1973	2	19.6 AF		24	30	47 W	Dawes
Dead Horse Creek												
A 17218		Dead Horse Creek Pond	8	19	1992	7	1		4	31	49 W	Dawes
A 749	R P-306	Pump No. 1	4	6	1904	1	0.56	70	32	33	49 W	Dawes
A 749	R P-306	Pump No. 2	4	6	1904	1	0.44	70	31	33	49 W	Dawes
A 16890		Scherbarth Pond No. 2	10	23	1989	2	2.65 AF		32	32	49 W	Dawes

Application	Annotation	Carrier	Priority Date	Use[1]	Grant[2]	Rate[3]	Sec	Twn	Rng	County
A 5065		Pump	11 5 1952	1	0.6	70	20	32	49 W	Dawes
A 749	R P-246	Pump	4 6 1904	1	0.95	70	30	33	49 W	Dawes
A 9790		Pump	1 19 1960	1	0.76	70	32	33	49 W	Dawes
A 17217		Scherbarth Pond No. 3AB&C	8 19 1992	2	1.5 AF		4	31	49 W	Dawes
A 4786		Pump	1 10 1951	1	1.48	70	30	33	49 W	Dawes
A 2021	R P-281	Pump	6 15 1928	1	0.55	70	30	33	49 W	Dawes
A 4911		Pump	9 24 1951	1	0.03	70	32	33	49 W	Dawes
Dead Man Creek										
A 17384		Pipeline	7 12 1994	7	0.89		1	30	53 W	Sioux
A 17383		Double Cross Ranch Res. No. 1	7 12 1994	2	2.28 AF		1	30	53 W	Sioux
A 14435		Pine Ridge Pond	8 30 1976	2	3 AF		18	30	52 W	Dawes
Deep Creek										
A 6814		Pump	11 22 1954	1	0.58	70	32	31	53 W	Sioux
A 17408		Double Cross Ranch Res. No. 2	9 29 1994	2	9 AF		4	30	53 W	Sioux
A 17409		Pipeline	9 29 1994	7	0.89		4	30	53 W	Sioux
Deer Creek										
A 4466		Pump	4 19 1949	1	1.85	70	5	29	42 W	Sheridan
Dodd Reservoir										
A 10312		Hazelton Canal	2 21 1964	5	0		13	31	52 W	Dawes
A 10312	D-475	Hazelton Canal	2 21 1964	6	0		13	31	52 W	Dawes
Dodd-Mcdowell Reservoir										
A 1571	A-1276	Dodd-Mcdowell Canal	4 15 1913	6	0		17	32	52 W	Dawes
Dorshorst Reservoir										
A 5630		Dorshorst Canal	11 14 1952	5	0		20	30	45 W	Sheridan
Dout Reservoir No. 1										
A 2000	A-5985	Dout Canal No. 1	4 2 1928	6	0		7	33	56 W	Sioux
Dout Reservoir No. 2										
A 2002	A-5986	Dout Canal No. 2	4 2 1928	6	0		7	33	56 W	Sioux
Dry Canyon										
A 1481		Betson Canal	3 22 1917	1	1	70	33	32	51 W	Dawes
Dry Creek										
A 2608		Baldwin Reservoir	8 11 1936	2	332 AF		18	33	50 W	Dawes
A 2608		Pilster Reservoir	8 11 1936	2	363 AF		15	33	51 W	Dawes
Dry Draw										
A 1475		Heath Reservoir	2 7 1917	2	200 AF		12	32	53 W	Sioux
Dunlap Reservoir										
A 9981		Dunlap Canal	11 5 1951	5	0		15	32	53 W	Sioux
A 7861		Dunlap Canal	8 4 1955	5	0		15	34	56 W	Sioux

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Dunlap Reservoir No. 2										
A 7861		Dunlap Canal	8 4 1955	5	0		15	34	56 W	Sioux
Eberspecher Reservoir No. 1										
A 3896		Eberspecher Canal	9 10 1945	5	0		28	33	54 W	Sioux
Eberspecher Reservoir No. 2										
A 4903		Eberspecher Canal	4 11 1950	5	0		2	32	55 W	Sioux
English Creek										
A 9869	A-2064	Mcdowell Lake No. 3	10 17 1960	8	17 AF		2	31	52 W	Dawes
A 2064		Mcdowell Lake No. 1	1 22 1929	2	36.2 AF		12	31	52 W	Dawes
A 772		Mcdowell System	10 24 1904	1	3	70	12	31	52 W	Dawes
A 2064	R P-365	Mcdowell Lake No. 3	1 22 1929	2	5.05 AF		2	31	52 W	Dawes
Geike Creek										
A 1967		Geike Canal	11 4 1927	1	0.43	70	19	33	56 W	Sioux
A 4752		Geike Reservoir	10 3 1950	2	5 AF		19	33	56 W	Sioux
Geiser Reservoir										
A 3439		Geiser Canal	10 4 1940	5	0		34	35	54 W	Sioux
Golf Course Pond										
A 17110		Pump	9 11 1991	5	210 AF		10	31	52 W	Dawes
Grote Reservoir										
A 3450		Grote Canal	6 4 1940	5	0		3	32	56 W	Sioux
A 3451	D-976	Grote Canal	6 4 1940	6	0		3	32	56 W	Sioux
Harris Reservoir										
A 1996		Harris Canal	9 29 1922	5	0		32	33	52 W	Dawes
Hat Creek										
A 1236		Coffee Flood Canal	10 22 1912	1	5.36	70	14	33	55 W	Sioux
A 3922		Semroska Canal	7 2 1946	1	0.43	70	5	34	54 W	Sioux
A 17044		Whispering Pines Pipeline	1 18 1991	7	0.28		3	32	55 W	Sioux
A 17045		Whispering Pines Ponds	1 18 1991	2	9.1 AF		3	32	55 W	Sioux
A 15592		Pumps	10 11 1979	1	2.35	70	28	35	54 W	Sioux
A 341		Miller Canal	5 19 1896	1	0.37	70	23	33	55 W	Sioux
D 512		Coffee Canal	9 1 1881	1	4.29	70	26	33	55 W	Sioux
A 5089		Pump	11 28 1952	1	3.96	70	26	34	55 W	Sioux
A 3291		Pump	10 11 1940	1	0.66	70	24	34	55 W	Sioux
A 15996		Pump	9 24 1981	1	0.42	70	13	34	55 W	Sioux
Hat Creek, Trib. To										
A 3281		Vyzourek Reservoir No. 2	10 7 1940	2	7 AF		28	35	54 W	Sioux
A 3279		Geiser Reservoir	10 4 1940	2	28 AF		34	35	54 W	Sioux
A 9640		Bill Coffee Canal	8 20 1958	1	1.59	70	34	34	55 W	Sioux

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A 9639			Bill Coffee Res. No. 1	8	20	1958	2	63 AF		34	34	55 W	Sioux
A 4647			Semroska Reservoir	4	21	1950	2	44 AF		6	34	54 W	Sioux
A 3343			Vyzourek Reservoir No. 3	12	6	1940	2	4 AF		27	35	54 W	Sioux
Hat Creek, West													
D 553	B	T-968	West Hat Creek Canal	5	31	1886	1	0.57	70	16	32	55 W	Sioux
D 553	A	T-967	West Hat Creek Canal	6	1	1880	1	0.43	70	16	32	55 W	Sioux
Hawk Nest Reservoir													
A 3818		A-3536	Moody Canal No. 1	12	8	1941	6	0		32	34	52 W	Dawes
Hay Creek													
A 4501			Wallace Reservoir No. 2	8	18	1949	2	109 AF		19	35	56 W	Sioux
Hay Springs Creek													
A 2539			Barnes-Phillips Res.	4	15	1935	2	12 AF		8	31	46 W	Sheridan
A 2549			Walgren Lake	5	20	1935	2	890 AF		29	31	45 W	Sheridan
Hay Springs Creek, North Branch													
A 3053		A-2549	Walgren Lake	12	15	1939	8	0		19	31	45 W	Sheridan
Hay Springs Creek, Trib. To													
A 4378			Linden Reservoir	11	26	1948	2	49 AF		1	31	46 W	Sheridan
A 11457			Davis Reservoir	6	21	1968	2	18.5 AF		26	32	46 W	Sheridan
Heath Reservoir													
A 1612			Heath Canal	2	7	1917	5	0		12	32	53 W	Sioux
Henry Reservoir No. 1													
A 4830			Henry Canal No. 1	5	17	1950	5	0		19	35	55 W	Sioux
Henry Reservoir No. 2													
A 15532		A-4830	Henry Canal No. 5	7	30	1979	6	0		30	35	55 W	Sioux
A 4829			Henry Canal No. 2	5	17	1950	5	0		30	35	55 W	Sioux
Hooker Creek													
A 803			Alcorn Reservoir	11	17	1905	9	1.01	70	31	32	51 W	Dawes
A 4864			Souther Reservoir	5	19	1951	2	41 AF		30	32	51 W	Dawes
Horse Head Creek, Trib. To													
A 4747			Snook Reservoir	9	18	1950	2	32 AF		20	35	52 W	Dawes
A 17193		A-4747	Snook Reservoir	6	8	1992	8	10.5 AF		20	35	52 W	Dawes
Hull Reservoir													
A 5614			Hull Reservoir Canal	2	17	1953	5	0		22	33	42 W	Sheridan
Indian Creek													
A 6159		A-4830	Mader-Henry Canal	4	1	1954	6	0		23	35	56 W	Sioux
A 1952			Norman Canal	8	18	1927	1	1.28	70	16	32	50 W	Dawes
A 1614			Norman Canal	8	3	1921	1	0.69	70	16	32	50 W	Dawes
A 15944			Pump	7	20	1981	1	0.26	70	28	32	50 W	Dawes

Application	Annotation	Carrier	Priority Date	Use [1]	Grant [2]	Rate [3]	Sec	Twn	Rng	County
A 5608	A-4578	Mader Reservoir No. 2	9 26 1953	8	0		23	35	56 W	Sioux
A 5610	A-4680	Henry Reservoir No. 1	9 26 1953	8	0		23	35	56 W	Sioux
A 4004		Meier Canal	11 14 1946	1	0.69	70	24	35	55 W	Sioux
A 5607	A-3983	Mader Reservoir No. 1	9 26 1953	8	0		23	35	56 W	Sioux
A 5612		Mader-Henry Canal	9 26 1953	1	2.88	70	23	35	56 W	Sioux
A 15797		Pump	3 23 1981	1	1.41	70	20	35	55 W	Sioux
A 9797		Jerome Mader Canals 1-2	2 18 1960	1	1.87	70	21	35	55 W	Sioux
A 1704		Norman Canal	1 17 1923	1	0.67	70	16	32	50 W	Dawes
A 9779		Geiser Canal No. 2	12 7 1959	1	0.44	70	22	35	57 W	Sioux
A 8739	A-4578	Mader Reservoir No. 2	8 10 1956	8	190 AF		28	35	55 W	Sioux
A 5611	A-4829	Indian Creek Canal	9 26 1953	6	0		23	35	56 W	Sioux
A 5609		Indian Creek Canal	9 26 1953	1	0.51	70	23	35	56 W	Sioux
Indian Creek, Trib. To										
A 4680		Henry Reservoir No. 1	5 17 1950	2	48 AF		19	35	55 W	Sioux
A 10729		Trotter Canal No. 1	12 9 1965	1	0.59	70	19	35	54 W	Sioux
A 9843		Merlin Mader Res. No. 1	7 20 1960	2	115 AF		27	35	55 W	Sioux
A 4925		Wiedenfeld Res. No. 1	1 2 1952	2	92 AF		25	35	55 W	Sioux
A 4527		Mader Reservoir No. 3	10 21 1949	2	24 AF		26	35	55 W	Sioux
A 3962		Wallace Reservoir	9 16 1946	2	39 AF		29	35	56 W	Sioux
A 13442	A-4680	Henry Reservoir No. 1	2 25 1975	8	115 AF		19	35	55 W	Sioux
A 3983		Mader Reservoir No. 1	10 15 1946	2	148 AF		21	35	55 W	Sioux
A 4578		Mader Reservoir No. 2	1 25 1950	2	84 AF		28	35	55 W	Sioux
A 4679		Henry Reservoir No. 2	5 17 1950	2	46 AF		30	35	55 W	Sioux
Indian Tree Creek										
A 3537		Hawk Nest Reservoir	12 8 1941	2	17 AF		31	34	52 W	Dawes
A 3536		Moody Canal	12 8 1941	1	0.74	70	32	34	52 W	Dawes
A 16001		Moody Reservoir No. 2	9 28 1981	2	80.5 AF		31	34	52 W	Dawes
Ivins Reservoir										
A 4948		Ivins Canal	10 30 1950	5	0		30	32	50 W	Dawes
Jim Creek										
A 5986		Dout Canal No. 2	2 24 1954	1	0.52	70	7	33	56 W	Sioux
A 2274		O'connell Canal	6 20 1932	1	0.35	70	17	33	55 W	Sioux
A 8703		Clarence Canal No. 2	7 30 1956	1	0.2	70	12	33	56 W	Sioux
A 2001		Dout Reservoir No. 2	4 2 1928	2	16 AF		7	33	56 W	Sioux
D 536		Woodruff South Canal	5 1 1890	1	0.36	70	14	33	57 W	Sioux
D 981		Dout Brothers Canal	5 15 1889	1	0.86	70	7	33	56 W	Sioux
A 1682		High Line Canal	7 20 1922	1	0.34	70	13	33	57 W	Sioux
A 4696	A-1680	Caladonia Reservoir	6 12 1950	8	13 AF		13	33	57 W	Sioux

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A 9471		Dout-Jim Creek Canal	4	26	1957	1	0.41	70	11	33	56 W	Sioux
D 543		Slattery Canal	5	31	1891	1	0.29	70	13	33	57 W	Sioux
A 1999		Dout Reservoir No. 1	4	2	1928	2	145 AF		7	33	56 W	Sioux
A 8702		Clarence Canal No. 1	7	30	1956	1	0.62	70	12	33	56 W	Sioux
A 5985		Dout Canal No. 1	2	24	1954	1	2.29	70	7	33	56 W	Sioux
A 1680		Caladonia Reservoir	7	20	1922	2	42 AF		13	33	57 W	Sioux
Jim Creek, East												
A 4520		Staudenmaier Reservoir	10	7	1949	2	44 AF		15	33	54 W	Sioux
A 3834		Jim Creek Canal	5	17	1945	1	0.27	70	15	33	54 W	Sioux
A 581		Wasserburger Canal	10	13	1900	1	2.29	70	29	34	54 W	Sioux
A 3848		Staudenmaier Canal	7	26	1945	1	0.56	70	23	33	54 W	Sioux
A 10961		Pump	10	5	1966	1	0.38	70	19	34	54 W	Sioux
Jim Creek, East, Trib. To												
A 3149		Wasserburger Reservoir	5	6	1940	2	45 AF		29	34	54 W	Sioux
D 984		Homestead Canal	5	31	1890	1	0.21	70	22	33	54 W	Sioux
A 3853		Eberspecher Res. No. 1	9	10	1945	2	16 AF		28	33	54 W	Sioux
A 451		Hunter Canal	5	12	1898	1	0.03	70	26	33	54 W	Sioux
A 9637		Eberspecher Res. No. 1	8	13	1958	2	110 AF		10	33	54 W	Sioux
Jim Creek, Trib. To												
A 4995		Badland Reservoir	7	23	1952	2	33 AF		7	33	56 W	Sioux
A 3358		Snyder Reservoir	12	23	1940	2	45 AF		17	33	56 W	Sioux
Johndreau Creek												
A 4954		Reynolds Reservoir	3	25	1952	2	5 AF		31	31	41 W	Sheridan
Jones Reservoir												
A 10125		Jones Canal	11	26	1962	5	0		31	35	47 W	Dawes
A 10125	A-10048	Jones Canal	11	26	1962	6	0		31	35	47 W	Dawes
Jordan Draw												
A 2071		Dan Jordan Reservoir	2	20	1929	2	200 AF		32	33	55 W	Sioux
Kilpatrick Reservoir												
A 1159	D-567	Kilpatrick Canals No. 1&2	6	7	1911	6	0		6	24	51 W	Box Butte
Larabee Creek												
A 10146		Pump	2	18	1963	1	1.64	70	8	34	44 W	Sheridan
A 8723		Pump	8	6	1956	1	0.52	70	36	34	44 W	Sheridan
A 10253		Robins Reservoir	10	15	1963	2	3.17 AF		6	33	43 W	Sheridan
A 15877		Pump	5	26	1981	1	0.71	70	8	34	44 W	Sheridan
A 6564		Pump	8	5	1954	1	1.97	70	17	34	44 W	Sheridan
Larabee Creek, Trib. To												
A 4848		Scott Reservoir	4	19	1951	2	3 AF		17	33	43 W	Sheridan

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A 17075		Glen Forney Reservoir	5 15 1991	2	14.4 AF		5	33	43 W	Sheridan
Lickett Creek										
A 549	R P-313	Lickett Canal	3 21 1900	1	0.42	70	27	33	54 W	Sioux
A 4891		Coffee Reservoir No. 1	7 17 1951	2	22 AF		27	33	54 W	Sioux
Linden Reservoir										
A 4512		Linden Canal	11 26 1948	5	0		1	31	46 W	Sheridan
Little Red Creek										
A 9768		Little Red Reservoir	10 6 1959	2	48 AF		26	33	56 W	Sioux
A 2003		Zerbst Canal	4 3 1928	1	0.9	70	34	33	56 W	Sioux
Lone Tree Creek										
A 4985		Mcmeekin Reservoir	7 5 1952	2	109 AF		14	34	52 W	Dawes
A 5597		Bauer's Lone Tree Res.	9 23 1953	2	208 AF		22	34	51 W	Dawes
Lone Tree Creek, Trib. To										
A 4553		Bauer Reservoir	12 21 1949	2	96 AF		10	34	51 W	Dawes
A 4676		Benthack Reservoir	5 12 1950	2	13 AF		5	33	49 W	Dawes
Long Branch										
A 587		O'connell Canal	11 10 1900	1	0.2	70	22	35	54 W	Sioux
A 16477		Diversion Dike	3 19 1986	1	0.75		8	34	53 W	Sioux
Lundy Reservoir										
A 6697		Lundy Canal	9 13 1954	5	0		33	34	46 W	Sheridan
Madden Creek										
A 9804		Ormesher Canal	3 24 1960	1	3.74	70	6	34	48 W	Dawes
A 1061		Ernest Canal	2 20 1911	1	3.71	70	22	35	49 W	Dawes
Mader Reservoir No. 1										
A 4236		Mader Canal	10 15 1946	5	0		21	35	55 W	Sioux
Mader Reservoir No. 2										
A 6982	A-4236	Mader Canals 2 & 6	1 25 1950	6	0		28	35	55 W	Sioux
Mader Reservoir No. 3										
A 4730		Mader Canals No. 4 & 5	10 21 1949	5	0		26	35	55 W	Sioux
Mader Reservoirs 1-2										
A 8738	A-4730	Mader Canals 2, 5, 6 & 7	1 25 1950	6	0		21	35	55 W	Sioux
A 8738		Mader Canals 2, 5, 6 & 7	1 25 1950	5	0		21	35	55 W	Sioux
Mayfield Reservoir										
A 4629		Mayfield Canal	10 19 1949	5	0		23	33	49 W	Dawes
Mcmeekin Reservoir										
A 5315		Mcmeekin Canal	7 5 1952	5	0		14	34	52 W	Dawes
Merlo Reservoir										
A 4087		Merlo Canal No. 1	5 21 1946	5	0		29	33	54 W	Sioux

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Messenger Creek, Trib. To												
A 4643		Snook Reservoir	4	17	1950	2	30 AF		31	35	50 W	Dawes
Monroe Creek												
A 2372		Big Monroe Canal	4	16	1934	1	2.1	70	33	33	56 W	Sioux
A 4880		Bruce Canal No. 1	7	5	1951	1	0.41	70	13	33	56 W	Sioux
A 1375		Kite Canal	7	30	1914	1	2	70	13	33	56 W	Sioux
A 4881		Bruce Canal No. 2	7	5	1951	1	0.21	70	13	33	56 W	Sioux
D 509		Schlit-Monroe Canal	7	2	1888	1	0.5	70	27	33	56 W	Sioux
A 2032		Richard Jordan Canal	9	19	1928	1	1.67	70	22	33	56 W	Sioux
A 1399	A-841	Cornelius Jordan Res.	1	14	1915	8	800 AF		13	33	56 W	Sioux
D 506		Big Monroe Canal	5	1	1888	1	1.43	70	33	33	56 W	Sioux
A 83		Noreisch Canal	7	19	1895	1	0.04	70	33	33	56 W	Sioux
A 841		Cornelius Jordan Canal	11	12	1906	1	2.2	70	13	33	56 W	Sioux
A 841		Cornelius Jordan Res.	11	12	1906	2	271 AF		13	33	56 W	Sioux
Monroe Creek, Trib. To												
A 10201		Lake Ellis	6	12	1963	2	6.08 AF		5	32	56 W	Sioux
A 2297		Monroe Reservoir	1	16	1933	2	2 AF		8	32	56 W	Sioux
A 3908		Parsons Reservoir	5	21	1946	2	8 AF		27	33	56 W	Sioux
A 7451		Wasserburger Res. No. 1	5	9	1955	2	43 AF		22	33	56 W	Sioux
A 16190		Lake Ellis	4	21	1983	8	7.55 AF		5	32	56 W	Sioux
Moody Reservoir No. 1												
A 16000		Pump	9	28	1981	5	0		29	34	52 W	Dawes
Moody Reservoir No. 2												
A 16111	A-3536	Moody Canals 3,4,5	5	28	1982	6	0		31	34	52 W	Dawes
A 16111	A-16000	Moody Canals 3,4,5	5	28	1982	6	0		31	34	52 W	Dawes
A 16111		Moody Canals 3,4,5	5	28	1982	5	0		31	34	52 W	Dawes
Morris Reservoir												
A 9998		Morris Canal	1	17	1961	5	0		24	34	49 W	Dawes
A 9998	A-6247	Morris Canal	1	17	1961	6	0		24	34	49 W	Dawes
A 9998	A-815	Morris Canal	1	17	1961	6	0		24	34	49 W	Dawes
A 9998	A-3030	Morris Canal	1	17	1961	6	0		24	34	49 W	Dawes
Musfelt Reservoir												
A 9641		Musfelt Canal	10	31	1956	5	0		32	32	44 W	Sheridan
Ned Painter Reservoir												
A 15410		Pump	1	31	1979	5	0		35	33	53 W	Sioux
Niobrara River												
A 18015		Iodence Wetland	9	6	2001	2	11.1 AF		26	29	48 W	Dawes
A 9999		Pumps	11	14	1961	1	2.24	70	20	29	45 W	Sheridan

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A 4758	A	Pump	10 19 1950	1	1.34	70	5	28	51 W	Box Butte
A 4758	B	Pump	10 19 1950	1	4.93	70	5	28	51 W	Box Butte
A 16598		Pump	10 29 1987	3	0.02		36	29	51 W	Dawes
D 442	A	Pioneer Canals	8 1 1887	1	2.22	85	36	29	51 W	Dawes
A 3812	R P-530	Pioneer Canal No. 2	3 8 1945	1	0.49	70	36	29	51 W	Dawes
A 4599		Pioneer Canal No. 3	2 16 1950	1	0.21	70	36	29	51 W	Dawes
A 5010		North Pioneer Canal	8 11 1952	1	0.62	70	36	29	51 W	Dawes
A 3812	R	Pioneer Canal No. 2	3 8 1945	1	0.28	70	36	29	51 W	Dawes
A 16398		Pump	6 14 1985	1	2.2	70	28	29	50 W	Dawes
A 5531		Pump	9 1 1953	1	0.78	70	24	29	46 W	Sheridan
A 1260		Geo. Hitshew Canal	2 17 1913	1	1.76	70	6	28	52 W	Box Butte
A 8565		Pump	5 15 1956	1	0.24	70	18	31	41 W	Sheridan
A 9838		Pump	6 26 1960	1	0.53	70	33	31	42 W	Sheridan
A 4603		Pump	2 23 1950	1	1.79	70	18	31	41 W	Sheridan
A 2264		Excelsior Canal	3 28 1932	1	1.92	70	10	28	52 W	Box Butte
D 568		Excelsior Canal	5 15 1895	1	2.86	70	10	28	52 W	Box Butte
D 566		Mclaughlin Canal	5 1 1888	1	3.69	70	9	28	52 W	Box Butte
A 9017		Pump	12 5 1956	1	1.16	70	28	30	44 W	Sheridan
A 4862		Hitshew Canal No. 2	5 17 1951	1	0.6	70	6	28	52 W	Box Butte
A 12893		Pump	6 28 1973	1	1.04	70	22	29	46 W	Sheridan
A 88	R P-305	Moore Canal	7 22 1895	1	5.71	70	9	28	53 W	Sioux
D 461	R P-406	Pumps	1 27 1894	1	0.53	70	27	29	50 W	Dawes
A 2555		Pumps	8 9 1935	1	0.96	70	24	31	42 W	Sheridan
A 2623		Pump	8 25 1936	1	0.34	70	17	31	41 W	Sheridan
D 514	B	Earnest Canal No. 2	5 15 1891	1	2.14	70	9	29	56 W	Sioux
D 987	A	Hughes Canal	5 31 1890	1	0.57	130	1	28	52 W	Box Butte
A 2523	R P-396	Lichte Canal	3 2 1935	1	0.77	70	26	29	48 W	Dawes
A 2266	T-703	Montague Canal	3 31 1932	1	0.91	115	28	29	48 W	Dawes
A 10686		Potmesil Canal	9 7 1965	1	1.59	70	26	29	48 W	Dawes
A 9018		Pump	12 5 1956	1	0.77	70	36	30	45 W	Sheridan
A 2523	R P-379	Mirage Flats Canal	3 2 1935	1	0.16	70	26	29	48 W	Dawes
A 4717		Pump	7 1 1950	1	0.71	70	11	29	45 W	Sheridan
A 10761		Pump	2 2 1966	1	0.17	70	11	29	45 W	Sheridan
D 980	A	Cook Canal No. 1	5 31 1891	1	2.31	70	2	28	56 W	Sioux
D 980	B	Mcginley-Stover N. & Cook Canal No. 2	5 31 1891	1	0.16	70	25	29	56 W	Sioux
D 513	B R T-754	Mcginley-Stover S. Canal	5 1 1890	1	1.34	70	25	29	56 W	Sioux
D 513	A R P-397	Mcginley-Stover N. Canal	5 1 1887	1	5.06	70	25	29	56 W	Sioux
D 513	A R P-430	Pump	5 1 1887	1	1.48		1	28	56 W	Sioux

Application	Annotation		Carrier	Priority Date			Use [1]	Grant [2]	Rate [3]	Sec	Twn	Rng	County
A 1362	R	P-311	Earnest Canal No. 2	3	24	1914	1	1.46	70	9	29	56 W	Sioux
A 1152	R	P-396	Lichte Canal	1	2	1912	1	0.2	70	26	29	48 W	Dawes
D 554			Lakotah Canal	10	1	1883	1	5.76	70	1	30	57 W	Sioux
D 511	R	P-243	Johnson Canal	5	1	1894	1	2.09	70	35	31	57 W	Sioux
D 510	R	P-282	Pumps	6	8	1891	1	0.96	70	21	31	57 W	Sioux
A 2683			Mirage Flats Canal	1	25	1937	1	136	70	26	29	48 W	Dawes
A 8216			Pump	10	7	1955	1	1.21	70	11	29	45 W	Sheridan
A 2837	R	P-380	Mirage Flats Canal	2	11	1938	1	0.26	70	26	29	48 W	Dawes
A 10490			Pump	12	21	1964	1	0.66	70	15	29	45 W	Sheridan
A 17398	B		Pump	9	7	1994	1	2.51	70	19	29	45 W	Sheridan
A 17398	A		Pump	9	7	1994	1	2.86	70	24	29	46 W	Sheridan
A 5531	R	P-485	Pump	9	1	1953	1	1.86	70	24	29	46 W	Sheridan
A 10432			Pump	9	3	1964	1	0.96	70	22	29	45 W	Sheridan
A 5840			Pump	1	4	1954	1	1.46	70	20	29	45 W	Sheridan
A 3729			Mirage Flats Canal	5	18	1944	1	30.8	70	26	29	48 W	Dawes
D 514	A		Earnest Canal No. 1	5	1	1885	1	2.86	70	9	29	56 W	Sioux
A 2654			Pump	11	6	1936	1	0.9	70	32	30	44 W	Sheridan
A 10870			Pump	6	20	1966	1	0.39	70	9	28	53 W	Sioux
A 5181	R	P-411	Pump	2	24	1953	1	1.1	70	26	29	50 W	Dawes
A 2709	A		BOX Butte Reservoir	3	6	1937	2	E+04 AF		28	29	49 W	Dawes
A 3456		A-2709A	BOX Butte Reservoir	6	24	1941	8	E+04 AF		28	29	49 W	Dawes
A 5467			Pumps	8	12	1953	1	0.3	70	17	30	43 W	Sheridan
A 7477			Pumps	5	14	1955	1	1.33	70	24	30	44 W	Sheridan
A 16048			Pump	1	13	1981	1	1.02	70	35	29	49 W	Dawes
A 7971			Pumps	8	22	1955	1	1.05	70	24	30	44 W	Sheridan
A 9572			Pump	9	26	1957	1	1.77	70	22	30	44 W	Sheridan
A 10716		T-702	Montague Canal	11	15	1965	1	0.34	70	28	29	48 W	Dawes
A 2566	R	P-314	Potmesil Canal	10	29	1935	1	6.2	70	26	29	48 W	Dawes
A 575	R	T-785	Montague Canal	9	27	1900	1	0.24	437	28	29	48 W	Dawes
D 980	R	P-428	Pump	5	31	1891	1	0.52	70	1	28	56 W	Sioux
A 1249	R	T-745	Bennett Canal	12	18	1912	1	3.45	70	1	28	54 W	Sioux
A 2275			Harris-Neece Canal	7	11	1932	1	2.54	70	3	28	55 W	Sioux
A 1248			Mettlen Canal	12	18	1912	1	0.5	70	4	28	54 W	Sioux
A 292			Mettlen Canal	4	27	1896	1	2.94	70	4	28	54 W	Sioux
A 60			Labelle Canal	7	3	1895	1	2.27	70	6	28	54 W	Sioux
D 518			Labelle Canal	3	12	1895	1	1.4	70	6	28	54 W	Sioux
A 1086	R	P-396	Lichte Canal	4	7	1911	1	1.97	70	26	29	48 W	Dawes
D 479	R	P-396	Lichte Canal	1	24	1895	1	0.86	70	26	29	48 W	Dawes

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A 2244		Mettlen Canal	10 13 1931	1	0.93	70	4	28	54 W	Sioux
A 1260	R P-500	Geo. Hitshew Canal	2 17 1913	1	2.76	70	6	28	52 W	Box Butte
A 3923		Montague Canal	7 11 1946	1	0.43	70	27	29	48 W	Dawes
D 517		Harris-Neece Canal	7 1 1892	1	7.13	70	3	28	55 W	Sioux
A 1088		Lichte Canal	4 19 1911	1	0.23	70	27	29	48 W	Dawes
Niobrara River, Trib. To										
A 4644		Anderson Reservoir	4 18 1950	2	157 AF		26	31	47 W	Dawes
A 3297		Anderson Reservoir	10 16 1940	2	20 AF		2	29	47 W	Dawes
A 10954		Frank Reservoir	9 19 1966	2	11 AF		17	32	43 W	Sheridan
A 4540		Peters Reservoir	12 1 1949	2	4 AF		11	29	45 W	Sheridan
A 3337		Wilson Reservoir	11 26 1940	2	7 AF		27	33	57 W	Sioux
A 18171		Pump	5 30 2003	1	0.74	70	28	31	47 W	Dawes
Norman Reservoir										
A 2179		Harry Canal	8 22 1927	5	0		8	32	50 W	Dawes
Norman Reservoir No. 1										
A 5290	RES NO. 2	Norman Canal No. 1	4 27 1953	5	0		35	34	53 W	Sioux
Norman Reservoir No. 2										
A 5290	RES NO. 1	Norman Canal No. 2	4 27 1953	5	0		2	33	53 W	Sioux
North Draw Reservoir										
A 3819		Moody Canal No. 2	12 8 1941	5	0		33	34	52 W	Dawes
North Platte River										
D 828	B	Empire Canal	12 19 1889	1	0.18	70	18	29	51 W	Morrill
Patton Creek										
A 2845		Pump	3 14 1938	1	0.18	70	32	35	44 W	Sheridan
Peters Reservoir										
A 4727		Pump	12 1 1949	5	0		11	29	45 W	Sheridan
Pine Creek										
A 9124		Pump	1 22 1957	1	0.42	70	27	30	44 W	Sheridan
A 4876		Hageman Reservoir	6 22 1951	2	25 AF		9	31	51 W	Dawes
A 4114		Smith Lake Reservoir	9 15 1947	2	3500 AF		16	28	44 W	Sheridan
A 14511		Pump	10 15 1976	1	1.53	70	34	30	44 W	Sheridan
Plunkett Reservoir										
A 2070		Plunkett Canal	9 18 1928	5	0		25	33	56 W	Sioux
Point of Rocks Creek, Trib. To										
A 12891		Hansen Reservoir	6 25 1973	2	70.7 AF		7	26	50 W	Box Butte
Prairie Dog Creek										
A 2031		Plunkett Reservoir	9 18 1928	2	110 AF		25	33	56 W	Sioux
D 551		Zerbst Canal	5 1 1893	1	0.14	70	25	33	56 W	Sioux

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A 9774		Little Red Reservoir	11	25	1959	2	149 AF		26	33	56 W	Sioux
D 508		Schilt-Prairie Dog Canal	5	31	1886	1	1.14	70	35	33	56 W	Sioux
A 3842		Plunkett Canal	6	14	1945	1	0.36	70	25	33	56 W	Sioux
A 3737		Plunkett Canal	6	24	1944	1	1.34	70	25	33	56 W	Sioux
Raben Reservoir No. 1												
A 4586		Raben Canal	2	19	1942	5	0		22	34	54 W	Sioux
Raben Reservoir No. 2												
A 4868	A-4586	Raben Canal No. 2	1	13	1950	6	0		23	34	54 W	Sioux
A 4868		Raben Canal No. 2	1	13	1950	5	0		23	34	54 W	Sioux
Rush Creek												
A 14092		Pump	3	12	1976	1	2.04	70	11	31	44 W	Sheridan
A 706		Braddock Canal	5	4	1903	1	3	87	10	34	49 W	Dawes
A 5590		Brown Canal	9	22	1953	1	1.14	70	33	31	43 W	Sheridan
A 17673		Brown Ranch Water Control Reservoir	5	6	1998	2	10.7 AF		33	31	43 W	Sheridan
Rush Creek, Trib. To												
A 8946		Musfelt Reservoir	10	31	1956	2	54 AF		32	32	44 W	Sheridan
Sand Creek												
A 11002		Dobesh & Jackson Res.	12	22	1966	2	41.6 AF		26	33	53 W	Sioux
A 189		Bendix Canal	11	19	1895	1	0.57	70	35	33	53 W	Sioux
A 1669		Bendix Canal	5	27	1922	1	0.71	70	35	33	53 W	Sioux
Sand Creek, Trib. To												
A 15363		Ned Painter Reservoir	11	17	1978	2	49.6 AF		35	33	53 W	Sioux
Saxson Draw												
A 1689		Harris Reservoir	9	29	1922	2	7 AF		32	33	52 W	Dawes
Schaefer Reservoir No. 1												
A 3557		Leonard Canals 1 And 2	2	27	1933	5	0		5	32	55 W	Sioux
Schnurr Reservoir No. 2												
A 3871		Schnurr Canal No. 2	10	10	1944	5	0		13	34	57 W	Sioux
Semroska Reservoir												
A 4768		Semroska Canal No. 1	4	21	1950	5	0		6	34	54 W	Sioux
Serres Reservoir No. 1												
A 3969		Serres Canal No. 1	6	18	1945	5	0		30	33	54 W	Sioux
Serres Reservoir No. 2												
A 3970		Serres Canal No. 2	6	18	1945	5	0		29	33	54 W	Sioux
Sheep Creek												
A 885		Horse Camp Res. Ditch	1	20	1908	1	0.43	70	36	27	58 W	Sioux
A 859		Nebraska Res. Canal	5	18	1907	1	0.57	70	36	27	58 W	Sioux

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Shepherd Reservoir												
A 3795	A-1965	Shepherd Reservoir Canal	1	29	1931	6	0		36	34	57 W	Sioux
Snake Creek												
A 1104		Kilpatrick Reservoir	6	7	1911	2	2300 AF		1	24	52 W	Box Butte
D 567		Kilpatrick Canals No. 1&2	6	6	1894	1	54.9	70	6	24	51 W	Box Butte
Snake Creek, Trib. To												
A 11904		Pump	3	30	1970	1	1.68	70	1	24	48 W	Box Butte
Snyder Reservoir												
A 3445		Snyder Canal	12	23	1940	5	0		17	33	56 W	Sioux
Soester Reservoir												
A 17448	A-17417	West Ash Creek Canal	4	27	1995	5	5.72 AF		35	32	51 W	Dawes
A 17448	A-3362	West Ash Creek Canal	4	27	1995	6	9.52 AF		35	32	51 W	Dawes
A 17448	A-5973R	West Ash Creek Canal	4	27	1995	6	48.3 AF		35	32	51 W	Dawes
Soldier Creek												
A 16115		Pump	6	2	1982	1	1.06	70	5	31	53 W	Sioux
A 9654		Carter P Johnson Res.	10	13	1958	2	124 AF		3	31	53 W	Sioux
Souther Reservoir												
A 15829	A-15828	Mansfield Canals 1-3	4	6	1981	6	0		30	32	51 W	Dawes
Sow Belly Creek												
A 9988		Zimmerman Canal	10	3	1961	1	0.91	70	34	33	55 W	Sioux
A 2530		Andrews Reservoir	3	26	1935	2	42 AF		5	32	55 W	Sioux
D 559		Montgomery Canal	12	1	1890	1	1	70	21	33	55 W	Sioux
A 11760		Pump	8	5	1969	1	0.72	70	5	32	55 W	Sioux
A 2306	R P-298	Schaefer Reservoir No. 1	2	27	1933	2	54.3 AF		7	32	55 W	Sioux
A 12762		Schaefer Reservoir	11	7	1972	2	17.3 AF		5	32	55 W	Sioux
A 4790		Zimmerman Canal	1	17	1951	1	0.61	70	34	33	55 W	Sioux
A 15127		Zimmerman Reservoir	10	18	1977	2	26 AF		27	33	55 W	Sioux
A 5343	T-1172 D-533R	Sow Belly Canal	6	3	1953	1	0.47 CF	698	7	32	55 W	Sioux
D 533	R T-1154P-299	Sow Belly Canal	6	1	1887	1	3 CF	109	7	32	55 W	Sioux
A 532		Zimmerman Canal	1	11	1900	1	0.71	70	34	33	55 W	Sioux
Sow Belly Creek, Trib. To												
A 3894		Lundy Reservoir	4	17	1946	2	3 AF		24	32	56 W	Sioux
Spring Branch												
D 557		Tucker Canal	6	1	1883	1	0.17	70	34	31	54 W	Sioux
Spring Creek												
A 5045		Marcy Reservoir	10	20	1952	2	8 AF		27	30	45 W	Sheridan
A 5069		Dorshorst Reservoir	11	14	1952	2	12 AF		20	30	45 W	Sheridan
A 4741		Marcy Canal	8	28	1950	1	3.37		27	30	45 W	Sheridan

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A 663		Forbes Canal No. 1	4 28 1902	1	0.43	70	20	32	52 W	Dawes
A 13736		Pump	8 14 1975	1	2.57	70	11	33	49 W	Dawes
A 15348		Pump	10 11 1978	1	1.69	70	11	33	49 W	Dawes
A 13706		Spring Creek Reservoir	8 4 1975	2	202 AF		3	33	49 W	Dawes
A 4904		Spring Creek Reservoir	9 6 1951	2	26 AF		7	32	55 W	Sioux
A 2078	D-473	Spring Creek Canal	12 1 1894	1	1.3	70	7	32	51 W	Dawes
A 14262		Hawley Pipeline	6 9 1976	1	0.37	70	24	33	49 W	Dawes
D 1014		Mozeter Canal	5 3 1888	1	1.14	70	13	32	52 W	Dawes
D 532		Spring Creek Canal	6 1 1893	1	0.29	140	7	32	55 W	Sioux
A 1954		Crystal Lake Reservoir	8 22 1927	2	80 AF		6	32	55 W	Sioux
A 5705	A-1954	Crystal Lake Reservoir	11 3 1953	8	53 AF		6	32	55 W	Sioux
D 550		Hall Spring Canal	3 26 1889	1	0.57	70	6	32	55 W	Sioux
D 473		Spring Creek Canal No. 1	12 1 1894	1	2	70	13	32	52 W	Dawes
Spring Creek Reservoir										
A 15334	A-13736	Pump	8 29 1978	6	0		3	33	49 W	Dawes
A 15334	A-15348	Pump	8 29 1978	6	0		3	33	49 W	Dawes
Spring Creek Reservoir No. 3										
A 4996	D-532	Spring Creek Canals 1 & 2	9 6 1951	6	0		7	32	55 W	Sioux
A 4996		Spring Creek Canals 1 & 2	9 6 1951	5	0		7	32	55 W	Sioux
Squaw Creek										
A 1132		Squaw Creek Reservoir	10 3 1911	2	200 AF		12	31	52 W	Dawes
A 333		Cooper Canal	5 8 1896	1	2.29	70	36	32	52 W	Dawes
A 12743		Pine Ridge Pump No. 1	9 18 1972	1	0.12	70	33	31	51 W	Dawes
A 1965		Shepherd Reservoir Canal	10 24 1927	1	3.16		36	34	57 W	Sioux
Squaw Creek Reservoir										
A 1631		Squaw Creek Canal	10 3 1911	5	0		12	31	52 W	Dawes
Squaw Creek, South										
A 4779		Thomas Canal	12 19 1950	1	0.47	70	10	33	57 W	Sioux
A 2189		Shepherd Reservoir	1 29 1931	2	240 AF		2	33	57 W	Sioux
D 555		Hamlin Canal	4 1 1891	1	0.01	70	10	33	57 W	Sioux
D 552		Dunn Canal	6 1 1890	1	0.36	70	15	33	57 W	Sioux
Squaw Creek, West Branch										
A 627		Thomas Ditch	7 23 1901	1	0.5	70	10	33	57 W	Sioux
Staudenmaier Reservoir										
A 4764		Staudenmaier Canals 1-2	10 7 1949	5	0		16	33	54 W	Sioux
Summers Reservoir										
A 4859		Nolan Canals 1-2	6 12 1950	5	0		23	33	57 W	Sioux
A 4859	D-957	Nolan Canals 1-2	6 12 1950	6	0		23	33	57 W	Sioux

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Trout Reservoir													
A 4860		D-959	Trout Canals 1-2	6	12	1950	6	0		23	33	57 W	Sioux
A 4860			Trout Canals 1-2	6	12	1950	5	0		23	33	57 W	Sioux
Trunk Butte Creek													
A 8678	B	P-492	Pump	7	19	1956	1	1.19	70	35	32	50 W	Dawes
A 8678	A	P-492	Pump	7	19	1956	1	1.39	70	35	32	50 W	Dawes
A 10068			Pump	5	29	1962	1	0.4	70	25	33	50 W	Dawes
Trunk Butte Creek, Trib. To													
A 9013			White Reservoir No. 1	12	3	1956	2	8 AF		36	33	50 W	Dawes
Turner Reservoir													
A 1676		D-537	Turner Canal	7	3	1922	6	0		26	34	57 W	Sioux
A 1677			Turner Canal	7	3	1922	5	0		26	34	57 W	Sioux
Vyzourek Reservoir No. 2													
A 3457			Emil Canal	10	7	1940	5	0		27	35	54 W	Sioux
Vyzourek Reservoir No. 3													
A 3458			Vyzourek Canal	12	6	1940	5	0		27	35	54 W	Sioux
Wallace Reservoir													
A 4036			Wallace Canal	9	16	1946	5	0		29	35	56 W	Sioux
Wallace Reservoir No. 2													
A 5117			Hay Creek Pump Canals 1-4	8	18	1949	5	0		19	35	56 W	Sioux
Warbonnet Creek													
D 548			Warbonnet Canal	7	31	1880	1	3.63	70	21	33	56 W	Sioux
A 892			Warbonnet Canal No. 2	3	11	1908	1	1.5	70	20	33	56 W	Sioux
D 959			Nolan Canal No. 2	5	1	1888	1	0.29	70	23	33	57 W	Sioux
D 957	R	P-301	Nolan Canal No. 1	3	15	1887	1	0.01	70	23	33	57 W	Sioux
Warbonnet Creek, Trib. To													
A 4697			Summers Reservoir	6	12	1950	2	4 AF		23	33	57 W	Sioux
A 4698			Trout Reservoir	6	12	1950	2	8 AF		23	33	57 W	Sioux
Wasserburger Reservoir													
A 3581			Wasserburger Canal	5	6	1940	5	0		29	34	54 W	Sioux
A 3581		A-581	Wasserburger Canal	5	6	1940	6	0		29	34	54 W	Sioux
Wasserburger Reservoir No. 1													
A 9501		A-2032	Wasserburger Canal	5	9	1955	6	0		22	33	56 W	Sioux
White Clay Creek													
D 477	R	P-494	White River Canal	12	31	1894	1	1	70	35	32	52 W	Dawes
A 2063			Mcdowell Reservoir	1	22	1929	2	23.9 AF		2	31	52 W	Dawes
A 42	R	P-408	Pump	6	22	1895	1	0.83	100	35	32	52 W	Dawes
A 42	R	P-128	Pump	6	22	1895	1	0.05	100	2	31	52 W	Dawes

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A 42		Cooper Canal	6 22 1895	1	0.66	100	2	31	52 W	Dawes
A 16478		Pump	3 20 1986	4	0.03	70	11	31	52 W	Dawes
D 475		Hazelton Canal	5 15 1894	1	0.87	70	13	31	52 W	Dawes
A 9979		Dodd Reservoir	9 31 1961	2	86.5 AF		36	31	52 W	Dawes
D 960		Mcfarland Canal	5 18 1891	1	1.64	70	35	32	52 W	Dawes
A 17159		Pump	3 5 1992	1	0.11	70	26	32	52 W	Dawes
A 9947		Pump	6 30 1961	1	1.14	70	25	35	45 W	Sheridan
A 15513		Pump	7 5 1979	1	0.91	70	36	35	45 W	Sheridan
A 9943		Pumps	6 7 1961	1	1.47	70	23	34	45 W	Sheridan
A 9238	T-710	Pump	2 21 1957	1	2.4	103	1	34	45 W	Sheridan
A 8896		Pump	10 11 1956	1	1.19	70	25	35	45 W	Sheridan
A 8999		Pump	11 26 1956	1	0.68	70	25	35	45 W	Sheridan
A 2369		Pump	3 26 1934	1	0.19	70	36	35	45 W	Sheridan
A 4912		Pump	9 24 1951	1	1.63	70	1	34	45 W	Sheridan
A 5551		Pump	9 8 1953	1	1.5	70	36	35	45 W	Sheridan
A 16371		Pump	4 4 1985	1	0	70	36	35	45 W	Sheridan
A 4813		Pump	2 28 1951	1	1.16	70	36	35	45 W	Sheridan
White River										
A 1626		Whitney Pipe Line	11 18 1921	1	2.07	70	26	32	52 W	Dawes
A 5115		Pump	12 18 1952	1	0.44	70	1	32	51 W	Dawes
A 3129		Cistern	4 2 1940	2	0.16 AF		19	33	49 W	Dawes
A 4835		Pump	4 2 1951	1	0.62	70	19	33	49 W	Dawes
A 4720		Pump	7 7 1950	1	2.14	70	19	33	49 W	Dawes
A 10033		Pump	3 20 1962	1	0.76	70	19	33	49 W	Dawes
A 3038		Pump	12 7 1939	1	0.64	70	30	33	49 W	Dawes
A 456		Rasher Canal	5 23 1898	1	0.5	70	19	32	51 W	Dawes
A 2046		Hageman Canal	10 18 1928	1	1.14	70	26	33	50 W	Dawes
A 4420	A R P-462	Pump	1 11 1949	1	0.54	70	27	34	49 W	Dawes
A 2627		Whitney Water Supply	8 28 1936	4	2		1	32	51 W	Dawes
A 1604		Whitney Pipe Line	5 2 1921	1	3.21	70	26	32	52 W	Dawes
A 15885		Pump	6 8 1981	1	1.06	70	2	32	51 W	Dawes
A 15593		Pump	10 23 1979	1	1.55	70	2	32	51 W	Dawes
A 10193		Rasher Canal	5 23 1963	1	0.03	70	19	32	51 W	Dawes
A 534		Rasher Canal	1 16 1900	1	1.43	70	19	32	51 W	Dawes
A 5517		Pump	8 28 1953	1	3.61	70	24	33	50 W	Dawes
A 815		Schwabe Canal	3 19 1906	1	0.26	70	24	34	49 W	Dawes
A 4021		Pump	1 10 1947	1	0.04	70	5	34	47 W	Dawes
A 12949		Pump	10 1 1973	1	0.05	70	10	34	48 W	Dawes

Application	Annotation	Carrier	Priority Date	Use [1]	Grant [2]	Rate [3]	Sec	Twn	Rng	County
A 15902		Pump	6 25 1981	1	3	70	5	34	47 W	Dawes
A 15892		Pump	6 15 1981	1	1.67	70	1	34	48 W	Dawes
A 9498		Pumps	5 15 1957	1	1.22	70	10	34	48 W	Dawes
A 4805		Pumps	2 23 1951	1	1.19	70	9	34	48 W	Dawes
A 15887		Pump	6 10 1981	1	1.85	70	17	33	49 W	Dawes
A 6247		Pump	4 28 1954	1	4.93	70	25	34	49 W	Dawes
A 15333		Pump	8 29 1978	1	2.42	70	34	34	49 W	Dawes
A 3030		Pump	11 24 1939	1	1.31	70	26	34	49 W	Dawes
A 4983		Pump	6 30 1952	1	2.09	70	26	34	49 W	Dawes
A 4420	D R P-462	Pump	1 11 1949	1	0.73	70	26	34	49 W	Dawes
A 4420	C R 0-462	Pump	1 11 1949	1	0.81	70	26	34	49 W	Dawes
A 4420	B R P-462	Pump	1 11 1949	1	1.31	70	27	34	49 W	Dawes
A 16051	A-1625	Pump	1 18 1982	1	0.91	70	2	32	51 W	Dawes
A 2285		Bartlett Canal	9 8 1932	1	0.3	70	19	34	48 W	Dawes
A 15484		Pump	5 31 1979	1	0.07	70	35	32	52 W	Dawes
D 464	B	Harris-Cooper Canal	6 15 1894	1	1.57	70	26	32	52 W	Dawes
A 2075	R T-599	Pump	3 12 1929	1	0.37	70	10	31	52 W	Dawes
D 464	A	Harris-Cooper Canal	3 9 1894	1	10.4	70	26	32	52 W	Dawes
D 467		Rasher Canal	6 20 1894	1	0.98	70	19	32	51 W	Dawes
A 8499		Pump	4 20 1956	1	1.1	70	2	32	51 W	Dawes
A 17064	P-473	Golf Course Pond	4 5 1991	2	210 AF		10	31	52 W	Dawes
A 10193	R P-440	Harris-Cooper Canal	5 23 1963	1	0.08		26	32	52 W	Dawes
D 478	C R P-279	Hall Pump	1 10 1895	1	0.73	70	26	32	52 W	Dawes
D 467	R P-441	Harris-Cooper Canal	6 20 1894	1	0.16		26	32	52 W	Dawes
A 1128		Rasher-Forbes Canal	9 26 1911	1	0.5	70	19	32	51 W	Dawes
A 16599		Pump	10 29 1987	3	0.02		35	32	52 W	Dawes
A 15895	A-4864	Souther Reservoir	6 16 1981	8	41 AF		34	32	52 W	Dawes
A 15828		White River Canal	4 6 1981	1	3.45	70	34	32	52 W	Dawes
A 936		White River Canal	3 11 1909	1	1.43	70	34	32	52 W	Dawes
D 477	T-508	White River Canal	12 31 1894	1	4.28	70	34	32	52 W	Dawes
A 2381		Pump	5 10 1934	1	0.05	70	3	31	52 W	Dawes
A 15041		Pump	7 25 1977	1	0.07	70	26	32	52 W	Dawes
D 477	A R P-489	Pump	12 31 1894	1	0.21	70	25	32	52 W	Dawes
A 2609	A-2608	Baldwin Reservoir	8 11 1936	8	332 AF		26	32	52 W	Dawes
A 1660		Whitney Pipe Line	4 26 1922	1	0.41	70	26	32	52 W	Dawes
A 9561		Pump	9 6 1957	1	0.64	70	34	31	54 W	Sioux
A 1603		Whitney Reservoir	4 28 1921	2	E+04 AF		26	32	52 W	Dawes
A 13602		Harris-Cooper Canal	5 28 1975	1	2.52	70	26	32	52 W	Dawes

Application	Annotation		Carrier	Priority	Date		Use[1]	Grant[2]	Rate[3]	Sec	Twn	Rng	County
A 4740			Pump	8	21	1950	1	0.3	70	26	32	52 W	Dawes
A 11403			Pump	4	23	1968	1	0.1	70	33	31	53 W	Sioux
D 1026	R	P-512	Crawford Pumps	10	1	1890	4	1.5		3	31	53 W	Sioux
A 15440	R	P-442	Harris-Cooper Canal	3	26	1979	1	0.17		26	32	52 W	Dawes
A 14989			Harris-Cooper Canal	6	21	1977	1	0.86	70	26	32	52 W	Dawes
A 14480			Harris-Cooper Canal	9	27	1976	1	0.23	70	26	32	52 W	Dawes
A 1625			Whitney Pipe Line	11	7	1921	1	25	70	26	32	52 W	Dawes
White River, Trib. To													
A 8266			Pump	11	29	1955	1	0.39	70	23	31	53 W	Sioux
A 16489			Don Littrel Reservoir	5	14	1986	2	45.3 AF		25	34	48 W	Dawes
A 9793			Fox Reservoir	2	11	1960	2	21 AF		18	33	49 W	Dawes
A 3889			Wright Reservoir	4	8	1946	2	18 AF		10	32	51 W	Dawes
A 10047			Jones Reservoir	4	24	1962	2	29.1 AF		31	35	47 W	Dawes
A 10099			Betson Canal	9	4	1962	1	0.27	70	4	31	51 W	Dawes
A 10048			Jones Canal	4	24	1962	1	1.14	70	31	35	47 W	Dawes
A 9880			Morris Reservoir	1	17	1961	2	65 AF		24	34	49 W	Dawes
Whitehead Creek													
A 3414			Geiser Canal	3	13	1941	1	1.24	70	4	34	54 W	Sioux
A 9644			Semroska Canal	9	8	1958	1	1.39	70	10	34	54 W	Sioux
Whitehead Creek, Trib. To													
D 547			Harrison Canal	5	30	1888	1	0.06	70	13	33	54 W	Sioux
A 4569			Raben Reservoir No. 2	1	13	1950	2	99 AF		23	34	54 W	Sioux
A 3553			Raben Reservoir No. 1	2	19	1942	2	15 AF		22	34	54 W	Sioux
Whitney Reservoir													
A 1787		A-1625	Whitney Pipe Line	4	28	1921	6	0		4	32	51 W	Dawes
Wickersham Reservoir													
A 2203			Wickersham Canal	12	24	1930	5	0		30	33	54 W	Sioux
Wiedenfeld Reservoir No. 1													
A 5193			Wiedenfeld Canals 1-2	1	2	1952	5	0		25	35	55 W	Sioux
Willow Creek													
A 4917			Dunlap Reservoir	11	5	1951	2	16 AF		15	32	53 W	Sioux
Zimmerman Reservoir													
A 4867			Zimmerman Canal No. 3	11	9	1950	5	0		27	33	55 W	Sioux

Application	Annotation	Carrier	Priority Date	Use [1]	Grant [2]	Rate [3]	Sec	Twn	Rng	County

1 - Uses:

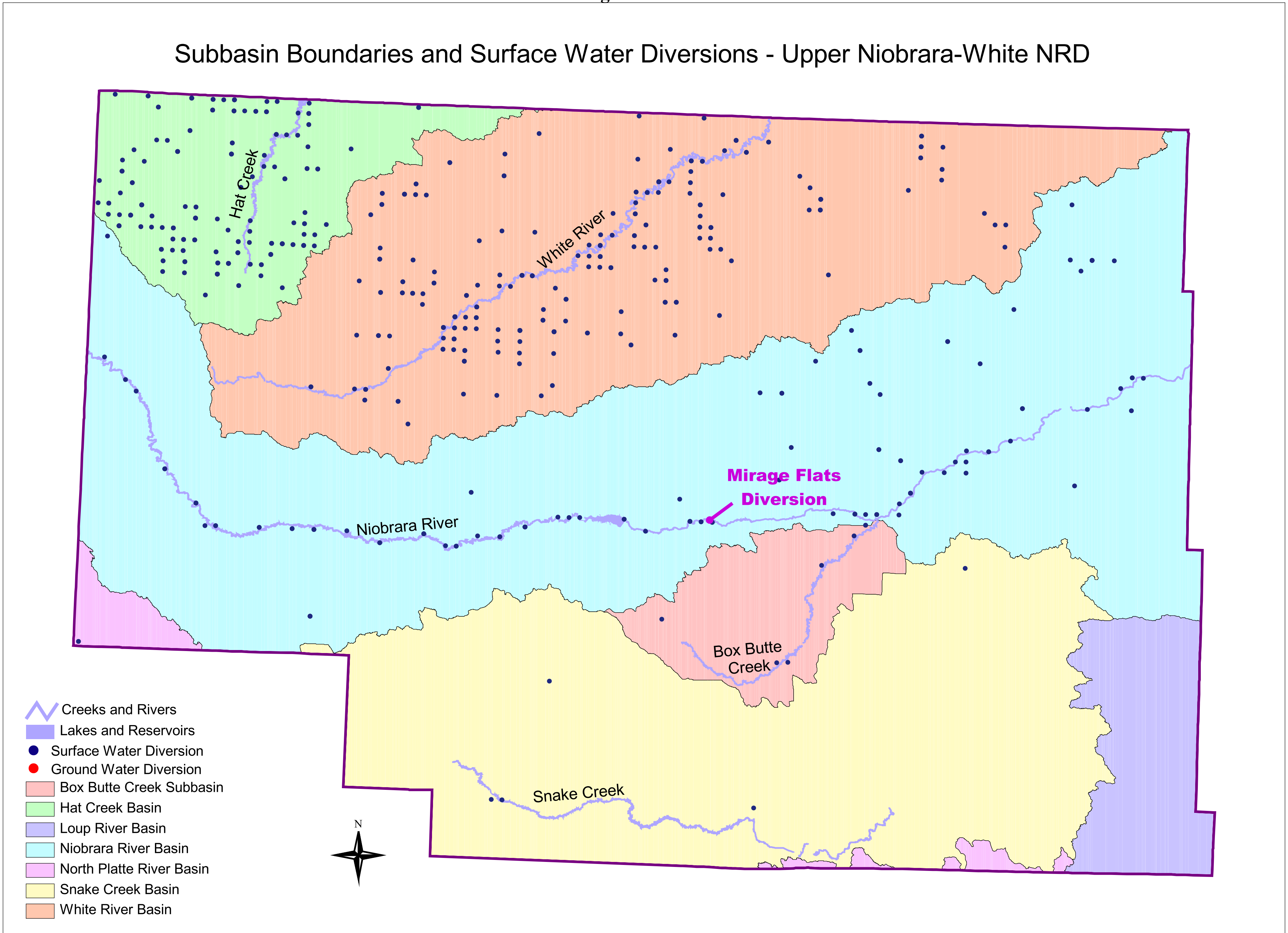
1Irrigation from natural stream
2Storage
3Manufacturing
4Domestic
5Stor-only (irrigation from reservoir on lands not covered by natural flow approriation)
6Supplemental Irrigation (irrig. from reservoir on lands also covered by Natural flow appr.)
7Fish Culture
8Supplemental Storage (An appropriation that has a prior appropriation for storage)
9irrigation and storage (An appropriation which was approoved for both uses)
10Supplemental power and incidental underground water storage
11Power
...
19Incidental underground storage
20Storage and incidental underground storage
21Irrigation and incidental underground storoage
22Supplemental irrigation and incidental underground storage
23Fish and wildlife

2 - Grant: The grant is listed in cubic feet per second (cfs) unless it is designated as acre-feet (af).

3 - Rate: The rate refers to the rate at which the applicant is allowed to withdraw water from a stream. Diversions from streams are limited by statute to a maximum of one cubic foot per second for every 70 acres of land.

Appendix II

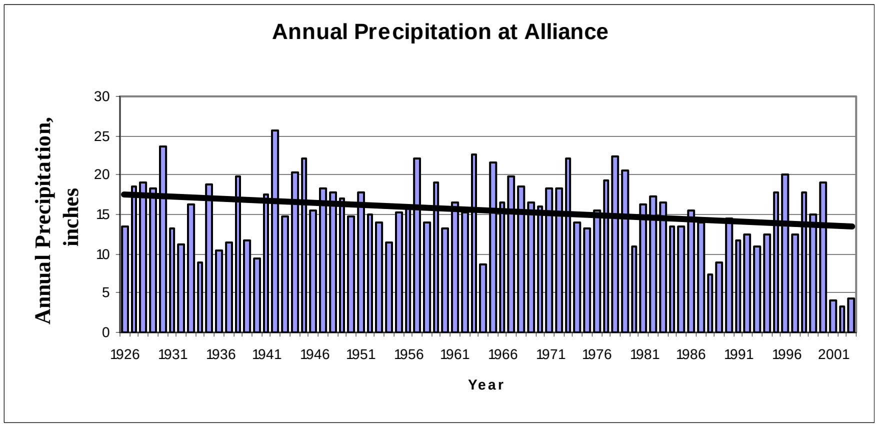
Figure 1

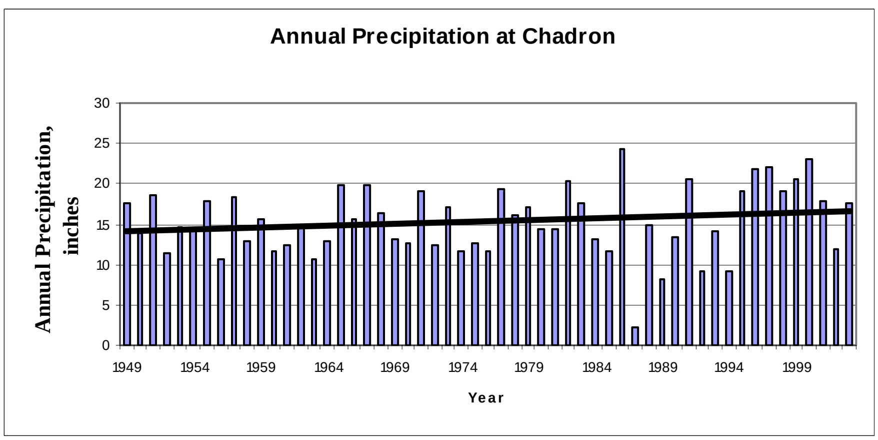


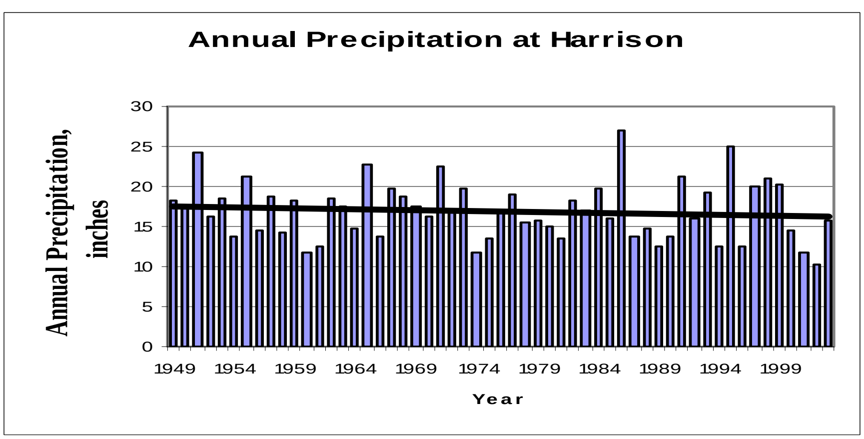
Source: Nebraska Department of Natural Resources Water Rights Database

Figure 2

Annual Precipitation at Alliance, Chadron, and Harrison By Year



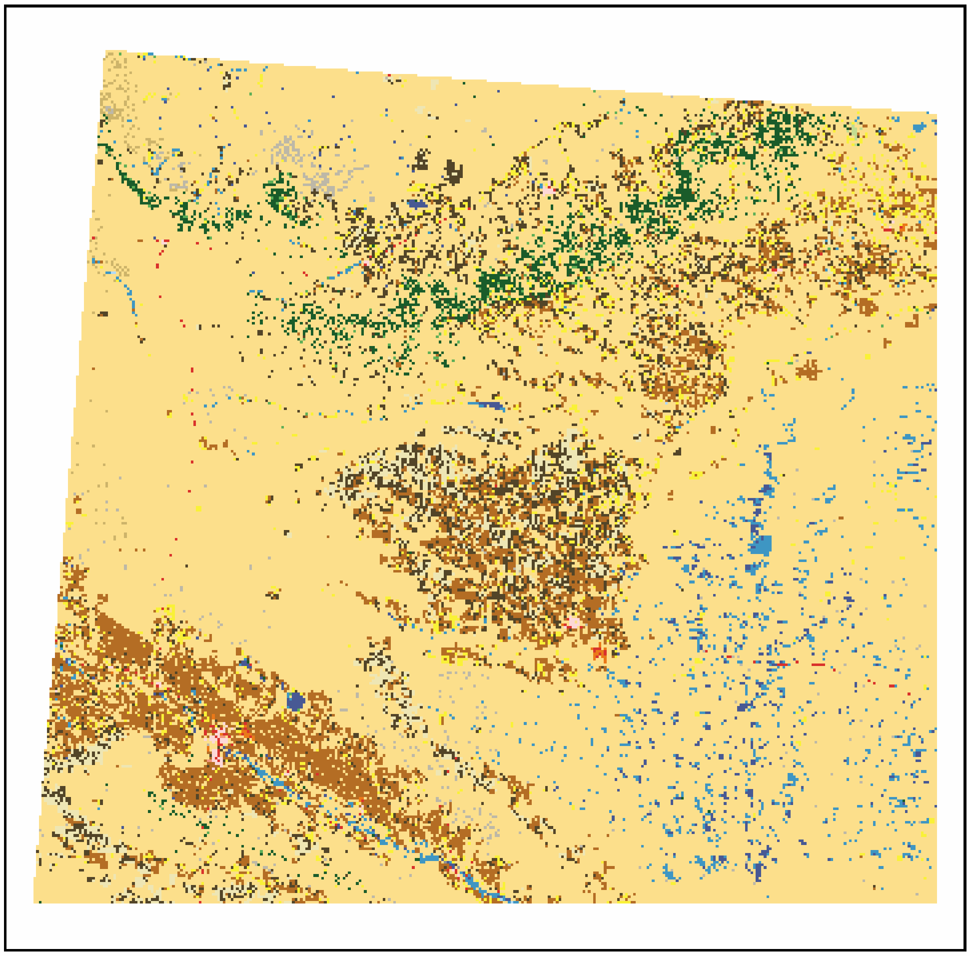




Source: High Plains Regional Climatic Center, University of Nebraska-Lincoln, Lincoln, NE.

Figure 3

National Land Cover Dataset
Northwest Nebraska



National Land Cover Dataset Classification System Legend

Color Key	RGB Value	Class Number and Name	Color Key	RGB Value	Class Number and Name
	102, 140, 190	11 - Open Water		220, 202, 143	51 - Shrubland
	255,255,255	12 - Perennial Ice/Snow		187, 174, 118	61 - Orchards/Vineyards
	253, 229, 228	21 - Low Intensity Residential		253, 233, 170	71 - Grasslands/Herbaceous
	247, 178, 159	22 - High Intensity Residential		252, 240, 93	81 - Pasture/Hay
	231, 86, 78	23 - Commerical/Industrial/Transporta		202, 145, 71	82 - Row Crops
	210, 205, 192	31 - Bare Rock/Sand/Clay		121, 108, 75	83 - Small Grains
	175, 175, 177	32 - Quarries/Strip Mines, Gravel Pits		244, 238, 203	84 - Fallow
	83, 62, 118	33 - Transitional		240, 156, 054	85 - Urban/Recreational Grasses
	134, 200, 127	41 - Deciduous Forest		201, 230, 249	91 - Woody Wetlands
	26, 129, 78	42 - Evergreen Forest		144, 192, 217	92 - Emergent Herbaceous Wetlands
	212, 231, 177	43 - Mixed Forest			

Source:
U.S. Geological Survey (USGS) and U.S. Environmental Protection Agency (USEPA)
1992 Landsat TM Data

Figure 4

Cropland Acres and Irrigated Acres in Upper Niobrara-White NRD General Area* – 1969 to 1997

	1969	1978	1987	1992	1997
Total Cropland	1,020215	971,857	1,038,654	1,028,134	1,017,896
Total Irrigated Cropland	102,584	184,071	234,666	237,707	250,078
Harvested Cropland	585,432	597,817	611,303	553,666	616,980
Harvested Irrigated Cropland	96,125	169,771	215,524	229,488	242,379

Corn for Grain and Wheat Production
Upper Niobrara-White NRD, 1969 and 1997

	1969		1997	
	Corn for Grain or Seed (Bushels)	Wheat for Grain (Bushels)	Corn for Grain (Bushels)	Wheat for Grain (Bushels)
Box Butte County	576,634	1,309,251	6,520,983	3,781,151
Dawes County	26,110	611,026	557,436	1,315,099
Sheridan County	324,356	576,569	3,455,817	1,844,016
Sioux County	272,187	65,117	1,930,956	270,842
TOTALS	1,199,287	2,561,963	12,465,192	7,211,108

Source: U.S. Department of Commerce, Bureau of the Census, Census of Agriculture, various years.

*A small portion of Sioux County is actually outside the Upper Niobrara-White NRD boundary. However, for purposes of this table the entire county is included

Figure 5

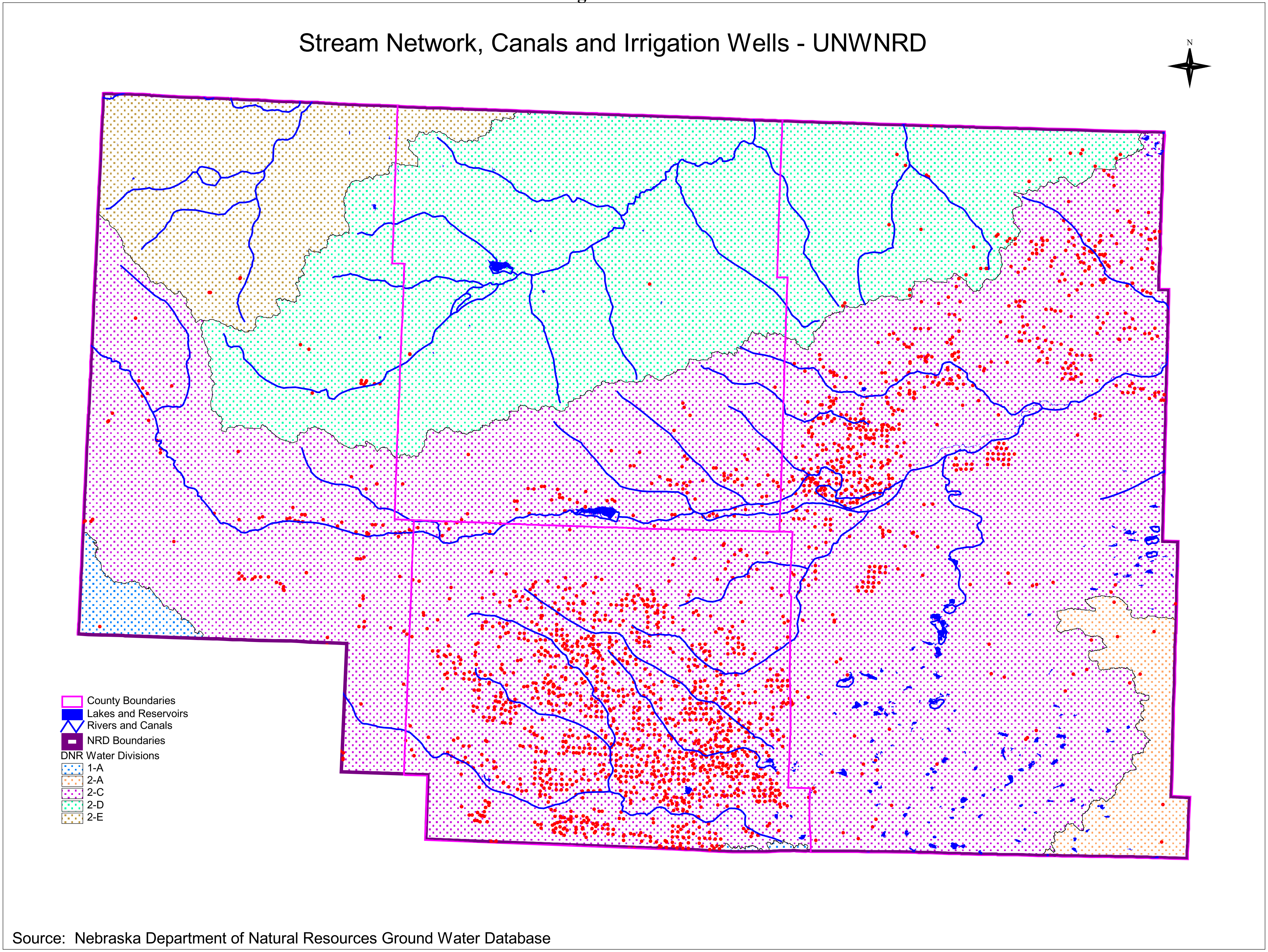

Stream Network, Canals and Irrigation Wells - UNWNRD
N
County Boundaries
Lakes and Reservoirs
Rivers and Canals
NRD Boundaries
DNR Water Divisions
1-A
2-A
2-C
2-D
2-E
Source: Nebraska Department of Natural Resources Ground Water Database

Figure 6

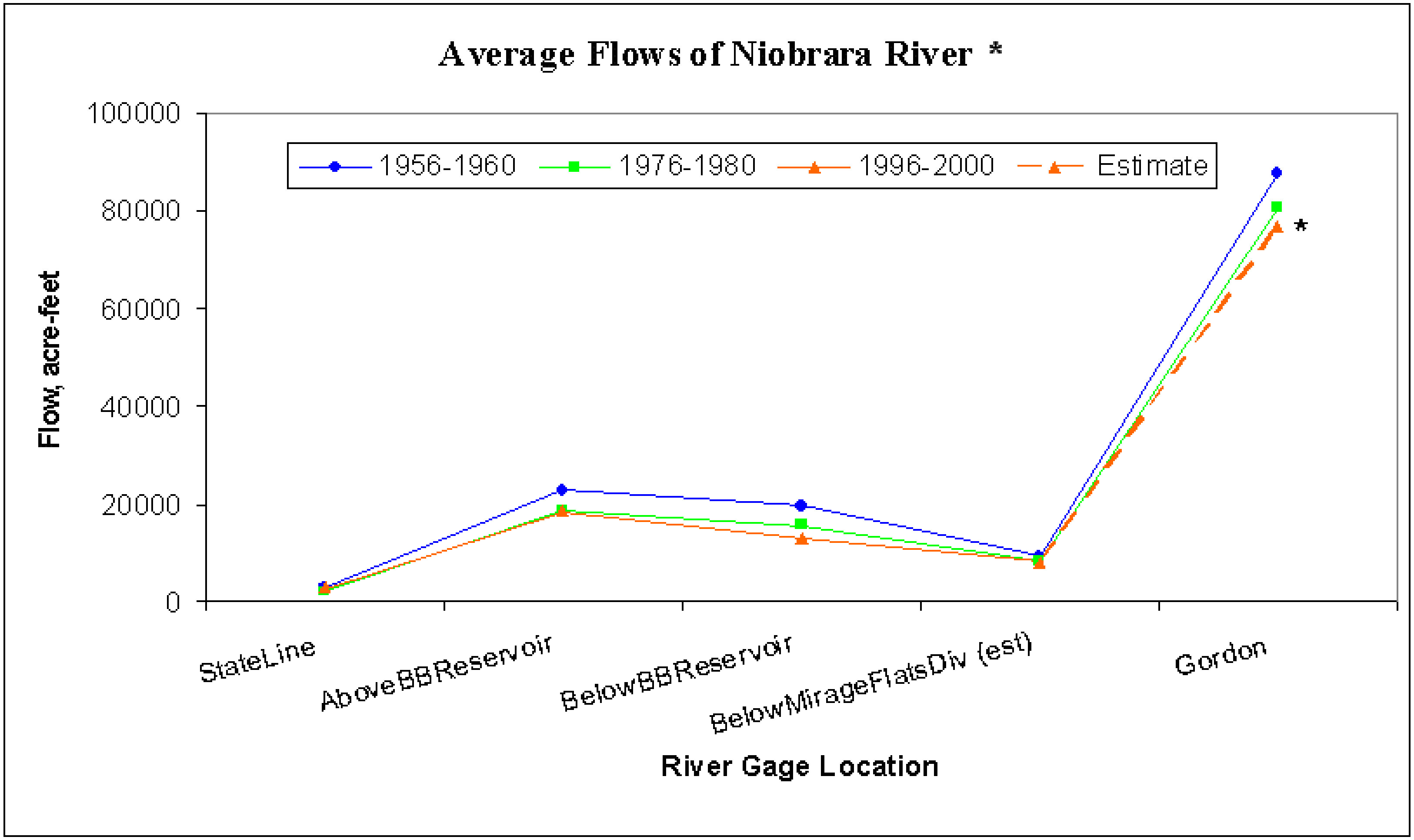
NIOBRARA RIVER AVERAGE GAGED ANNUAL FLOWS

State Line (1956-2002)	**2,615**	**Acre feet/Year**
Above Box Butte Reservoir (1947-2002)	**20,334**	**Acre feet/Year**
Below Box Butte Reservoir (1947-2002)	**17,018**	**Acre feet/Year**
Diversion 7 Miles Below Box Butte Reservoir (1956-2002)	(16,758)*	Acre feet/Year
Near Gordon (1946-1994)	**82,489**	**Acre feet/Year**

*Include diversions by Montague Canal, Licthe Canal, Mirage Flats Canal, and Potmesil Canal.

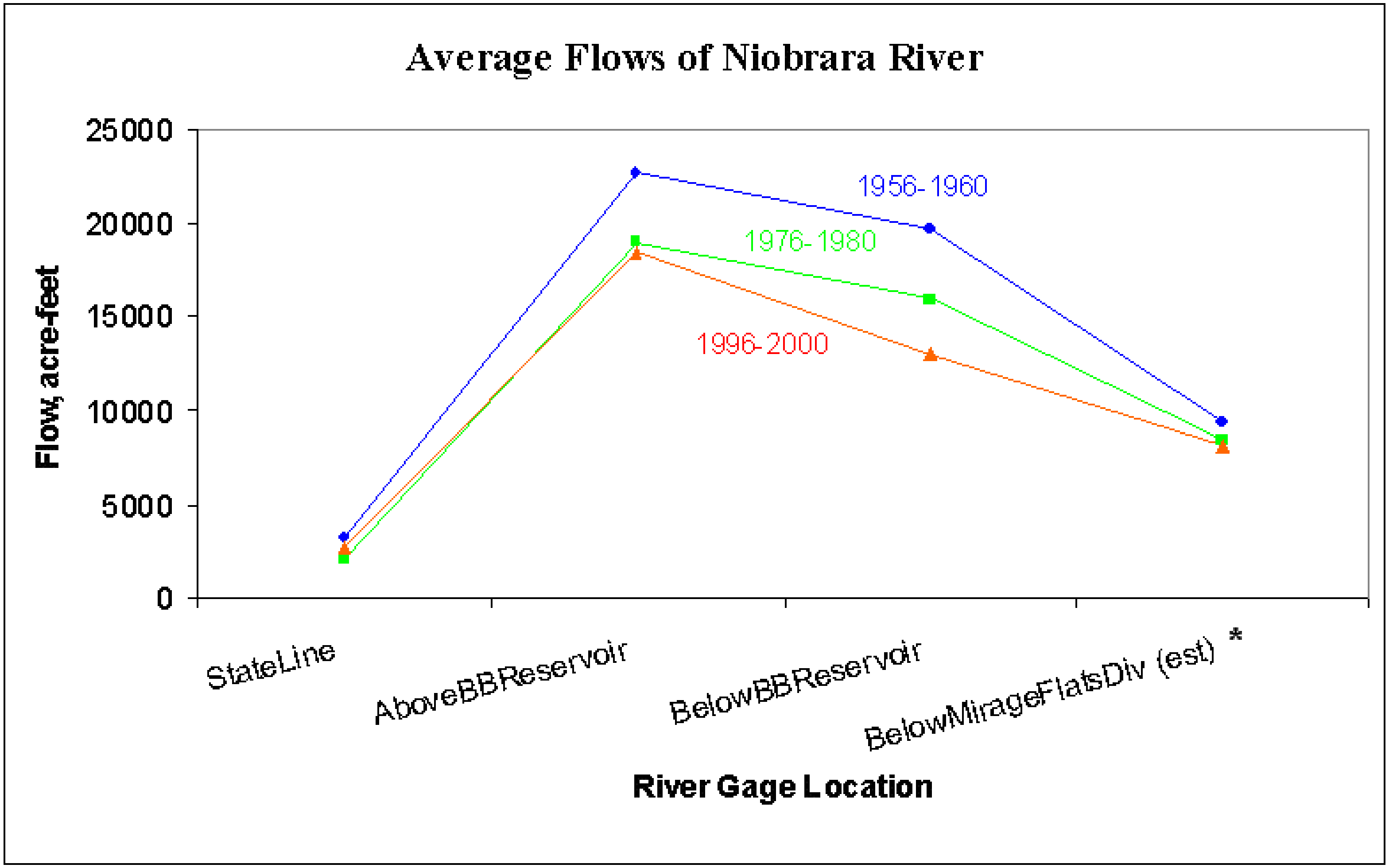
Source: Nebraska Department of Natural Resources Stream Gaging Records

Figure 7



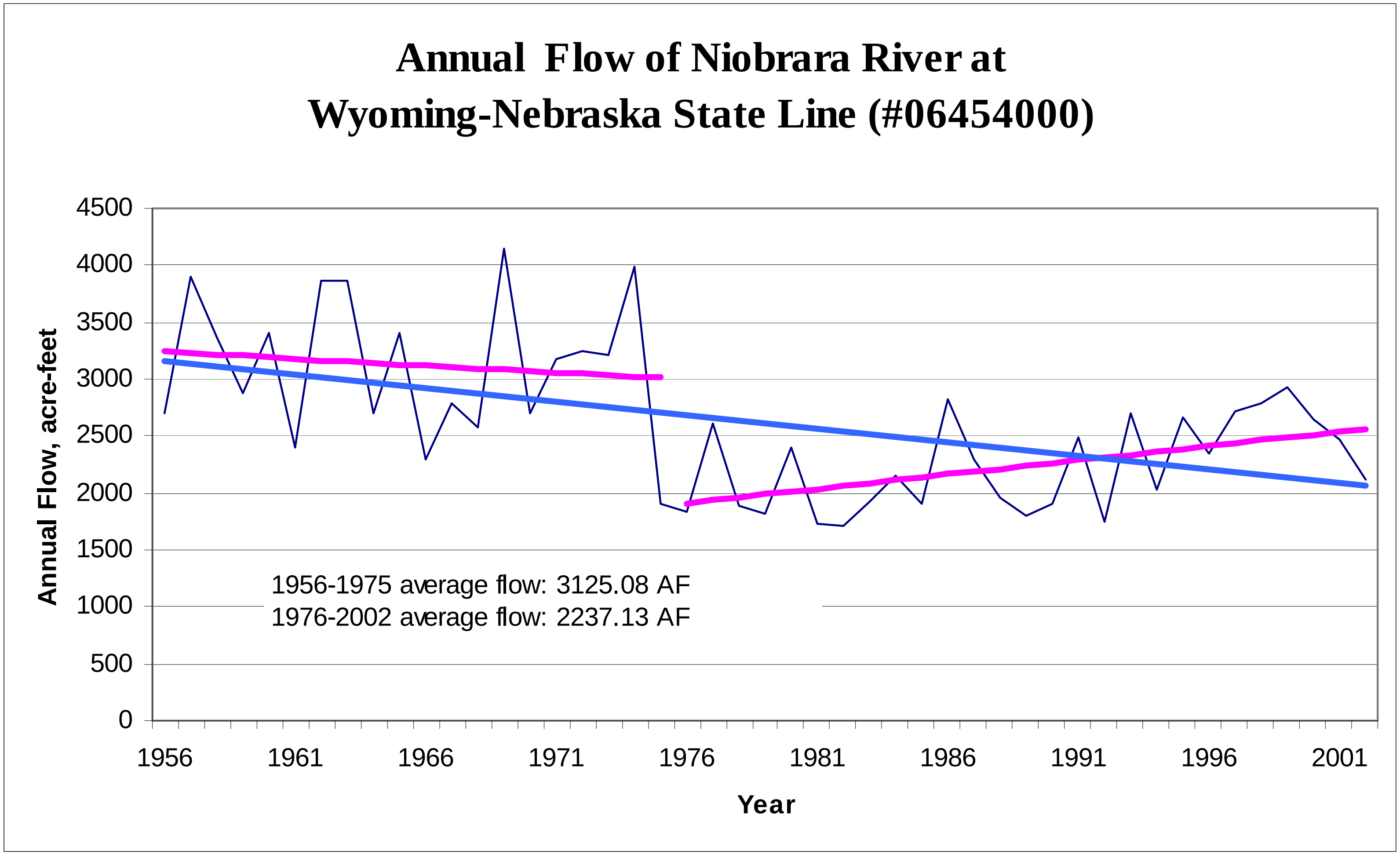
Source: Nebraska Department of Natural Resources Stream Gaging Records
* Note: Figures for below Mirage Flats are estimates based upon diversion records and non-irrigation season reach gain measurements. The 1996-2000 Figure for Gordon is an estimate.

Figure 8



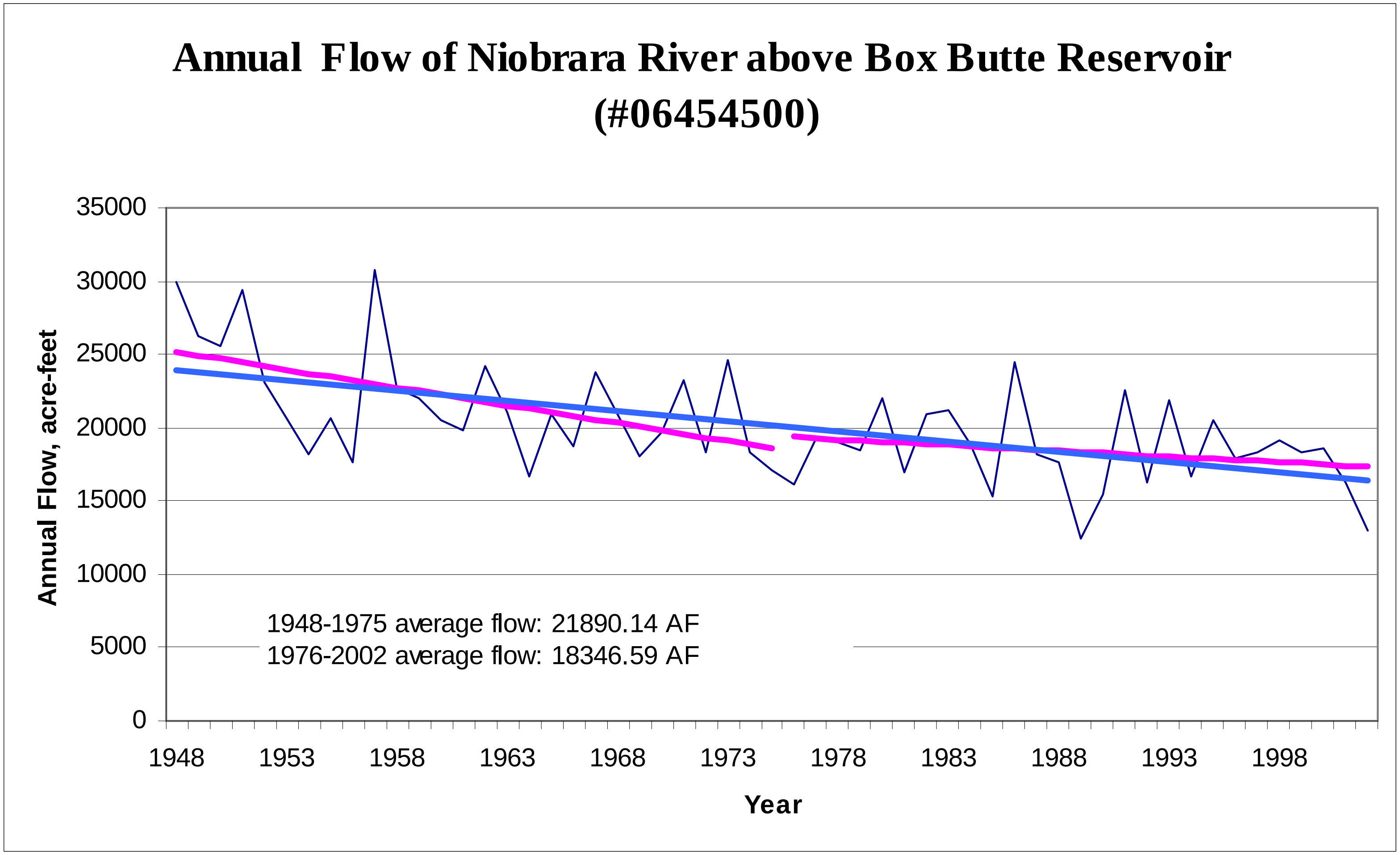
Source: Nebraska Department of Natural Resources Stream Gaging Records
* Note: The Figure for below Mirage Flats is an estimate based upon diversion records and non-irrigation season reach gain measurements.

Figure 9



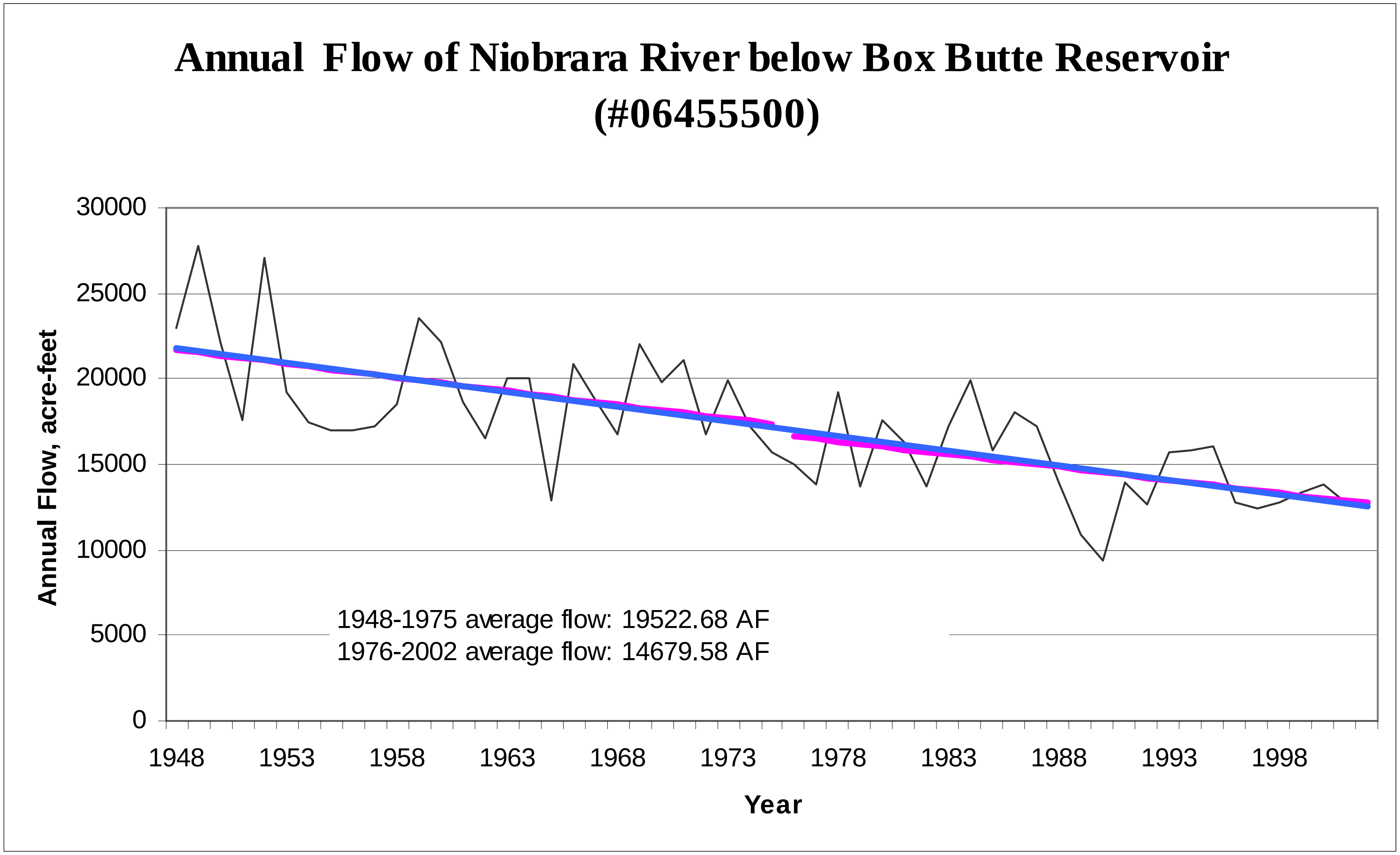
Source: Nebraska Department of Natural Resources Stream Gaging Records

Figure 10



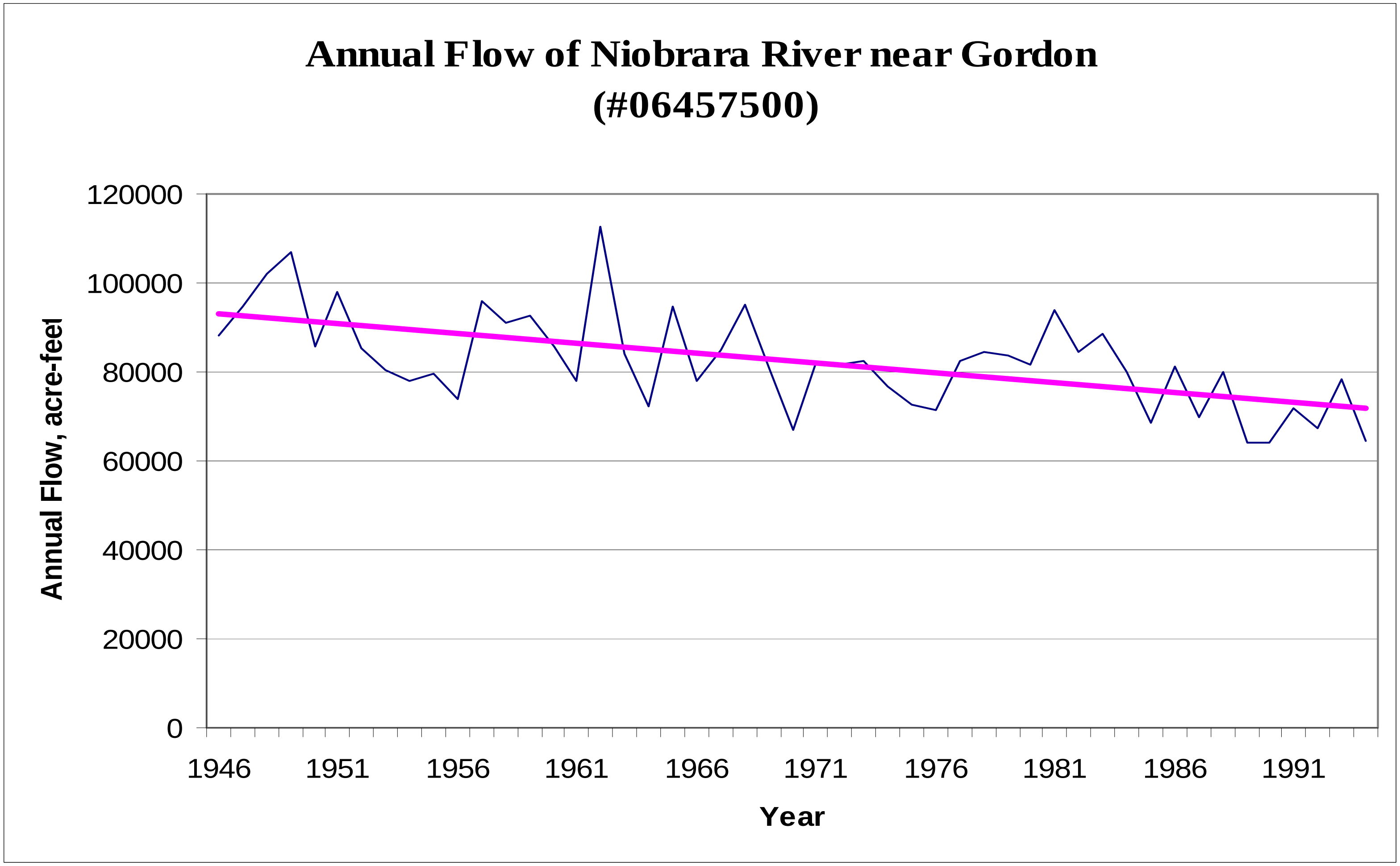
Source: Nebraska Department of Natural Resources Stream Gaging Records

Figure 11



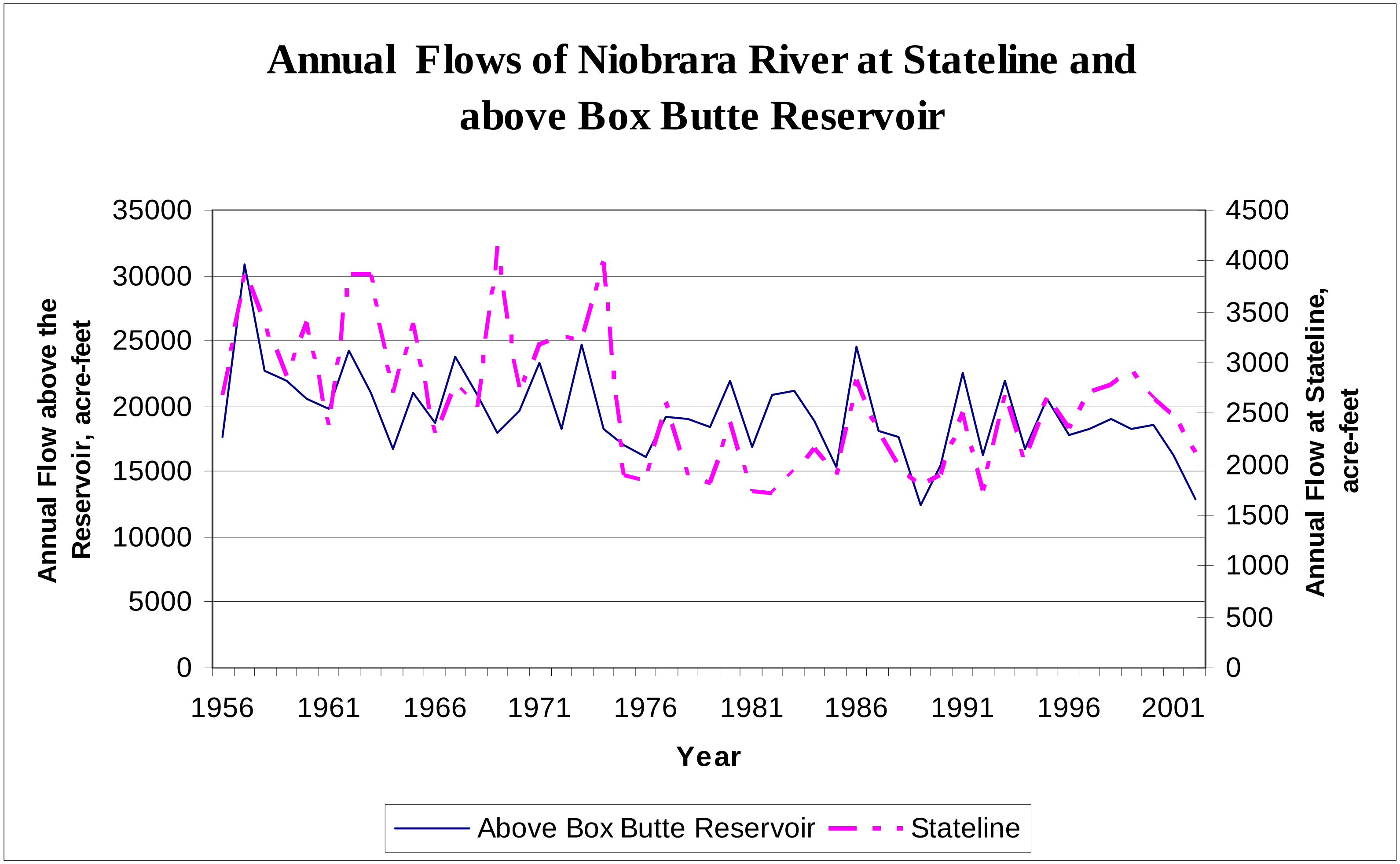
Source: Nebraska Department of Natural Resources Stream Gaging Records

Figure 12



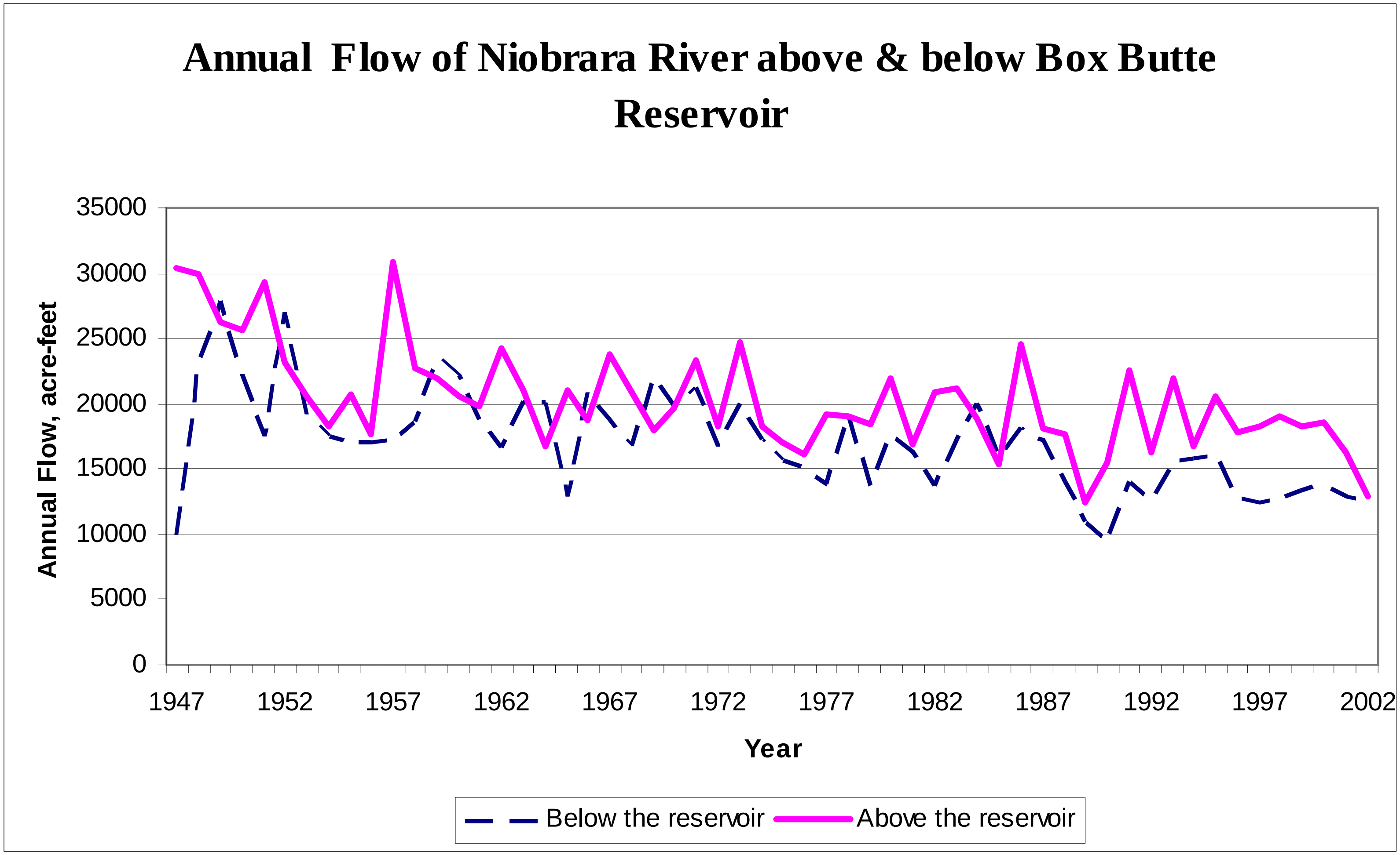
Source: Nebraska Department of Natural Resources Stream Gaging Records

Figure 13



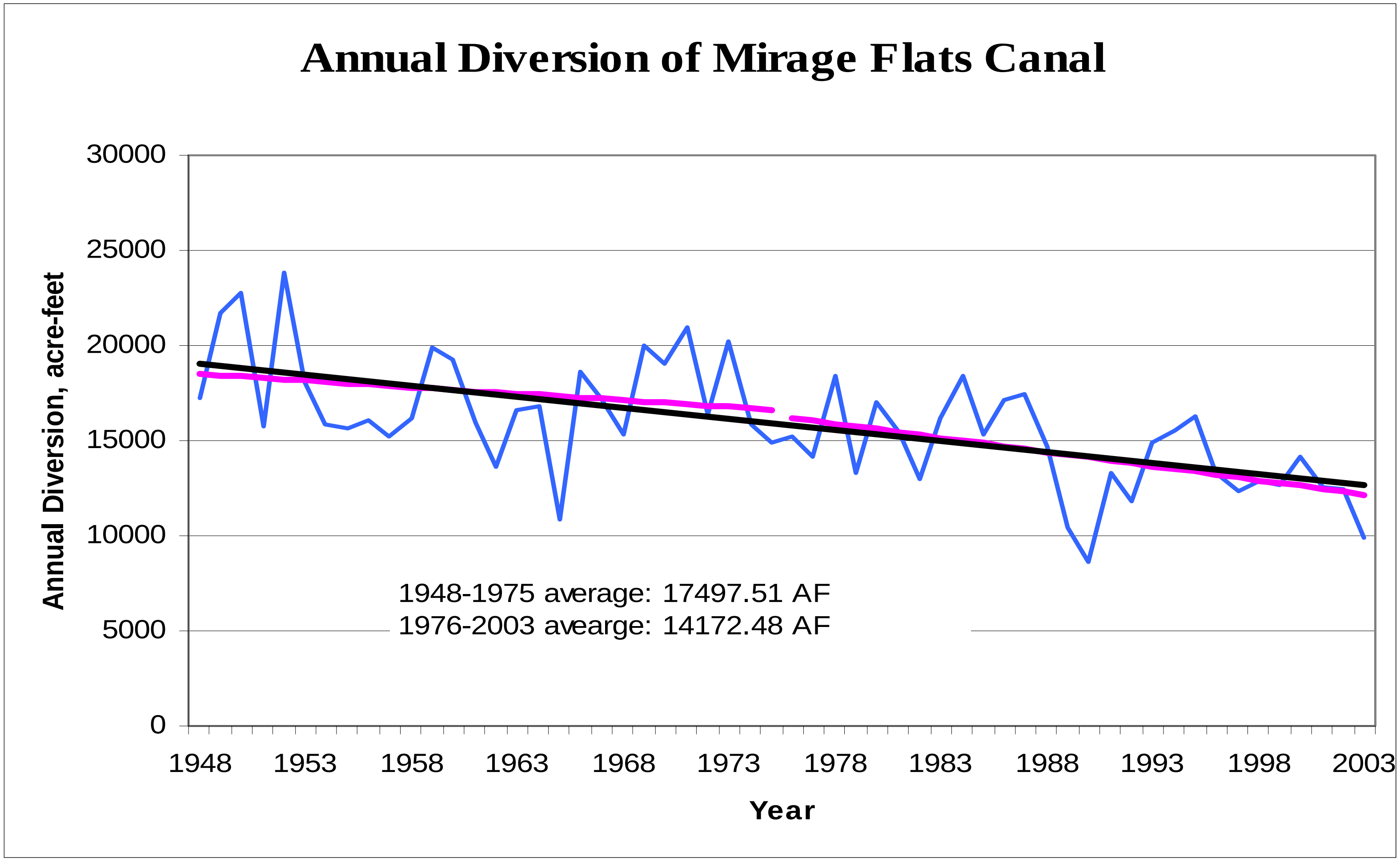
Source: Nebraska Department of Natural Resources Stream Gaging Records

Figure 14



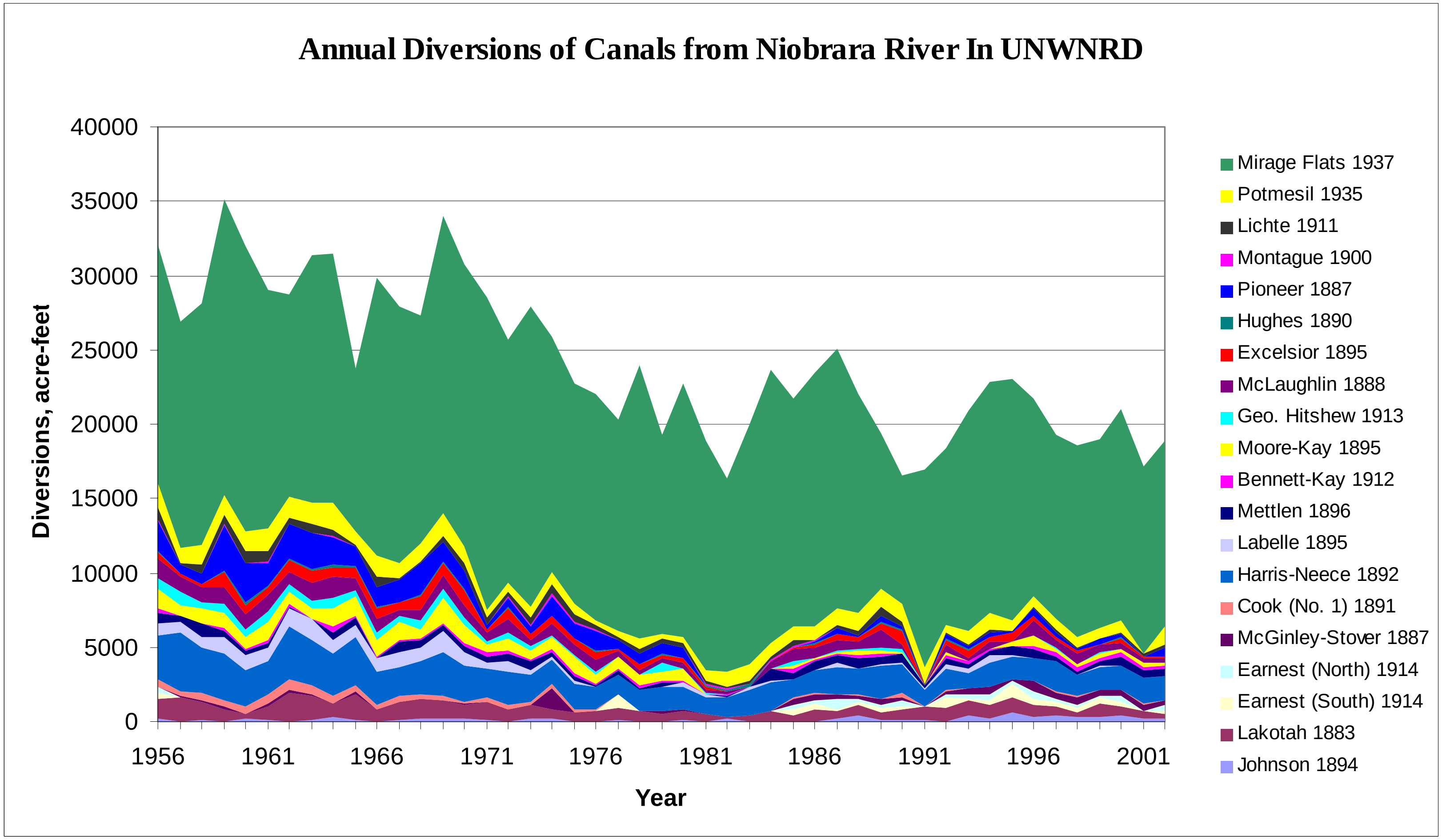
Source: Nebraska Department of Natural Resources Stream Gaging Records

Figure 15



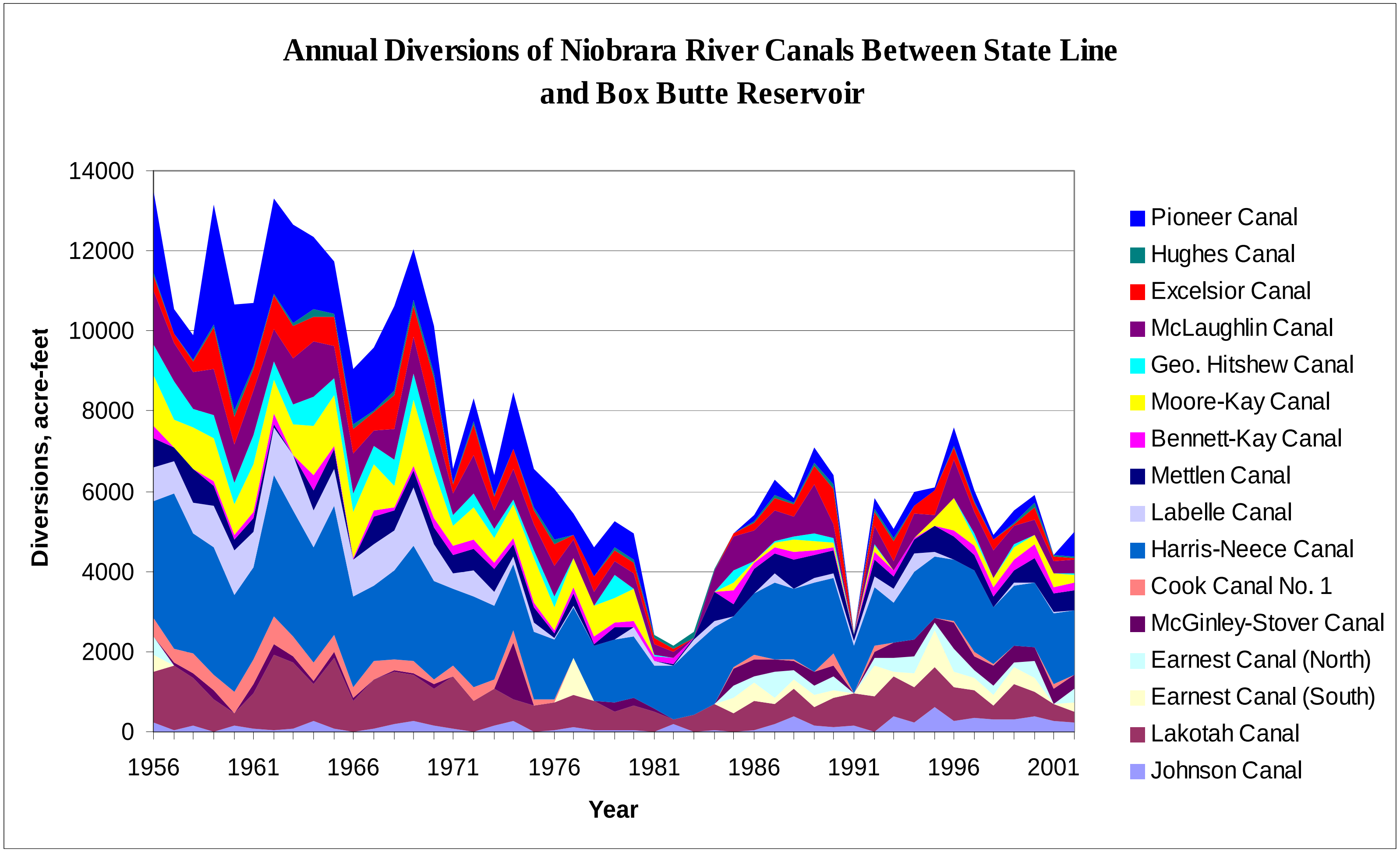
Source: Nebraska Department of Natural Resources Stream Gaging / Canal Diversion Records

Figure 16



Source: Nebraska Department of Natural Resources Stream Gaging / Canal Diversion Records

Figure 17



Source: Nebraska Department of Natural Resources Stream Gaging / Canal Diversion Records

Figure 18

Geology of the Upper Niobrara White Natural Resources District

Geology and Water Table Source: http://csd.unl.edu/general/gis-datasets.asp
The Conservation and Survey Division has produced this product using what is thought to be the most reliable information available or reproduced the material asprovided. The detail and precision of the interpretations madeare according to accepted professional standards and are dependant upon the techniques, hardware, and/or software utilized.

Legend

UNWNRD Boundary
County Boundaries

Geology

Ogallala Group
Arikaree Group
White River Group
Pierre Shale
Niobrara Formation
Carlile Fromation
Greenhorn-Graneros Formations

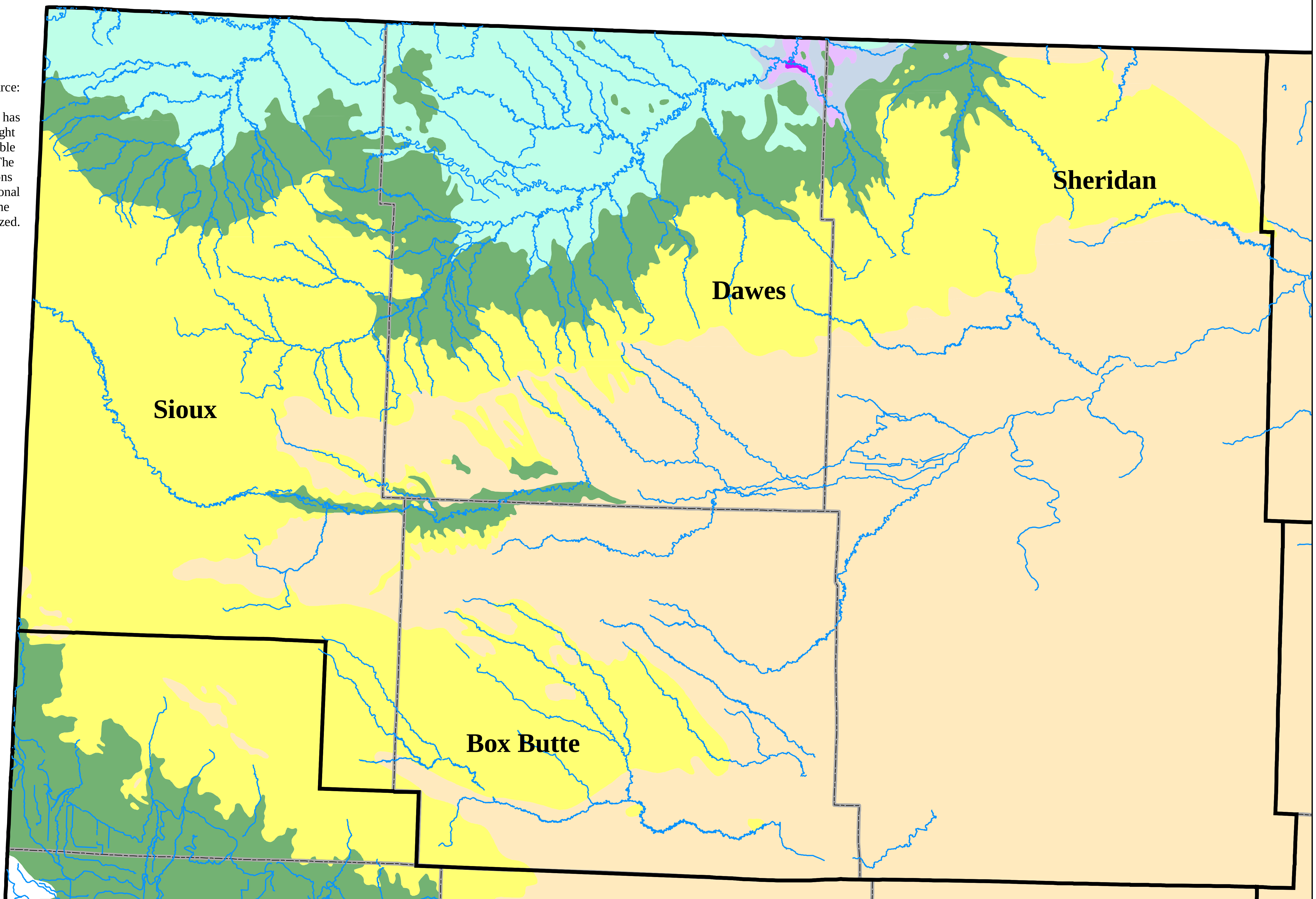
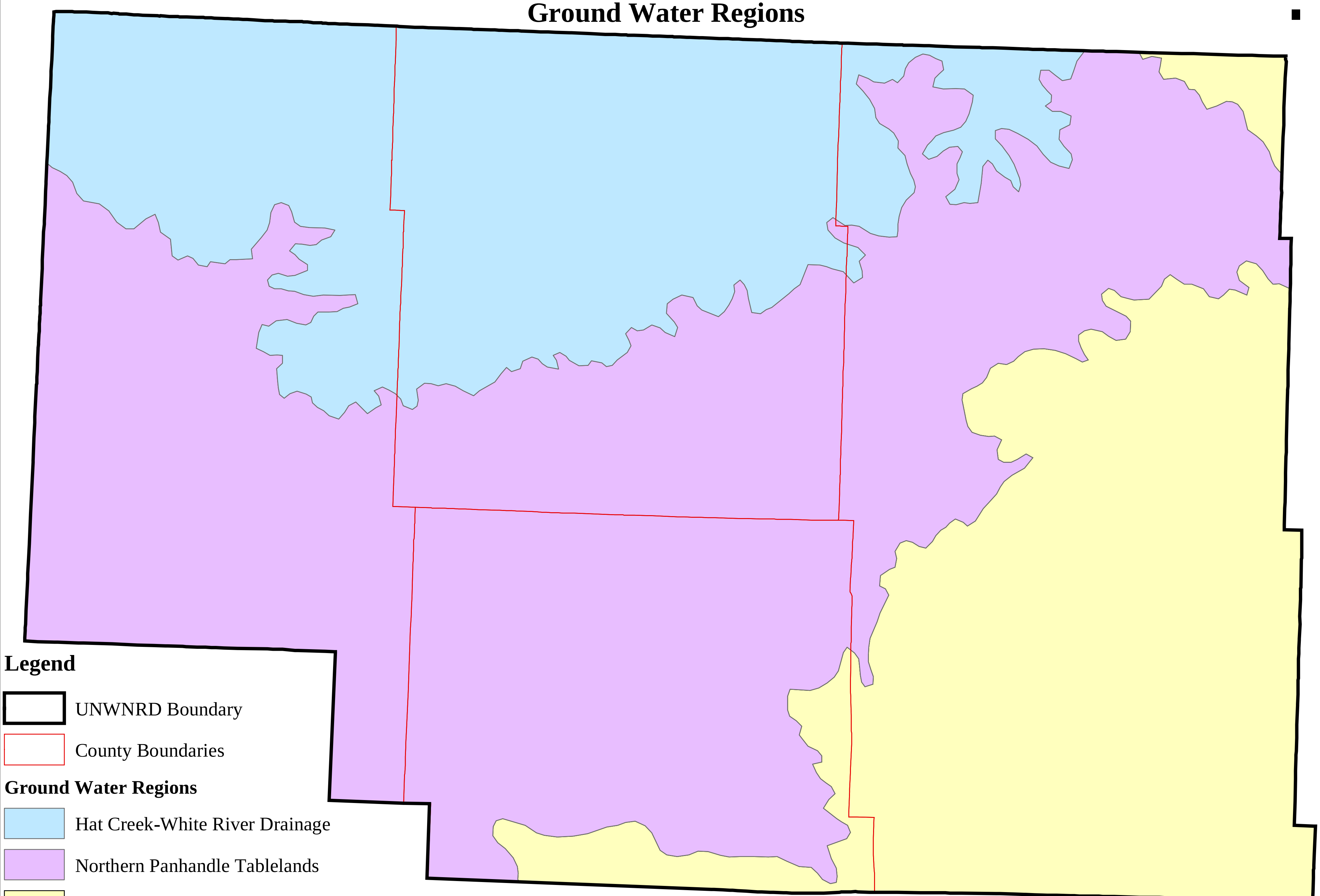


Figure 19

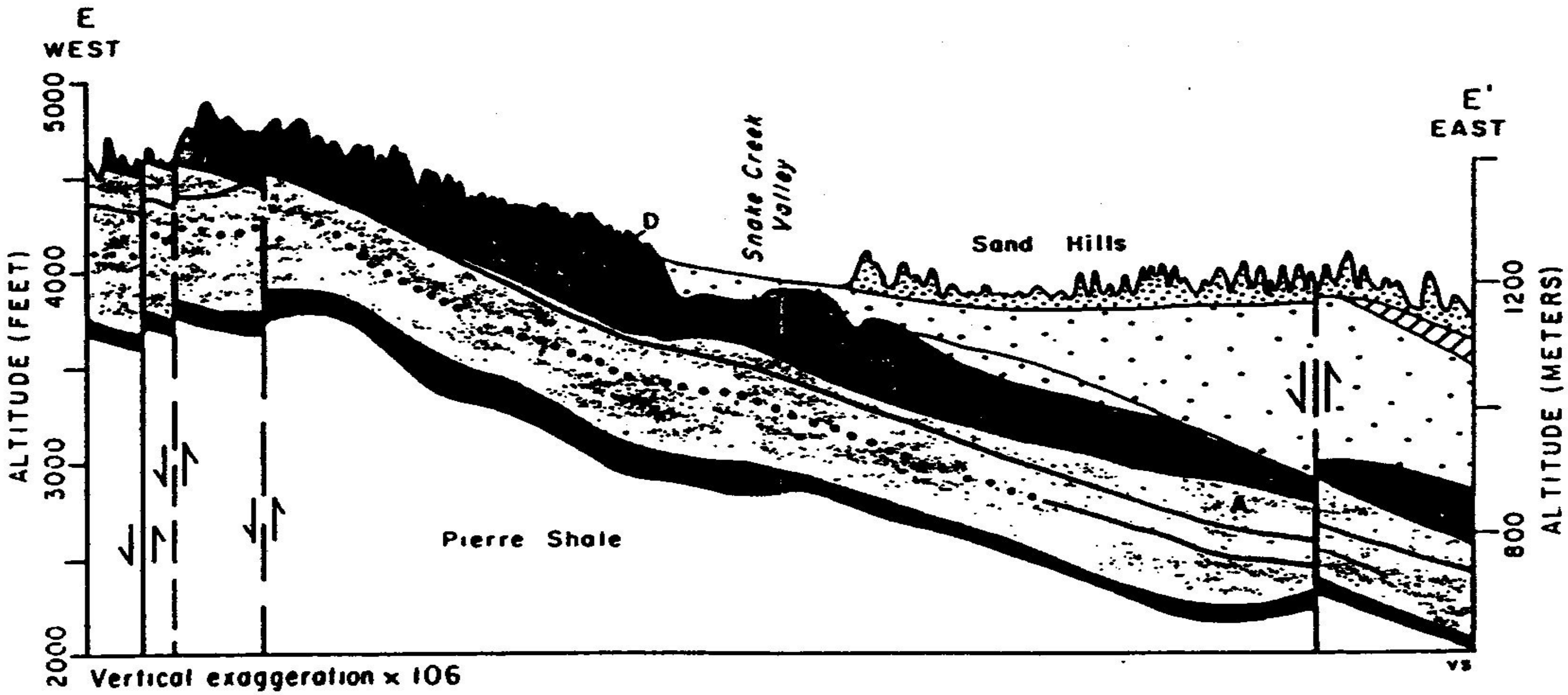
Ground Water Regions

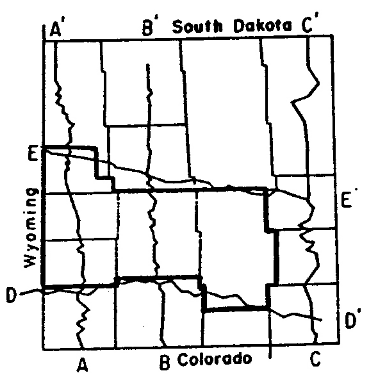


Source:
http://csd.unl.edu/general/gis-datasets.asp

The Conservation and Survey Division has produced this product using what is thought to be the most reliable information available or reproduced the material as provided. The detail and precision of the interpretations made are according to accepted professional standards and are dependant upon the techniques, hardware, and/or software utilized. Source map was provided by Nebraska Department of Health. Groundwater 'region' is an interpreted term. CSD has a similar map done in 1968 by Eugene Reed at 1:500,000.

Figure 20





Source: Swinehart, J.B. et al., 1985

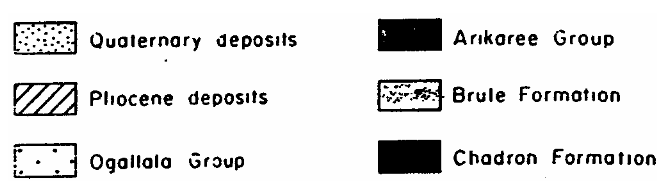
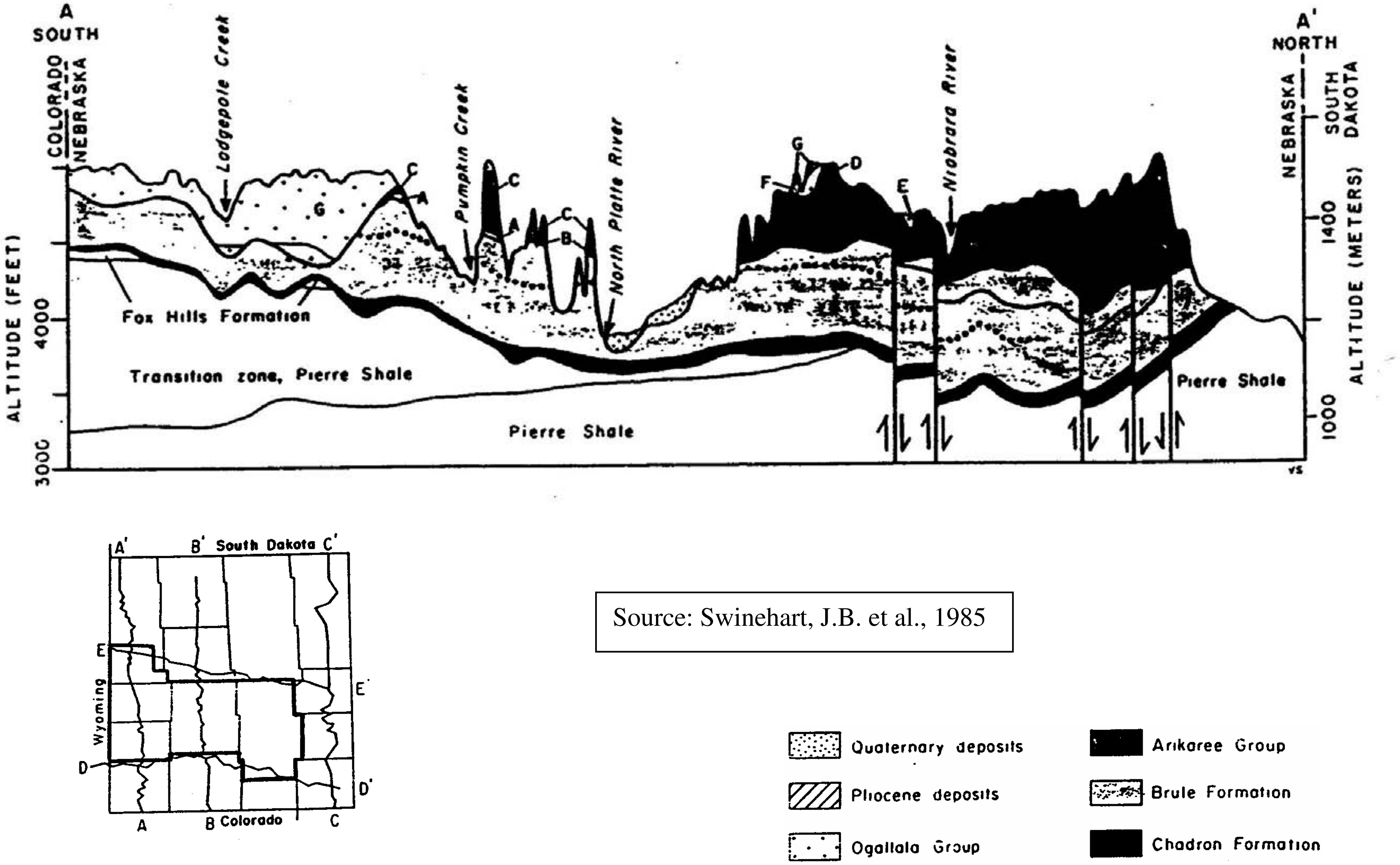
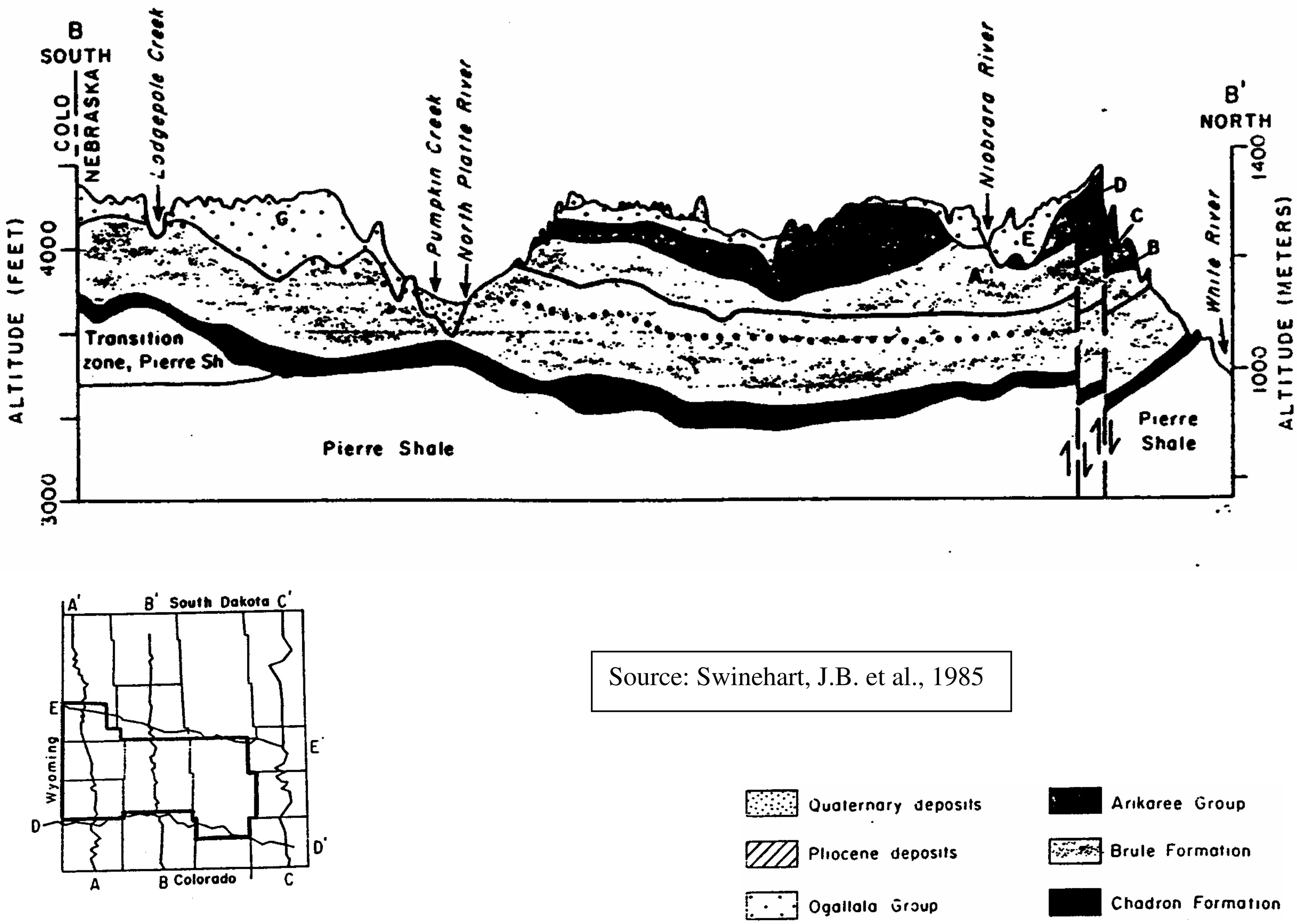


Figure 21



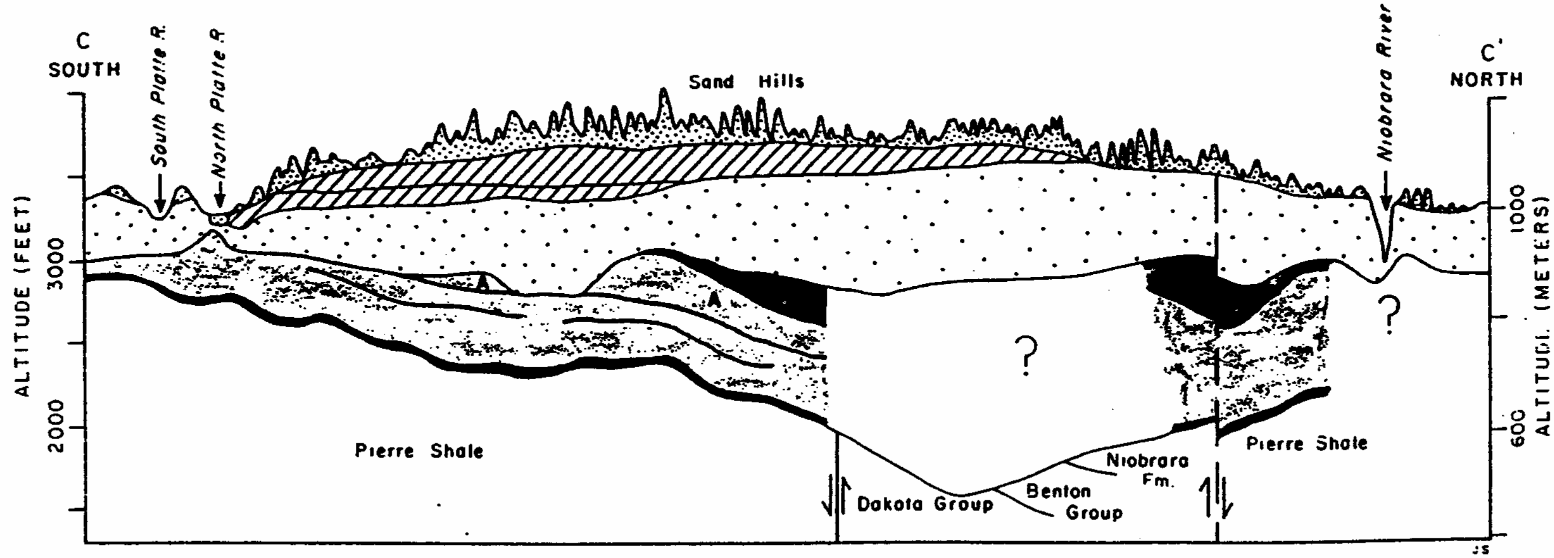
Source: Swinehart, J.B. et al., 1985

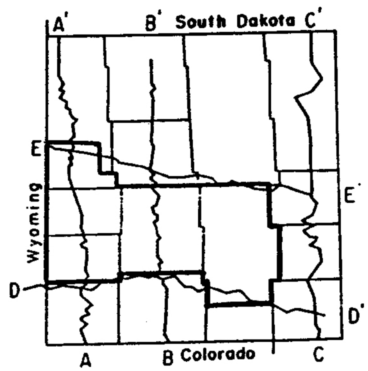
Figure 22



Source: Swinehart, J.B. et al., 1985

Figure 23





Source: Swinehart, J.B. et al., 1985

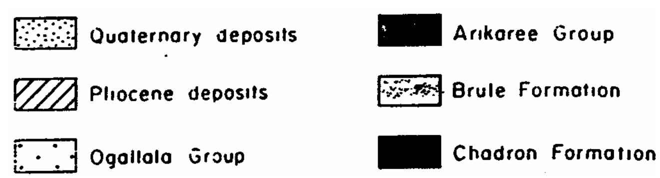
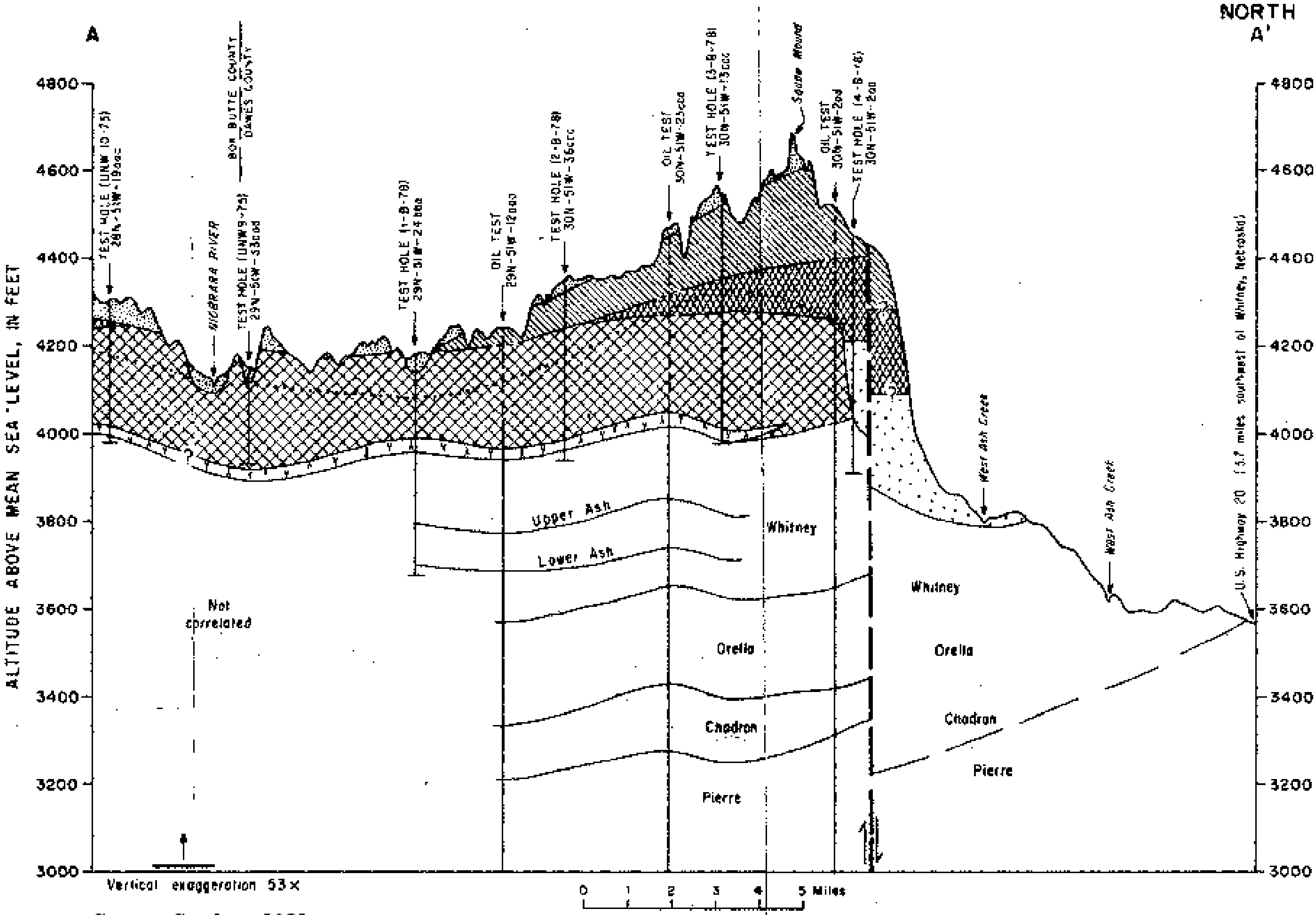
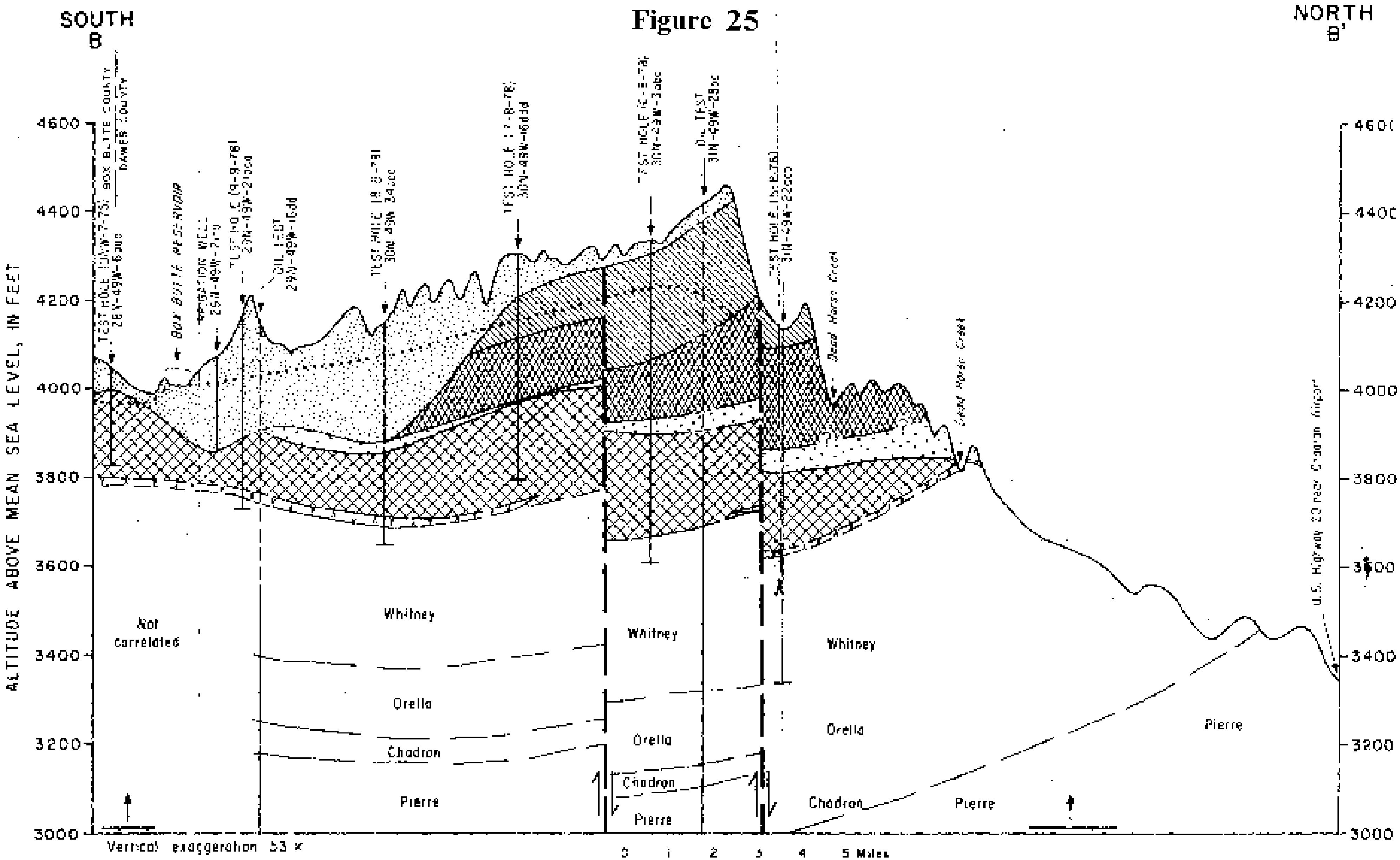


Figure 24



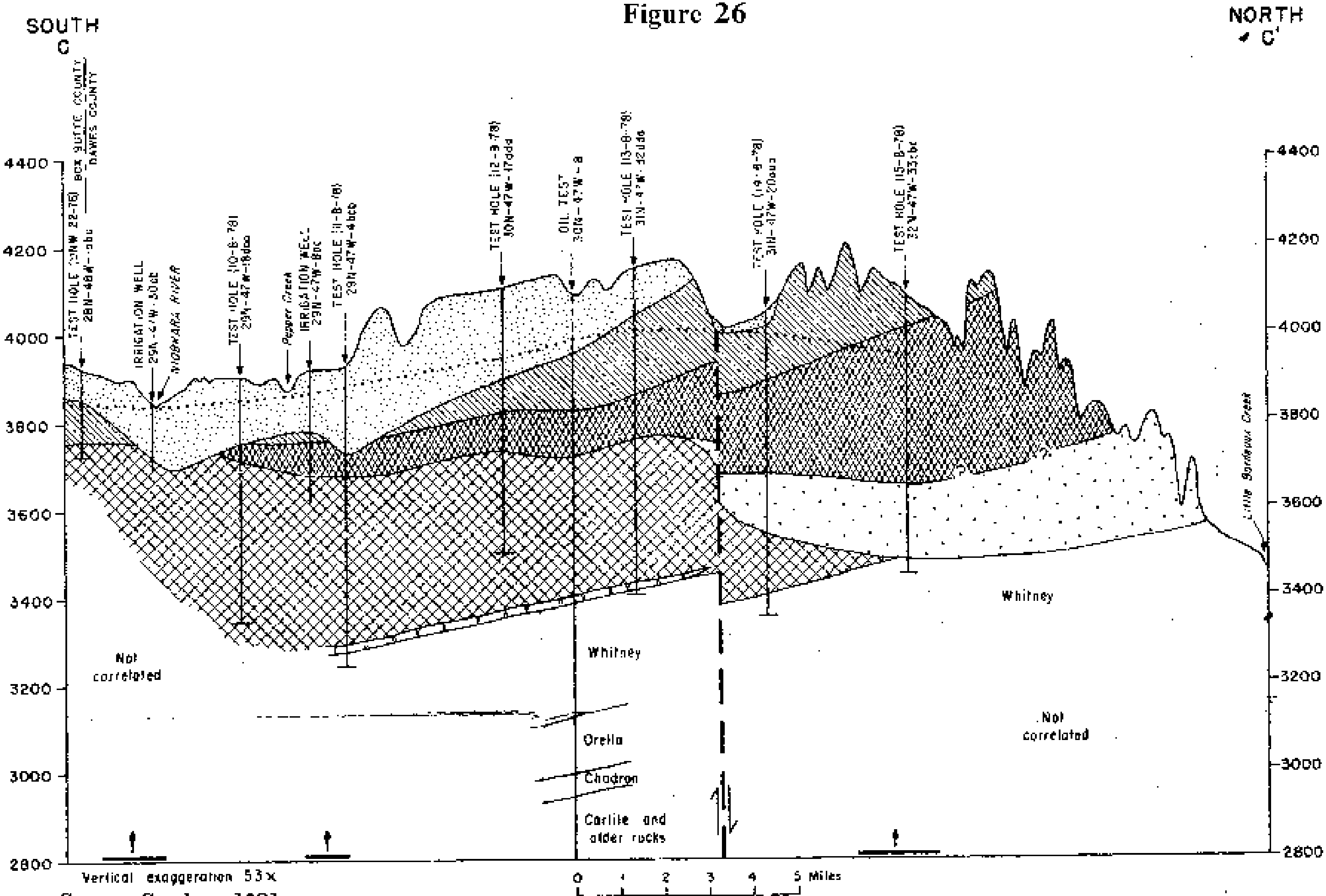
Source: Souders, 1981

Figure 25



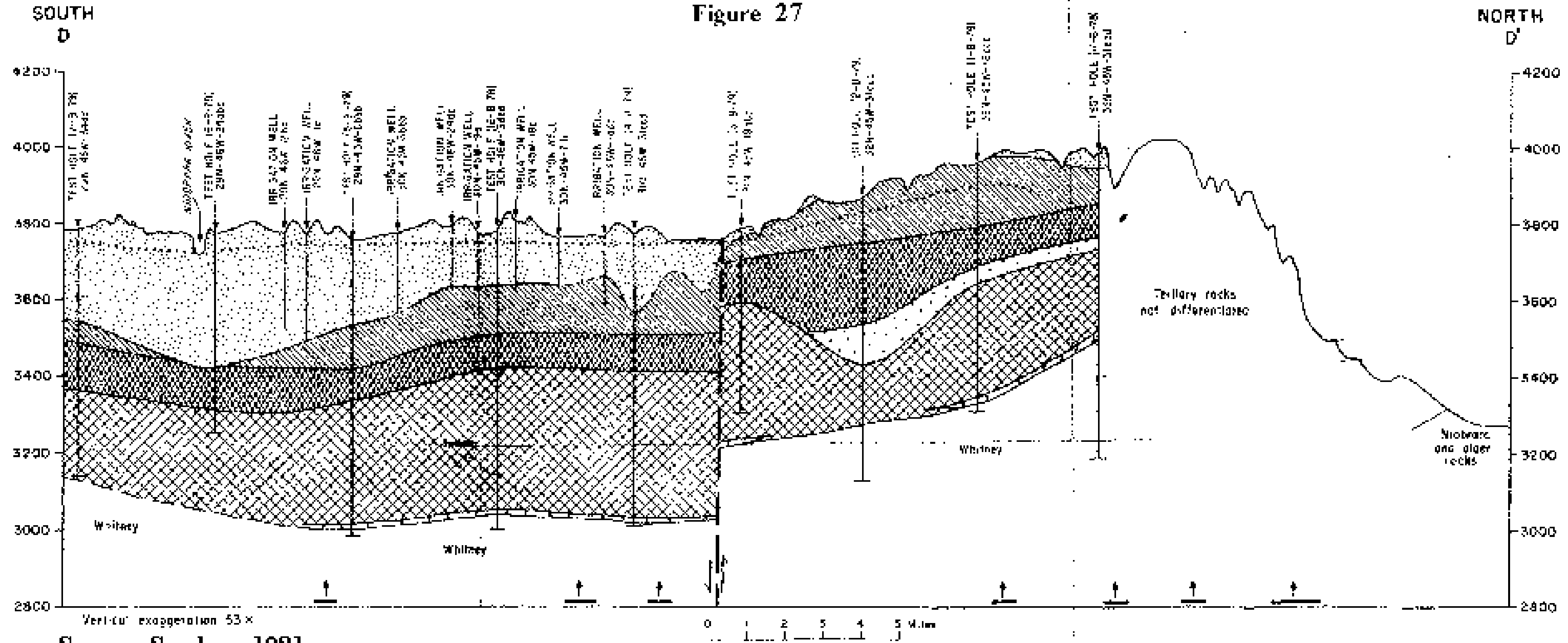
Source: Souders, 1981

Figure 26



Source: Souders, 1981

Figure 27



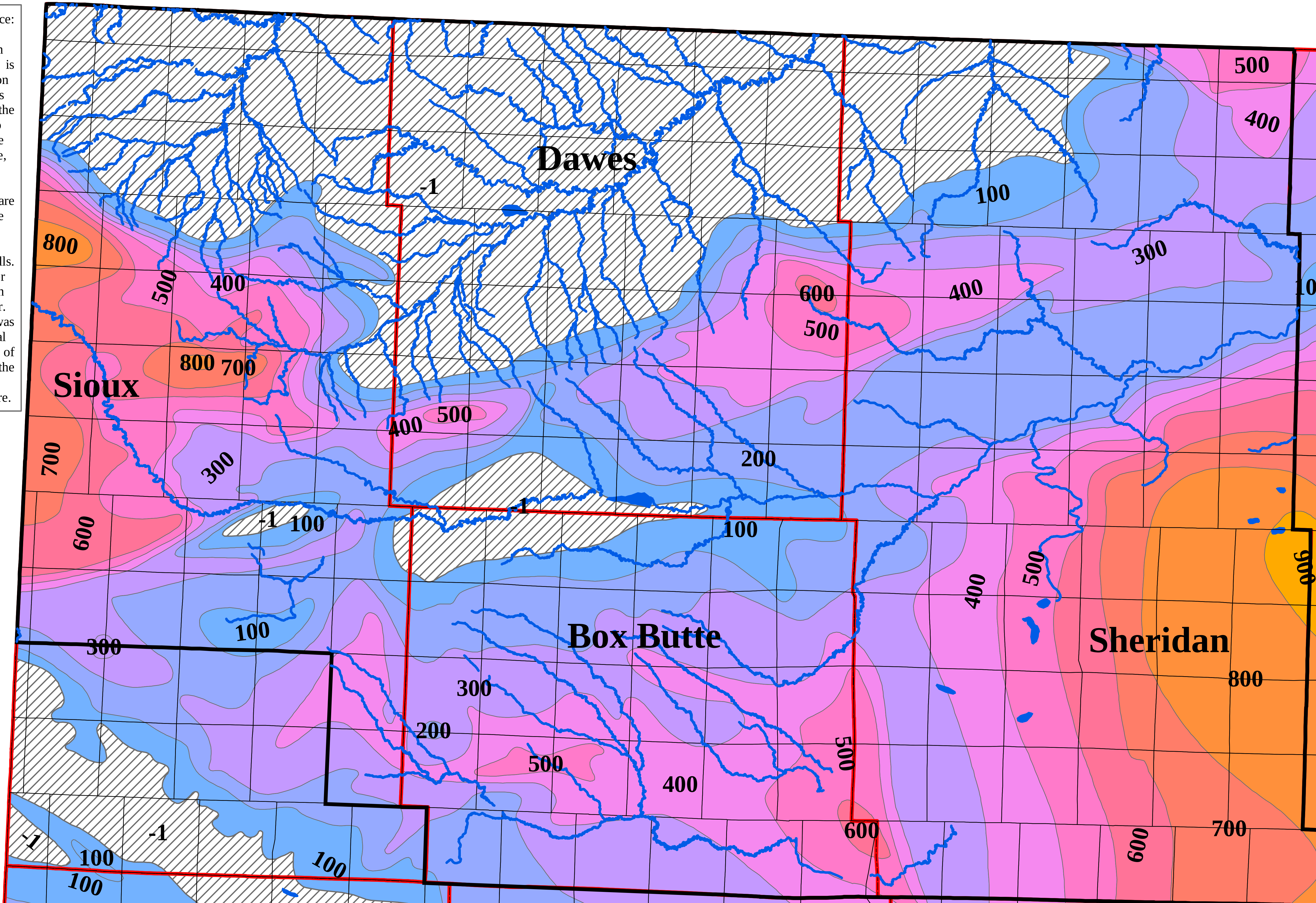
Source: Souders, 1981

Saturated Thickness of Principal Aquifer

Figure 28

Saturated Thickness Contour Source: http://csd.unl.edu/general/gis-datasets.asp
The Conservation and Survey Division has produced this product using what is thought to be the most reliable information available or reproduced the material as provided. The detail and precision of the interpretations made are according to accepted professional standards and are dependant upon the techniques, hardware, and/or software utilized.

The thickness of the principal aquifer are a series of contour lines showing the estimated thickness of the saturated sediments that serve as the source aquifer for domestic and irrigation wells. It was digitized from 1:250,000 paper maps published in 1980 and has been used as the 'normal' thickness of the aquifer. The principal CSD geoscientist was Vern Souders. Areas where the principal aquifer is'absent or very thin' are areas of impermeable rock or clay. Some of the areas are fractured and may yield considerable water if the well hits the fracture.



Legend

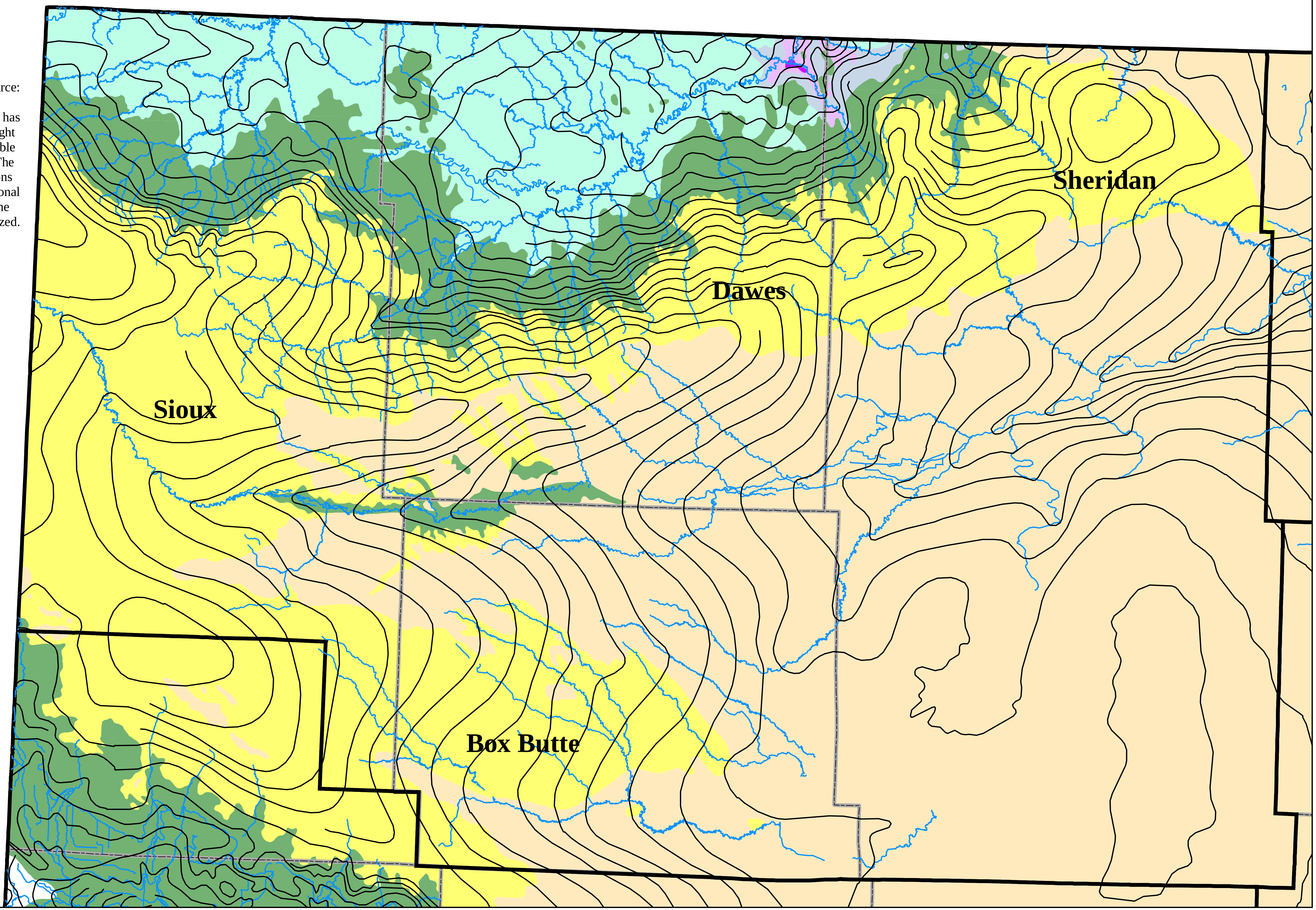
- UNWNRD Boundary
- County Boundaries
- Township Boundaries

Saturated Thickness

- very thin or absent
- 100
- 200
- 300
- 400
- 500
- 600
- 700
- 800
- 900

Figure 29

Geology and 1995 Water Table Contours in the Upper Niobrara White Natural Resources District



Geology and Water Table Source: http://csd.unl.edu/general/gis-datasets.asp
The Conservation and Survey Division has produced this product using what is thought to be the most reliable information available or reproduced the material asprovided. The detail and precision of the interpretations madeare according to accepted professional standards and are dependant upon the techniques, hardware, and/or software utilized.

Legend

- UNWNRD Boundary
- County Boundaries
- 1995 Water Table

Geology

- Ogallala Group
- Arikaree Group
- White River Group
- Pierre Shale
- Niobrara Formation
- Carlile Fromation
- Greenhorn-Graneros Formations

Figure 30

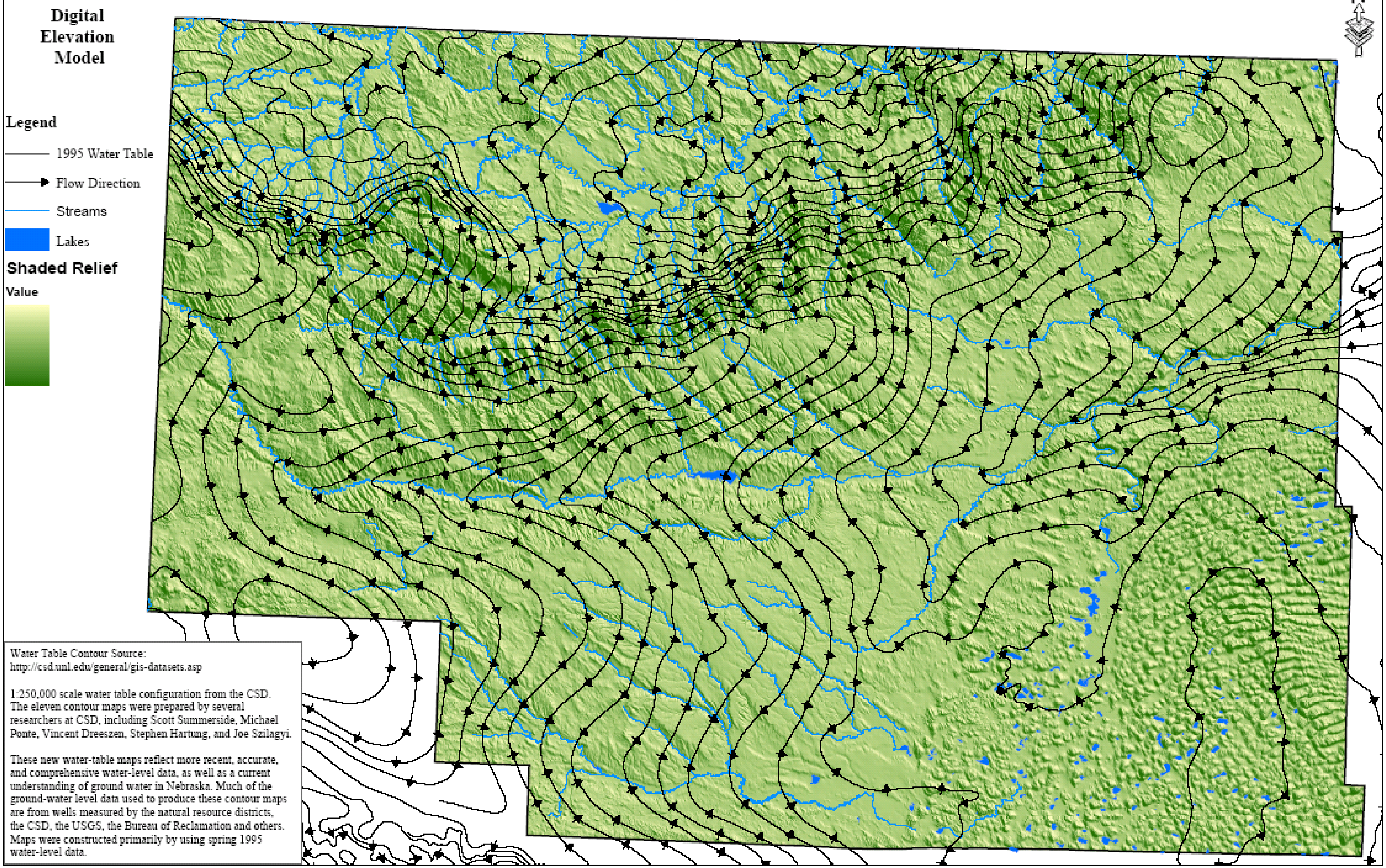
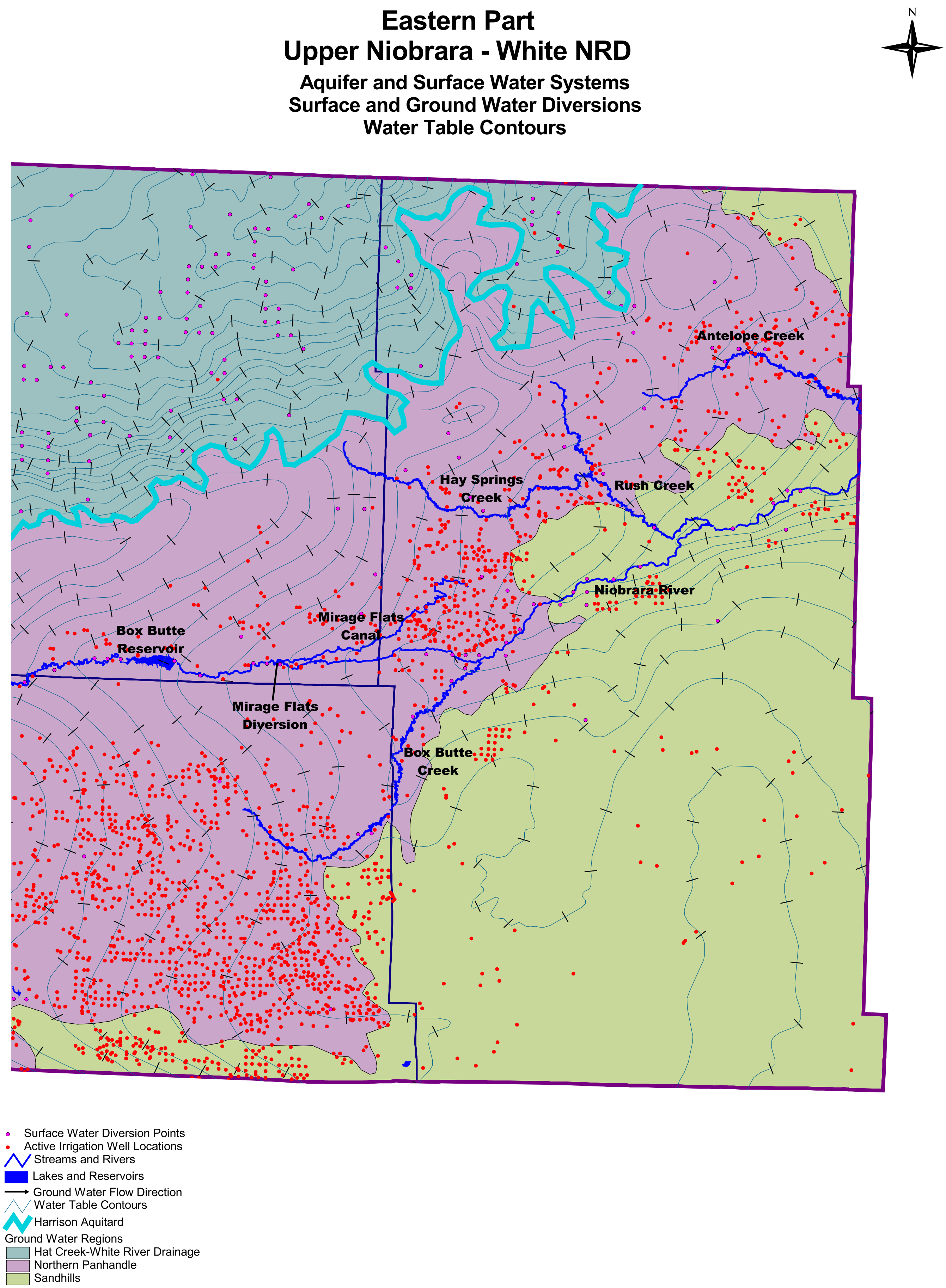
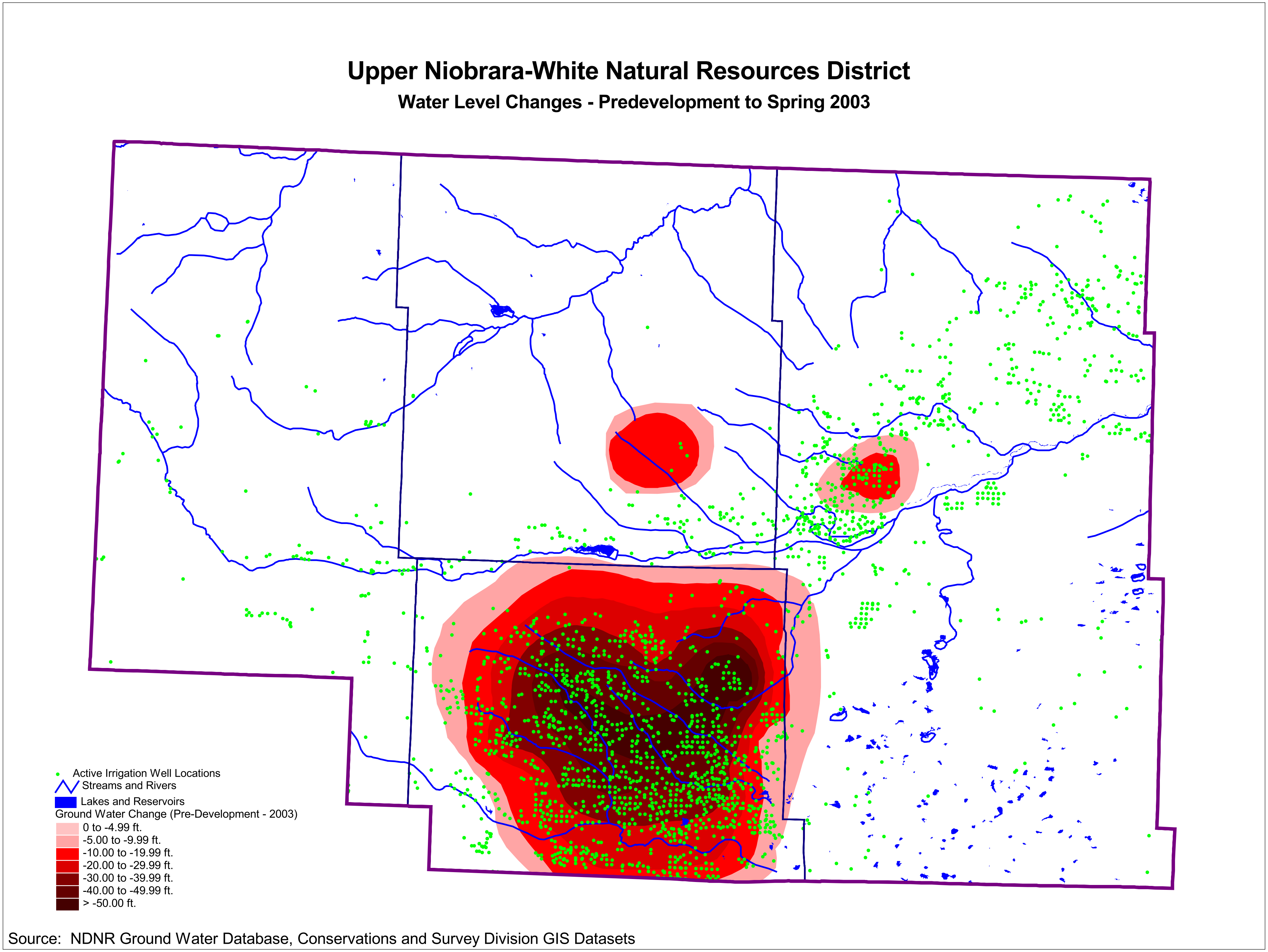

Digital Elevation Model
Legend
1995 Water Table
Flow Direction
Streams
Lakes
Shaded Relief
Value
N
Water Table Contour Source:
http://csd.unl.edu/general/gis-datasets.asp
1:250,000 scale water table configuration from the CSD. The eleven contour maps were prepared by several researchers at CSD, including Scott Summerside, Michael Ponte, Vincent Dreeszen, Stephen Hartung, and Joe Szilagyi.
These new water-table maps reflect more recent, accurate, and comprehensive water-level data, as well as a current understanding of ground water in Nebraska. Much of the ground-water level data used to produce these contour maps are from wells measured by the natural resource districts, the CSD, the USGS, the Bureau of Reclamation and others. Maps were constructed primarily by using spring 1995 water-level data.

Figure 31



Source: NDNR Surface Water and Ground Water Databases, Conservations and Survey Division GIS Datasets

Figure 32



Upper Niobrara-White Natural Resources District
Water Level Changes - Predevelopment to Spring 2003
Active Irrigation Well Locations
Streams and Rivers
Lakes and Reservoirs
Ground Water Change (Pre-Development - 2003)
0 to -4.99 ft.
-5.00 to -9.99 ft.
-10.00 to -19.99 ft.
-20.00 to -29.99 ft.
-30.00 to -39.99 ft.
-40.00 to -49.99 ft.
> -50.00 ft.
Source: NDNR Ground Water Database, Conservations and Survey Division GIS Datasets

Figure 33

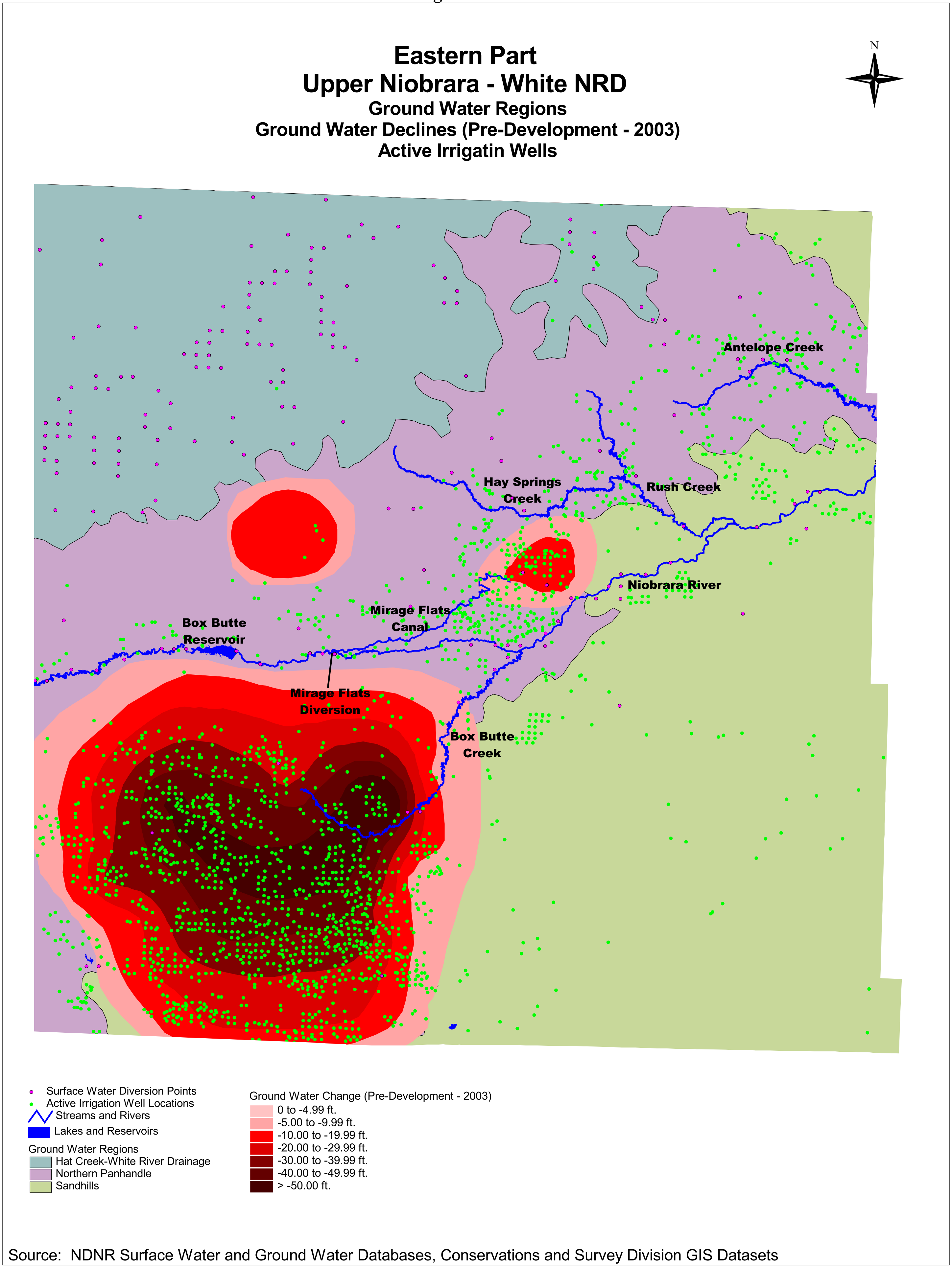
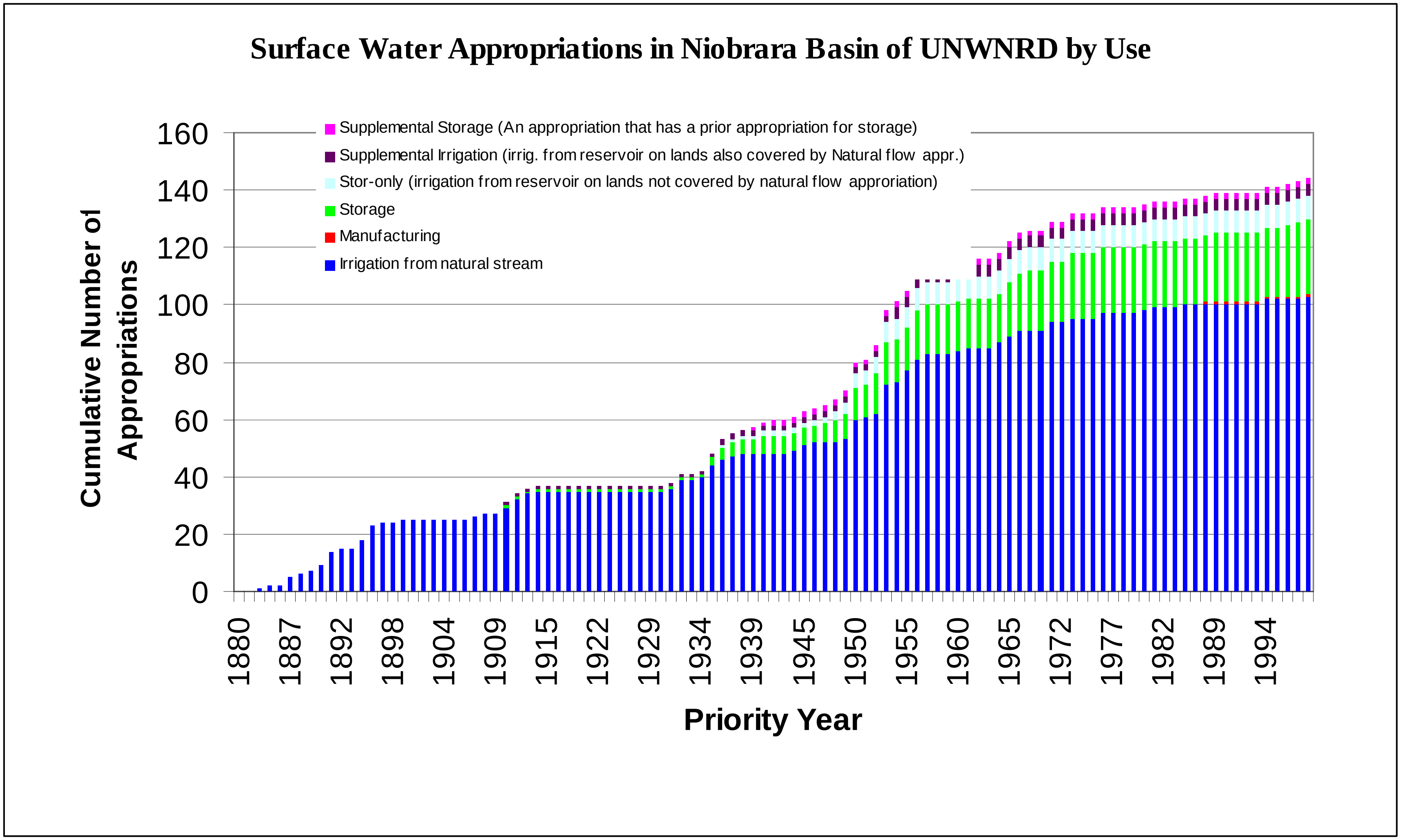
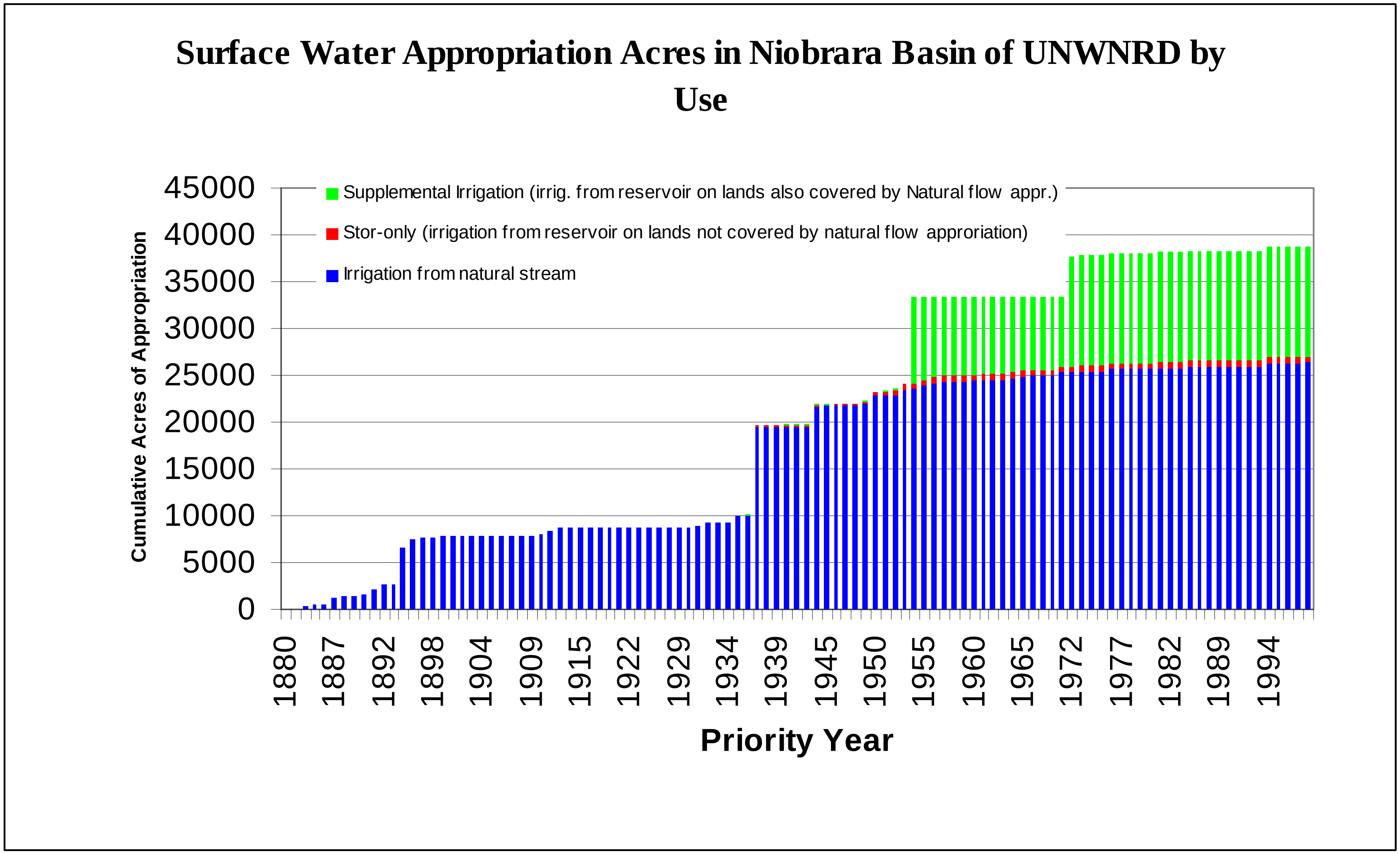

Eastern Part
Upper Niobrara - White NRD
Ground Water Regions
Ground Water Declines (Pre-Development - 2003)
Active Irrigatin Wells
N
Antelope Creek
Hay Springs Creek
Rush Creek
Niobrara River
Mirage Flats Canal
Box Butte Reservoir
Mirage Flats Diversion
Box Butte Creek
Surface Water Diversion Points
Active Irrigation Well Locations
Streams and Rivers
Lakes and Reservoirs
Ground Water Regions
Hat Creek-White River Drainage
Northern Panhandle
Sandhills
Ground Water Change (Pre-Development - 2003)
0 to -4.99 ft.
-5.00 to -9.99 ft.
-10.00 to -19.99 ft.
-20.00 to -29.99 ft.
-30.00 to -39.99 ft.
-40.00 to -49.99 ft.
> -50.00 ft.
Source: NDNR Surface Water and Ground Water Databases, Conservations and Survey Division GIS Datasets

Figure 34



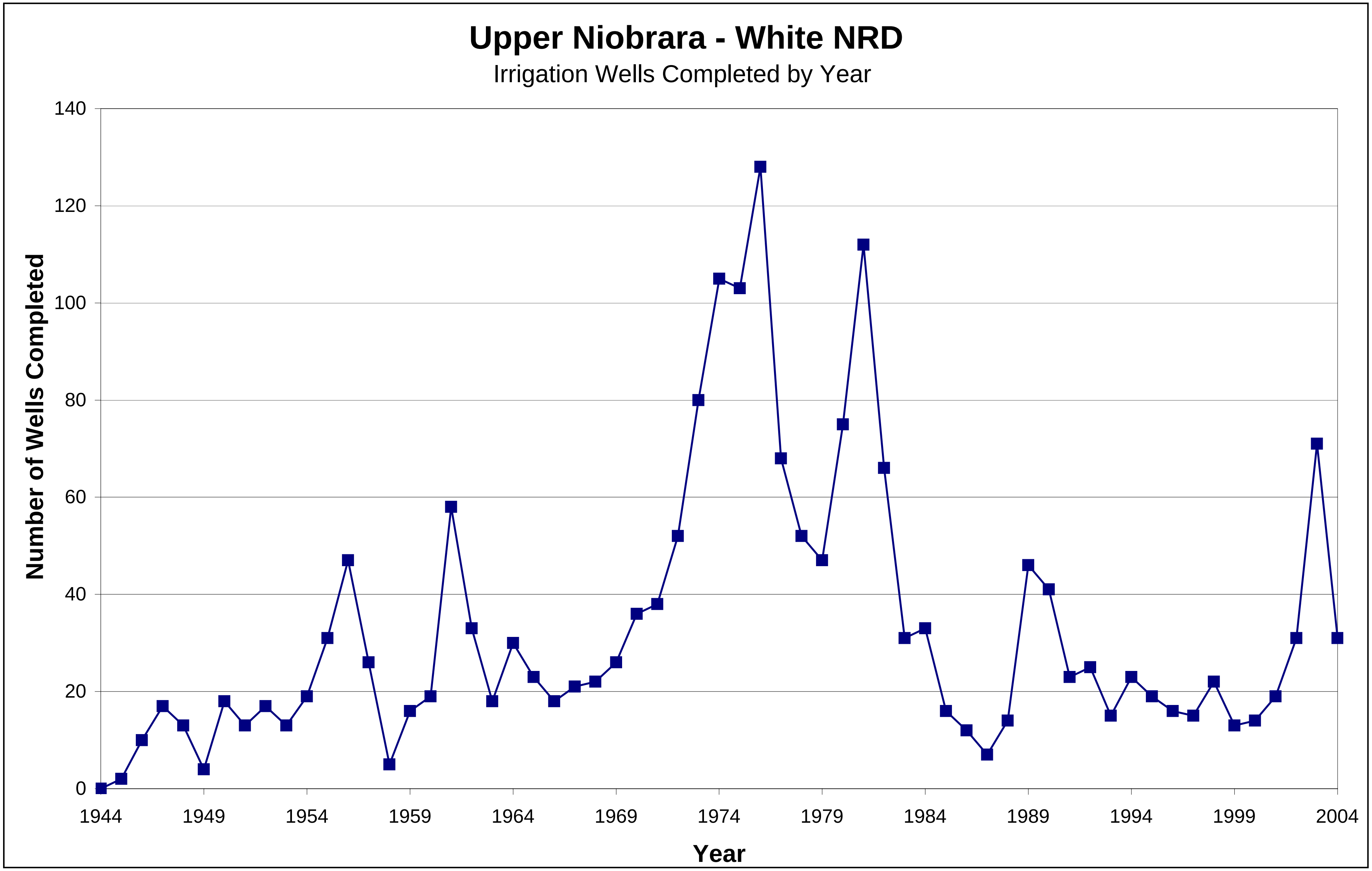
Source: Nebraska Department of Natural Resources Surface Water Rights Records

Figure 35



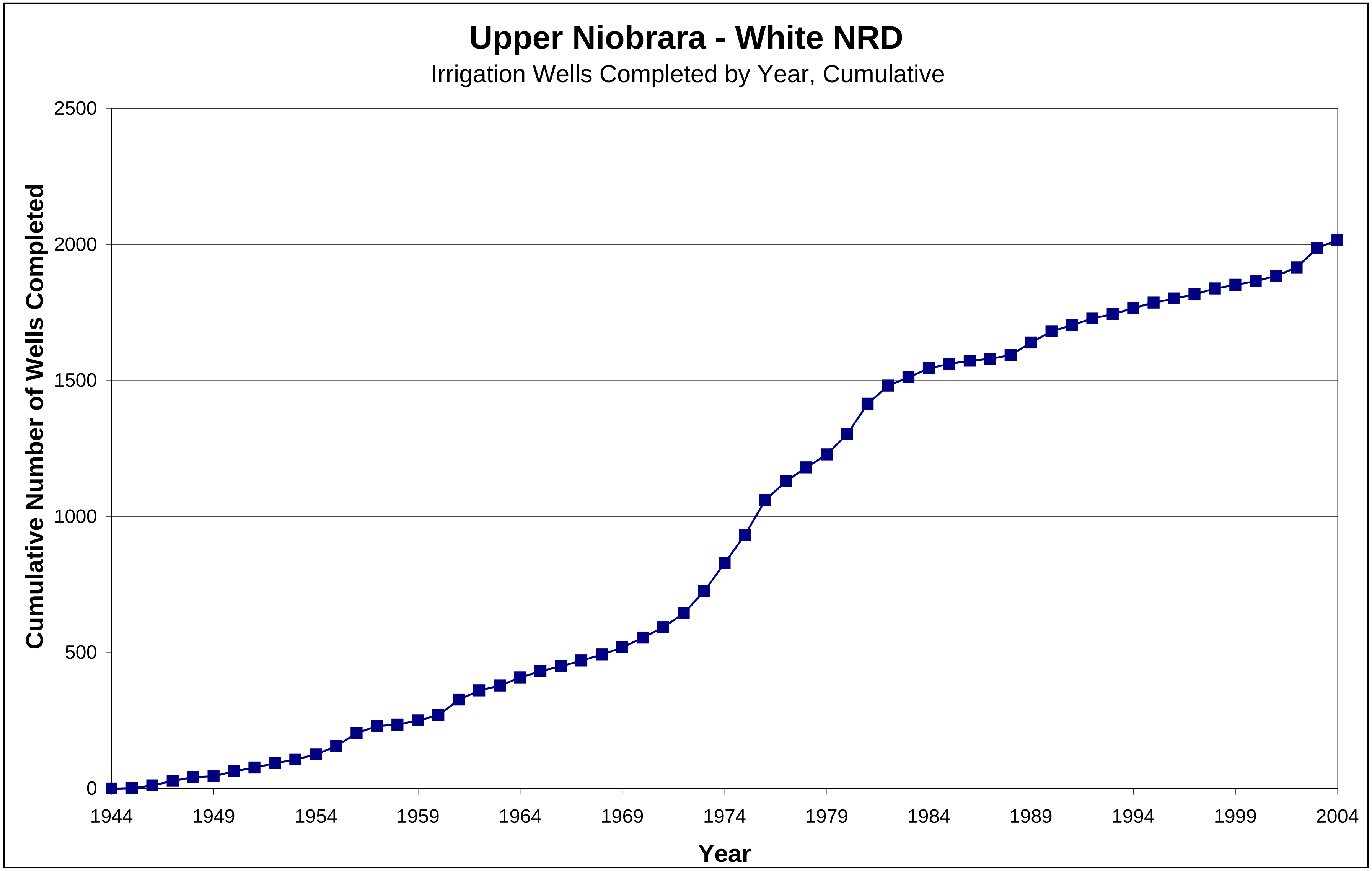
Source: Nebraska Department of Natural Resources Surface Water Rights Records

Figure 36



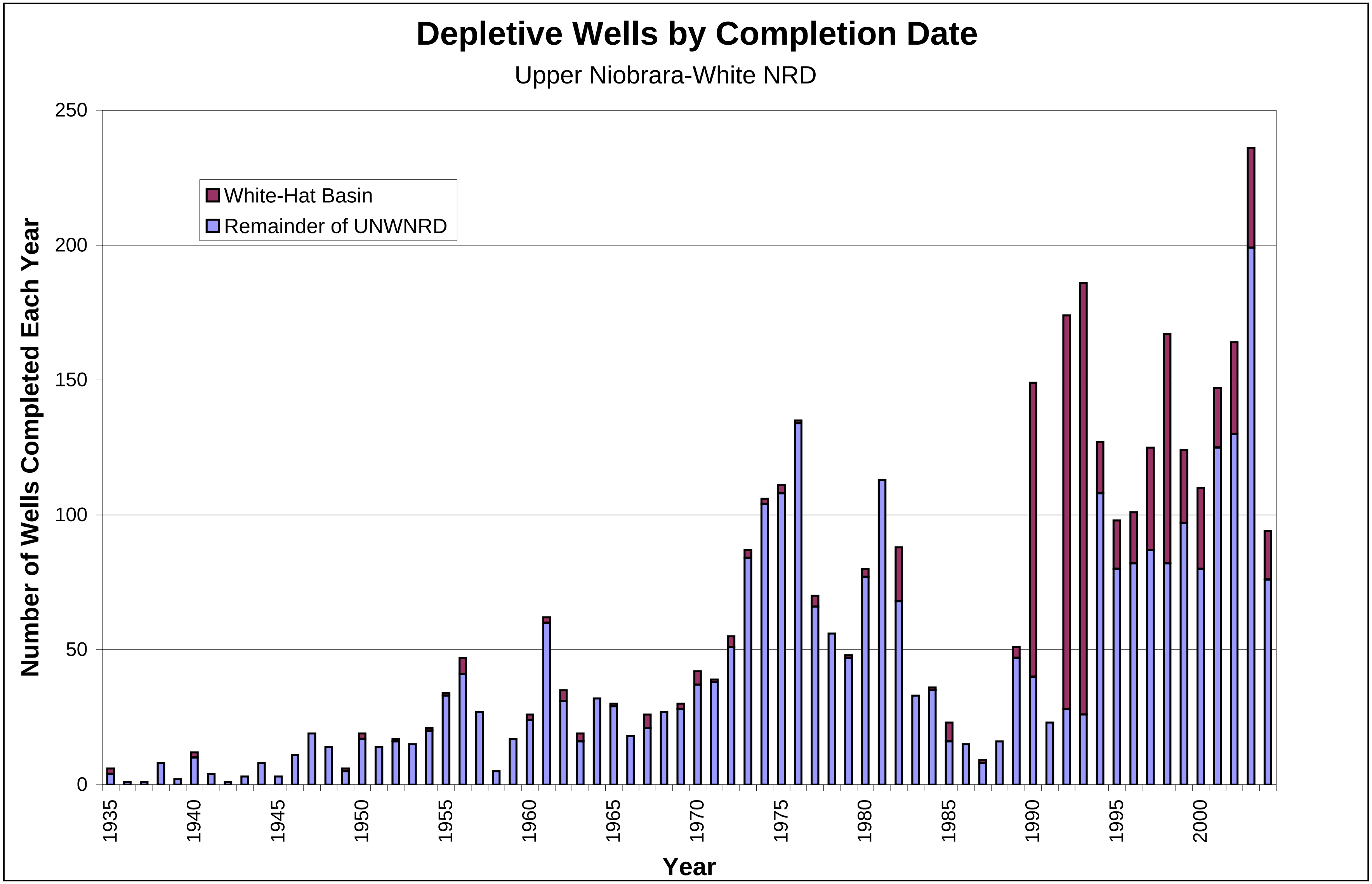
Source: Nebraska Department of Natural Resources Ground Water Database

Figure 37



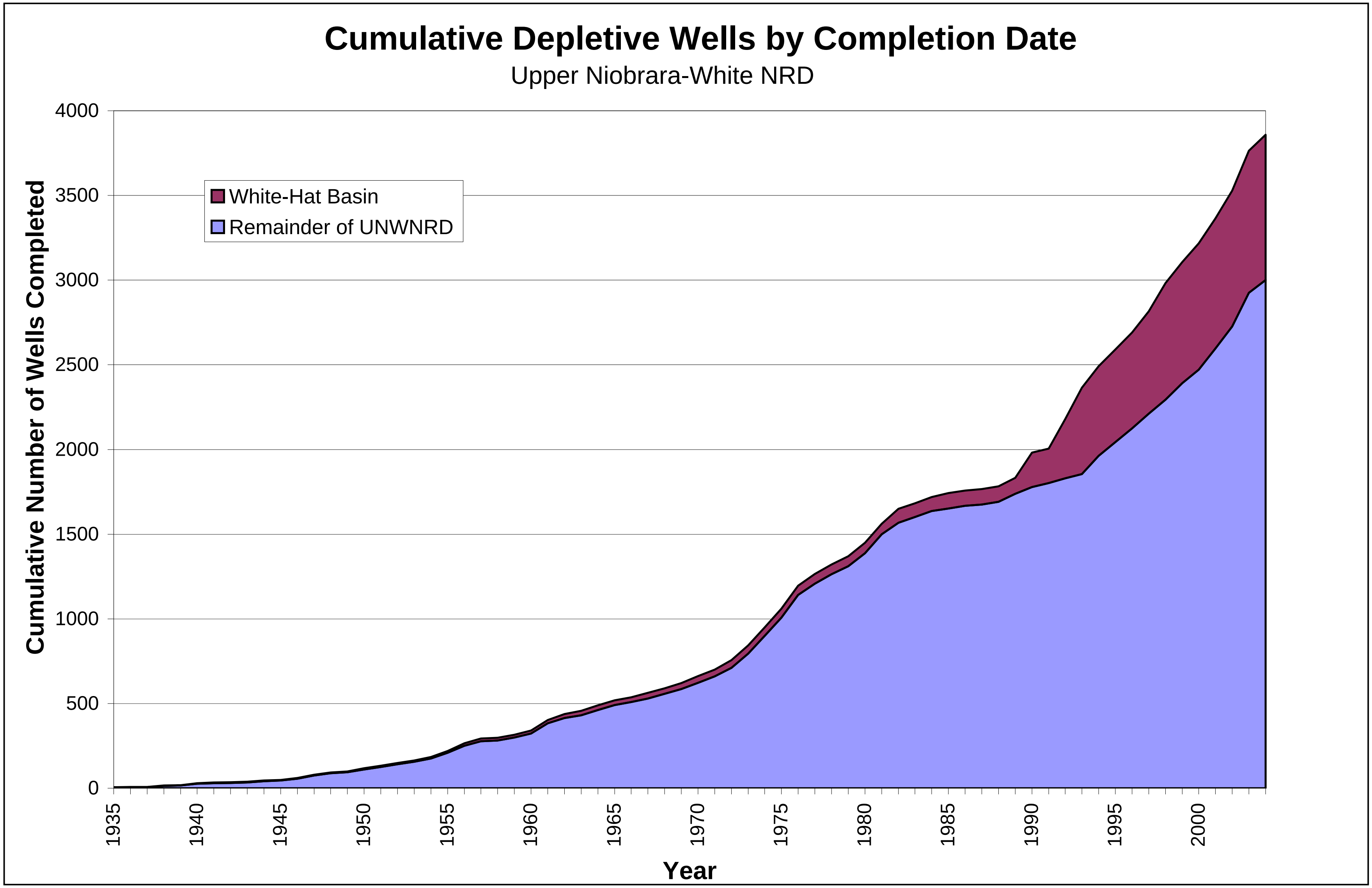
Source: Nebraska Department of Natural Resources Ground Water Database

Figure 38



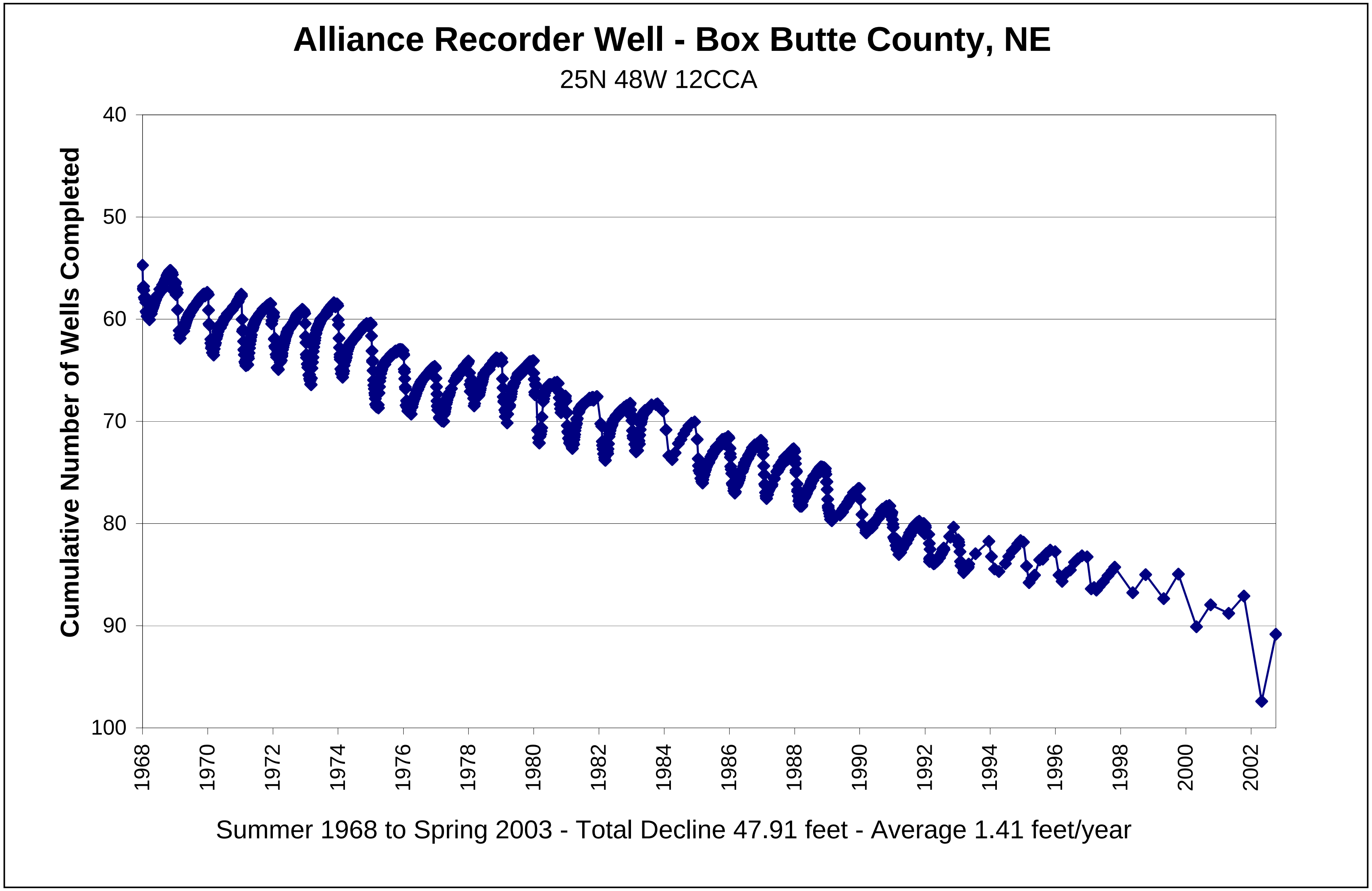
Source: Nebraska Department of Natural Resources Ground Water Database

Figure 39



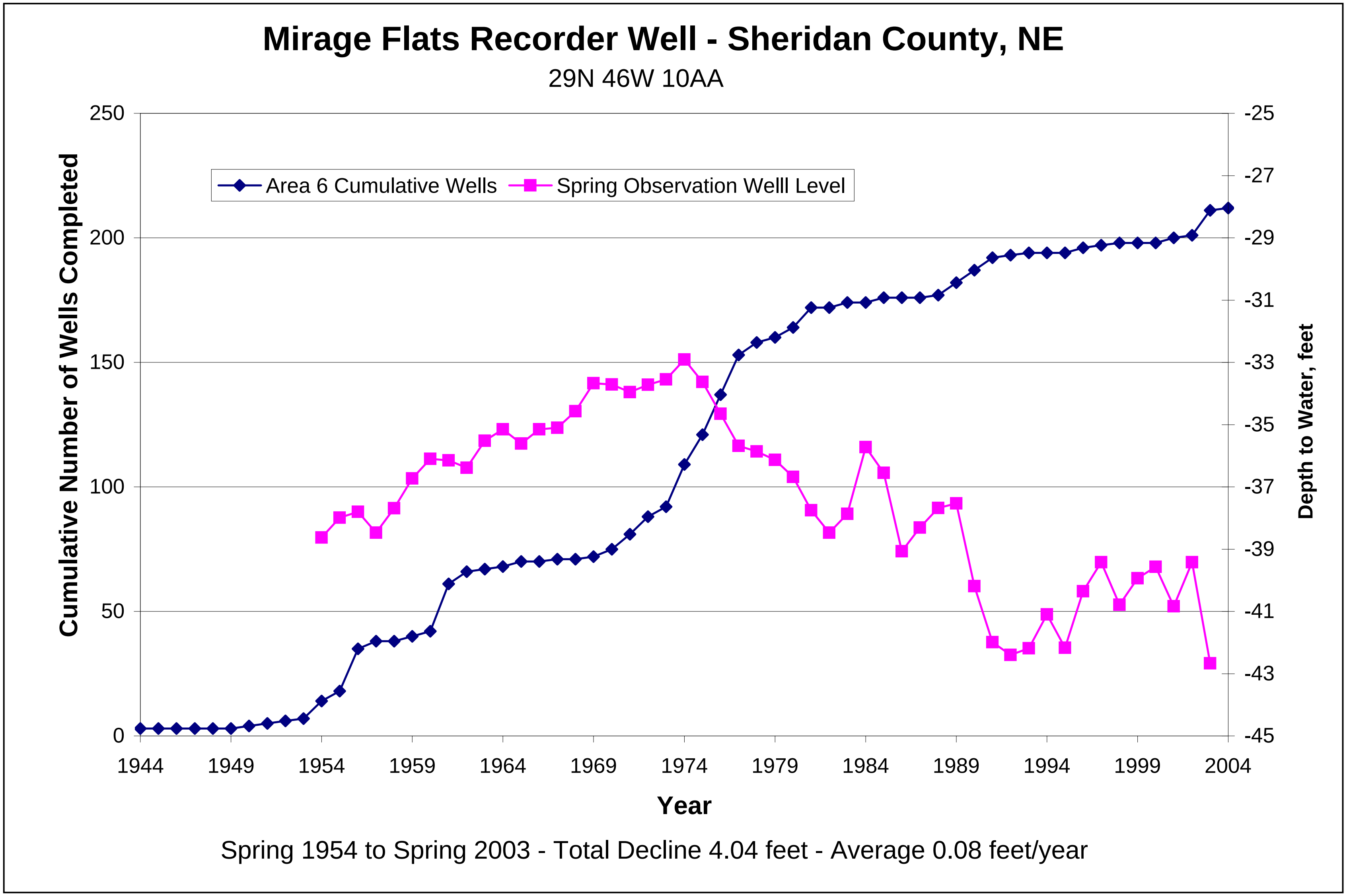
Source: Nebraska Department of Natural Resources Ground Water Database

Figure 40



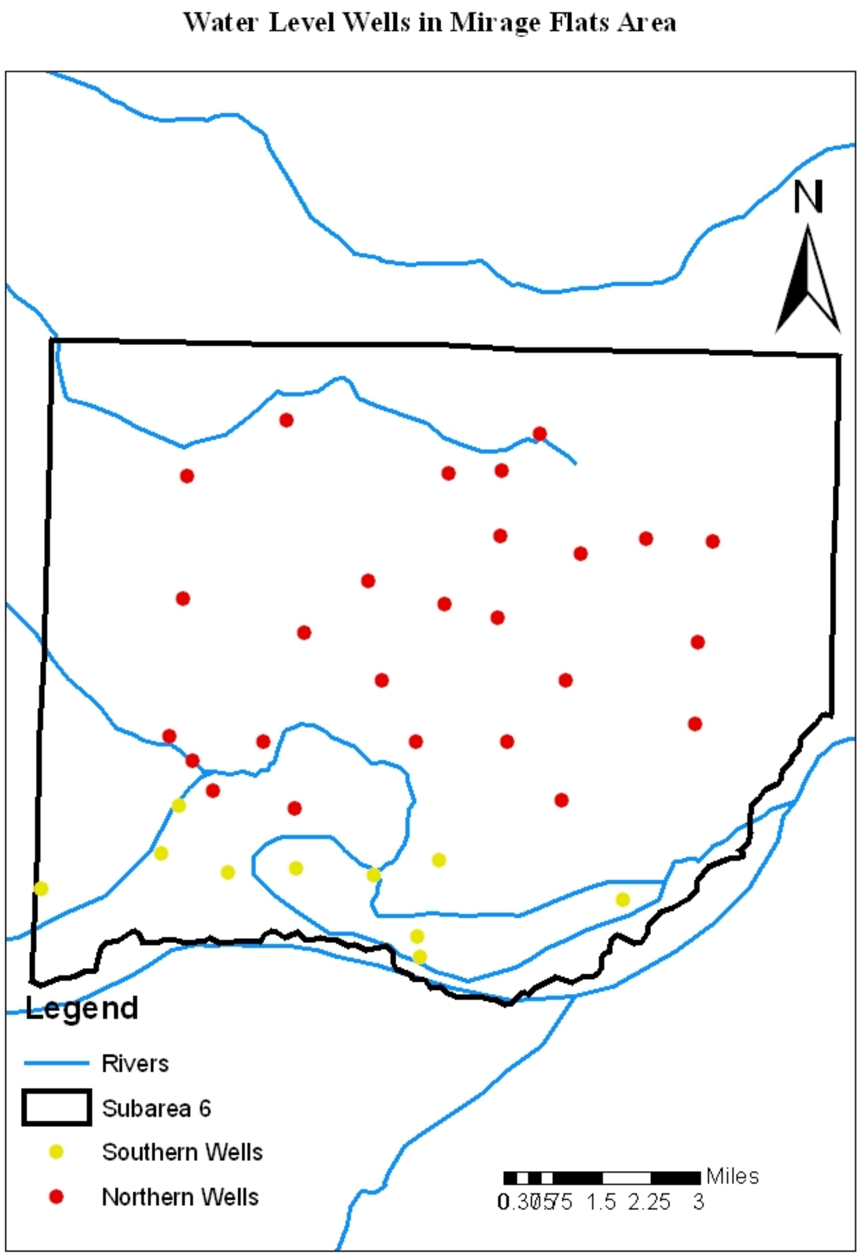
Source: Nebraska Department of Natural Resources Databank, USGS Observation Well Database

Figure 41



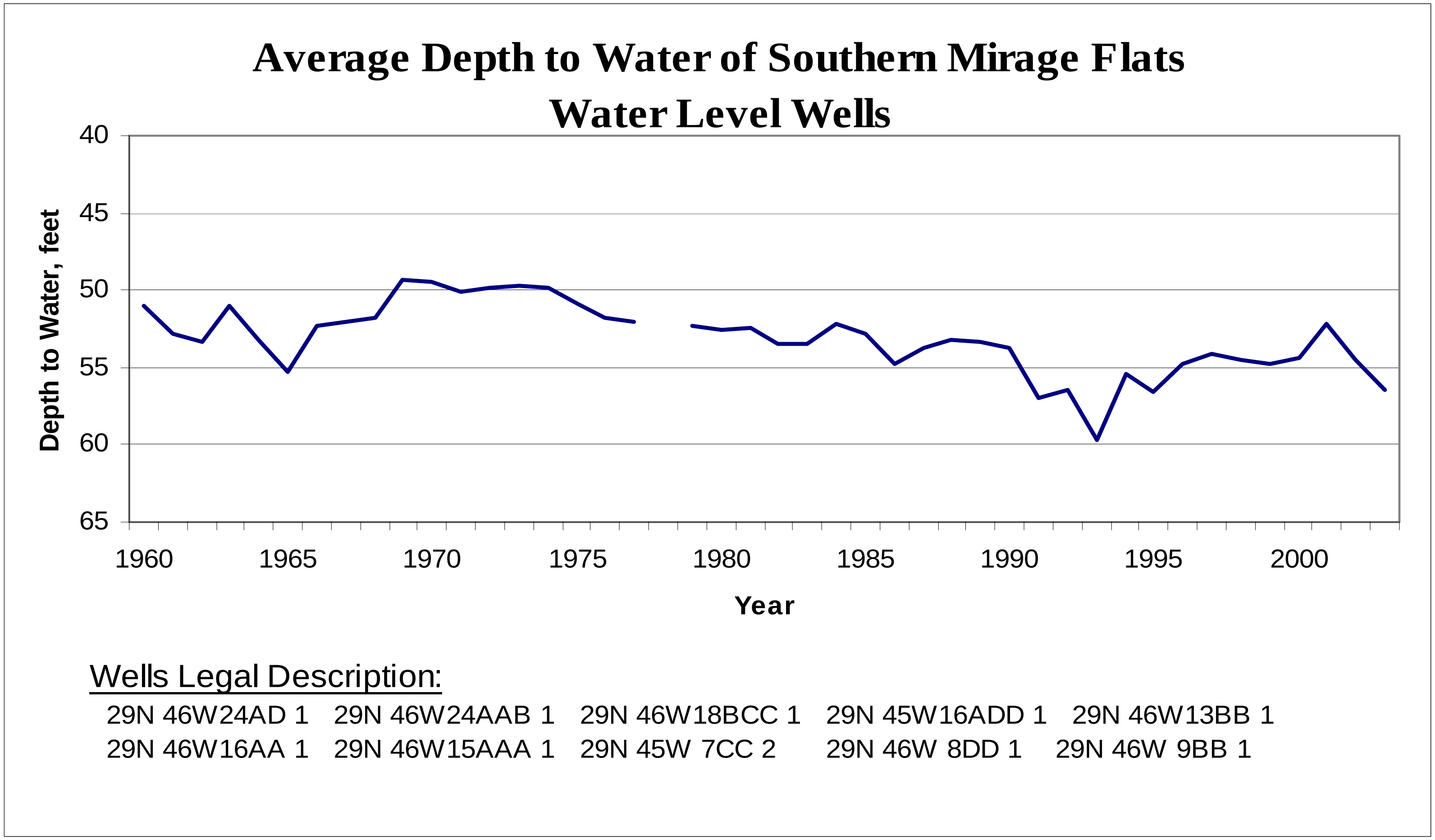
Source: Nebraska Department of Natural Resources Ground Water Database, USGS Observation Well Database

Figure 42



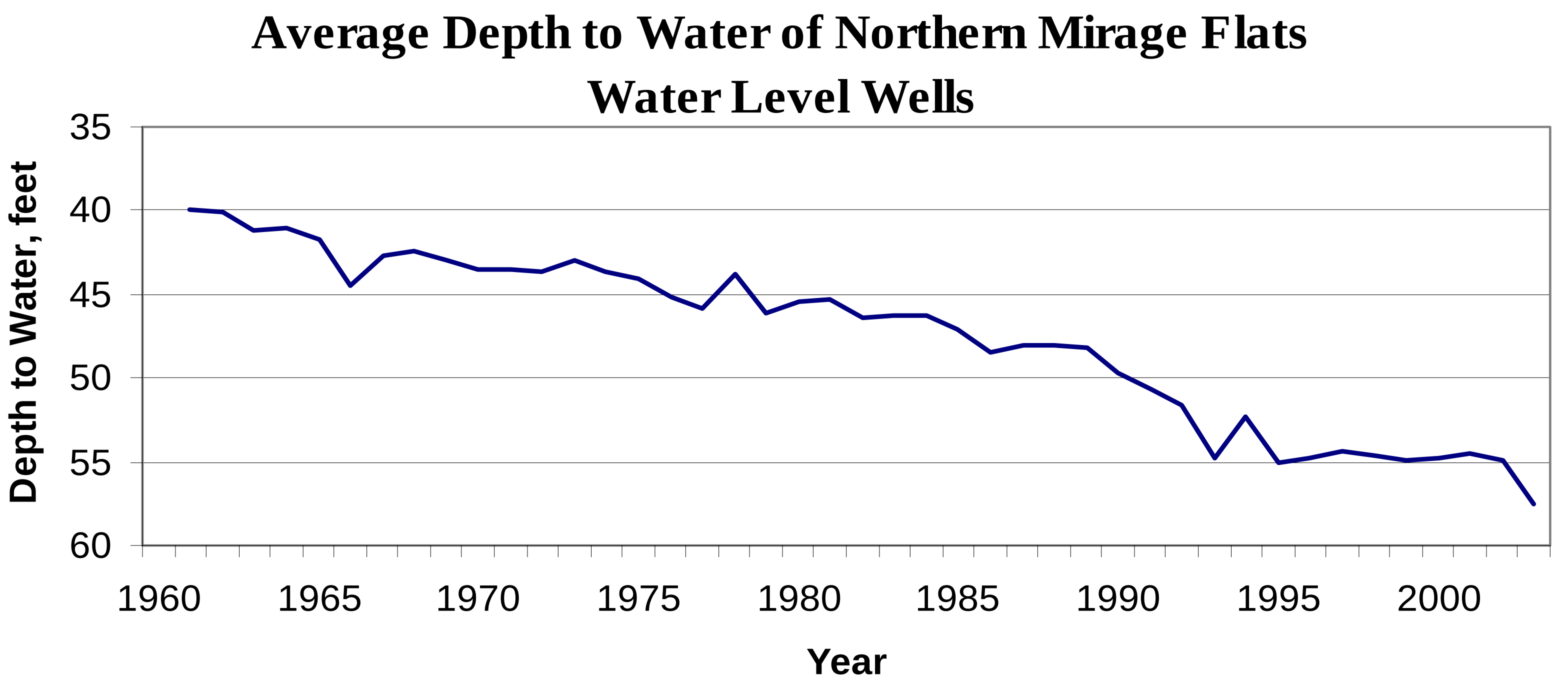
Source: U.S. Geological Survey Wells, Nebraska Department of Natural Resources

Figure 43



Source: United States Geological Survey Observation Well Database

Figure 44



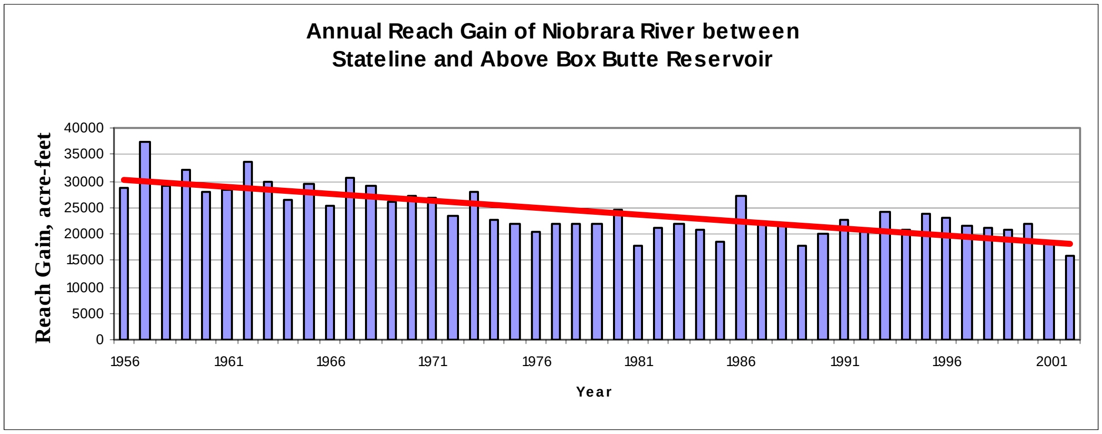
Wells Legal Description:

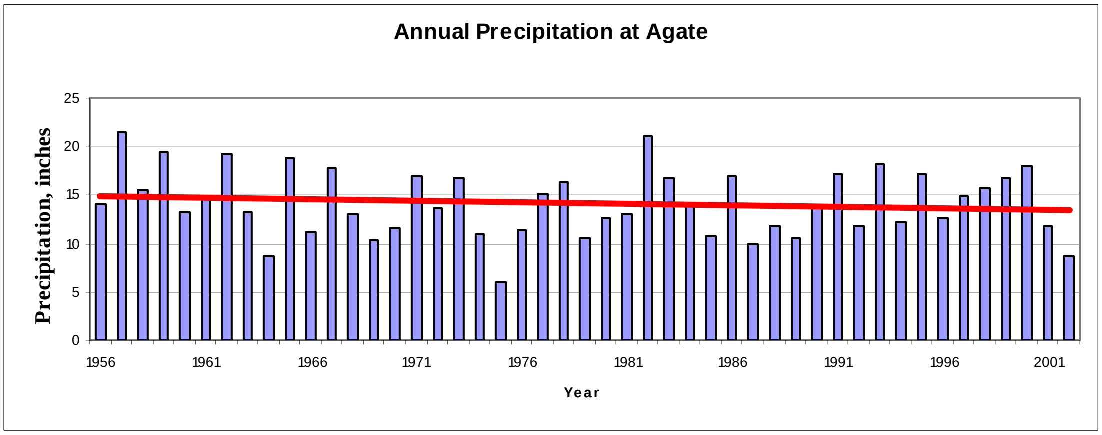
29N 46W10AA 1 29N 45W 5DDD 1 29N 46W 4DC 1 29N 46W 4BDC 1 29N 46W 3BA 1 29N 46W 1ABA 1 29N 46W 5AAA 1
29N 45W 5BBB 1 30N 45W34DAD 1 30N 46W36BB 1 30N 45W32AAA 1 30N 45W27ADD 1 30N 46W27ADD 1 30N 45W30AA 1
30N 46W21CCC 1 30N 45W19CCC 1 30N 46W23DA 1 30N 45W21BB 1 30N 45W14CC 1 30N 45W15CC 1 30N 45W18DD 1
30N 46W16BBB 1 30N 45W 7CCC 1 30N 45W 7DD 1 30N 45W 8BDA 1 30N 46W10ABC 1

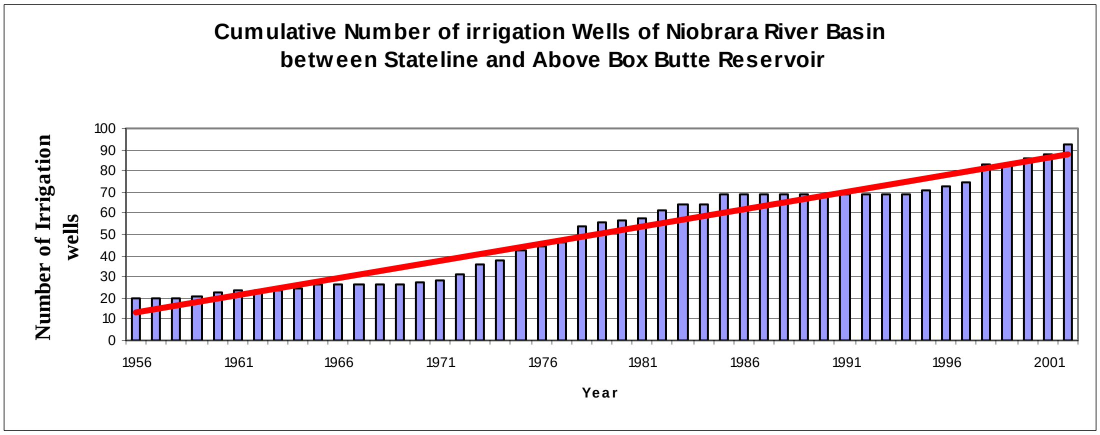
Source: United States Geological Survey Observation Well Database

Figure 45

Trend Analyses of Annual Reach Gain, Precipitation, and Number of Irrigation Wells







Sources: Nebraska Department of Natural Resources; Precipitation data from High Plain Regional Climatic Center, UNL, Lincoln, NE.

Figure 46

Irrigation Wells and Canals - Mirage Flats Area

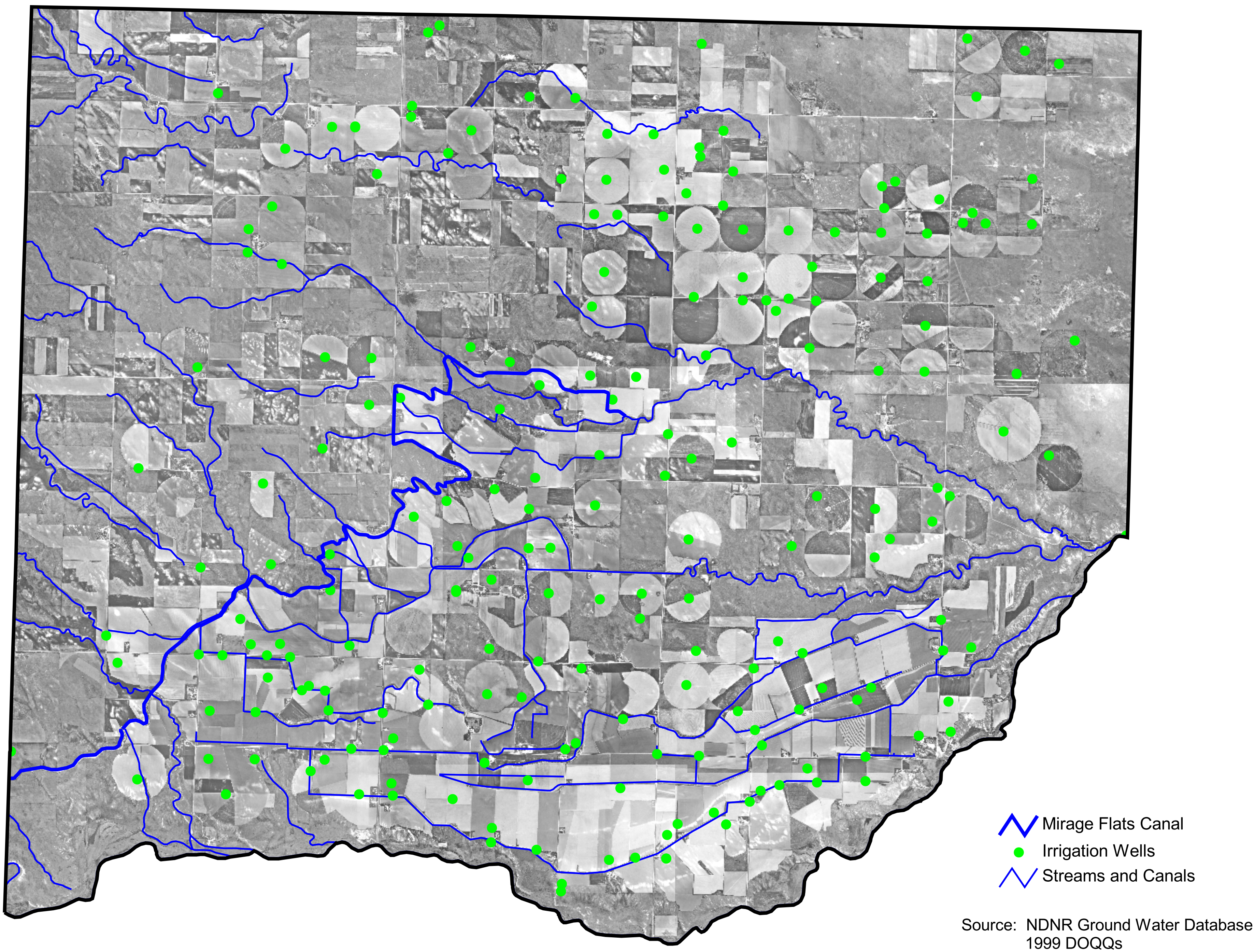
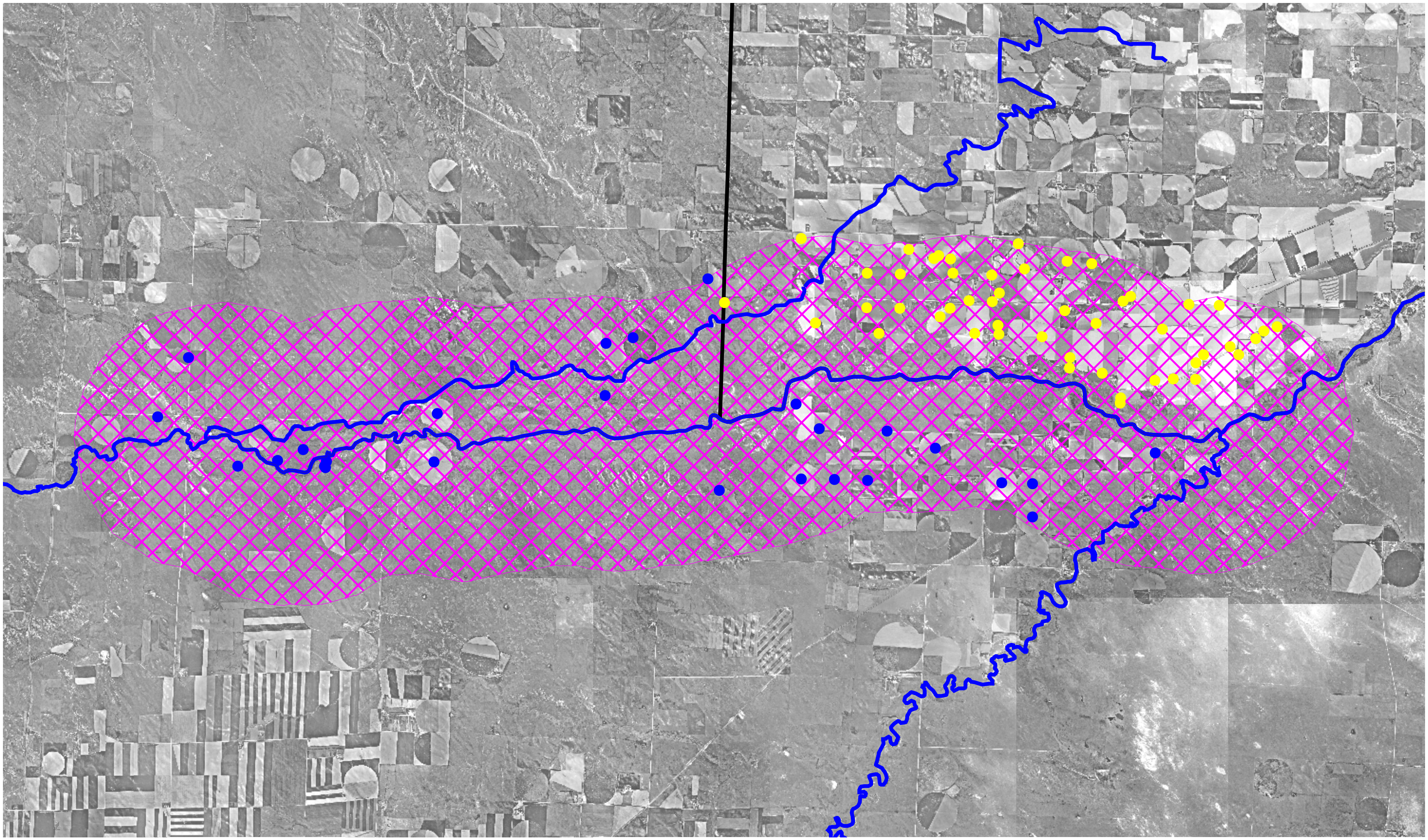


Figure 47

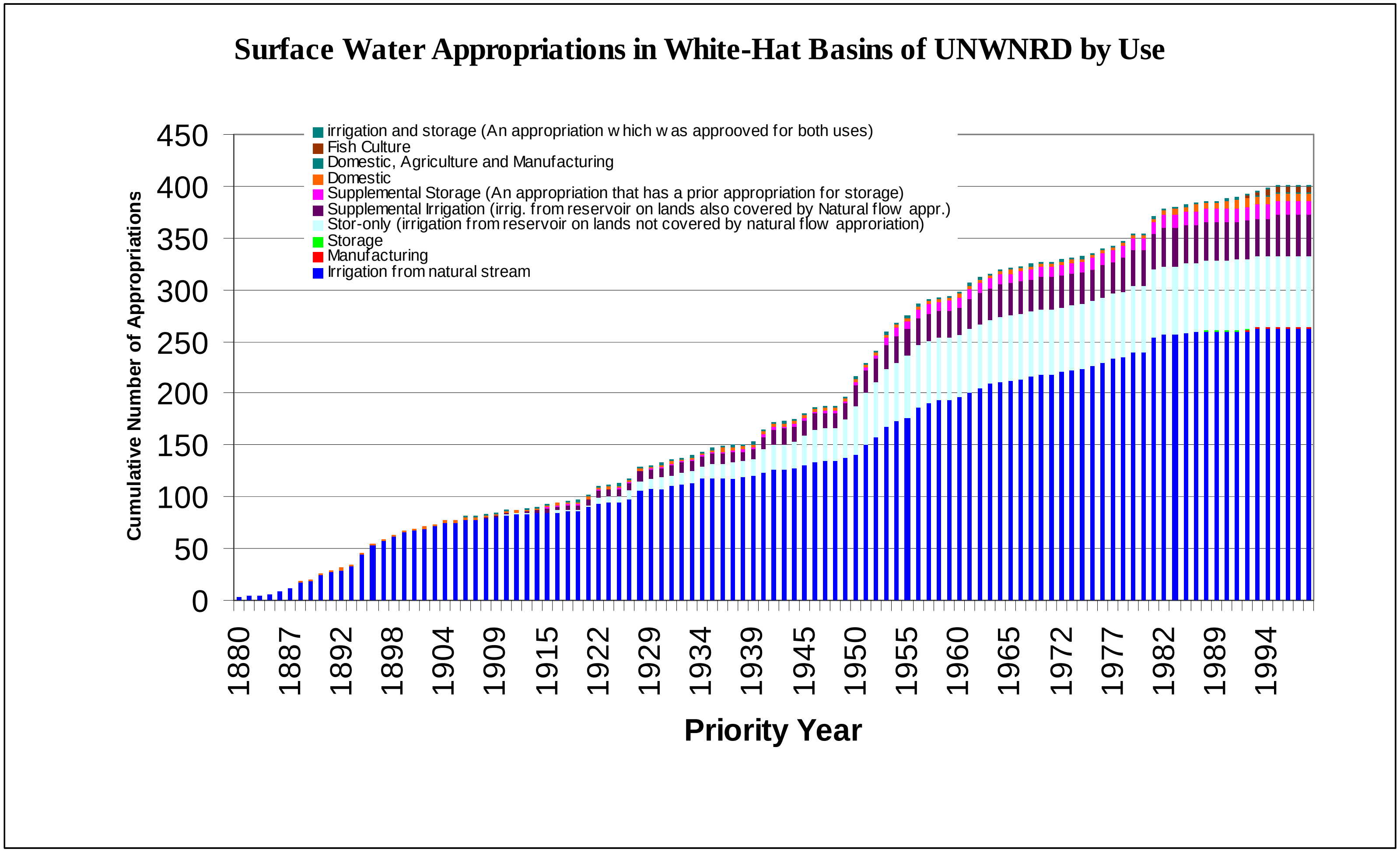
Active Irrigation Wells Within Two Miles of the Niobrara River
Mirage Flats Diversion to Box Butte Creek Confluence



Active Irrigation Well Within Area 6
Active Irrigation Well
Streams, Rivers, and Canals
Area 6 Boundary
2-Mile Buffer - Mirage Flats Diversion to Confluence of Box Butte Creek

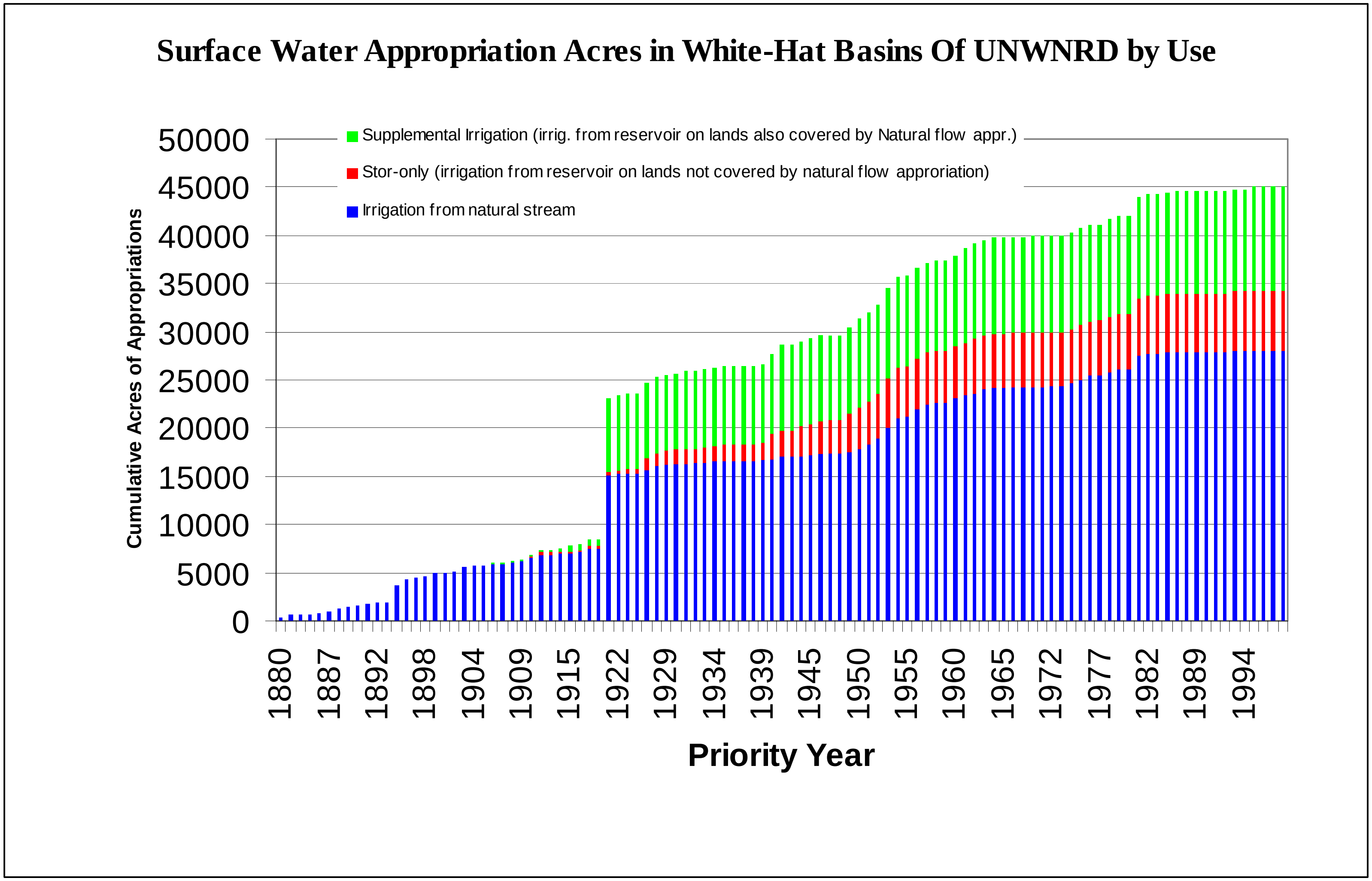
Source: NDNR Ground Water Database
1999 DOQQs

Figure 48



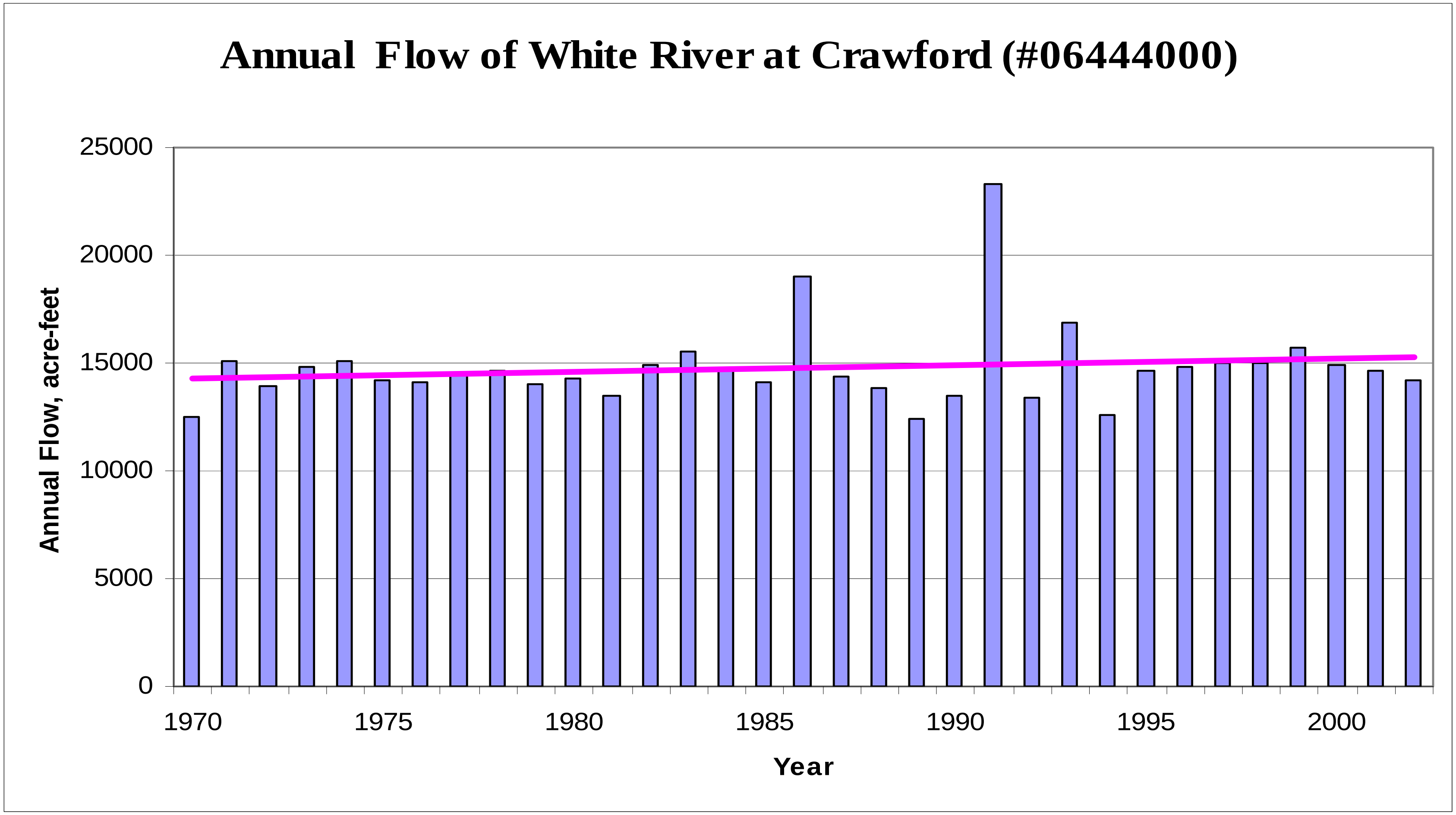
Source: Nebraska Department of Natural Resources Water Rights Database

Figure 49



Source: Nebraska Department of Natural Resources Surface Water Rights Database

Figure 50



Source: Nebraska Department of Natural Resources Stream Gaging Records