Soil Salinization Hazards Associated with Devils Lake Flood Damage Reduction Alternatives

Irrigation

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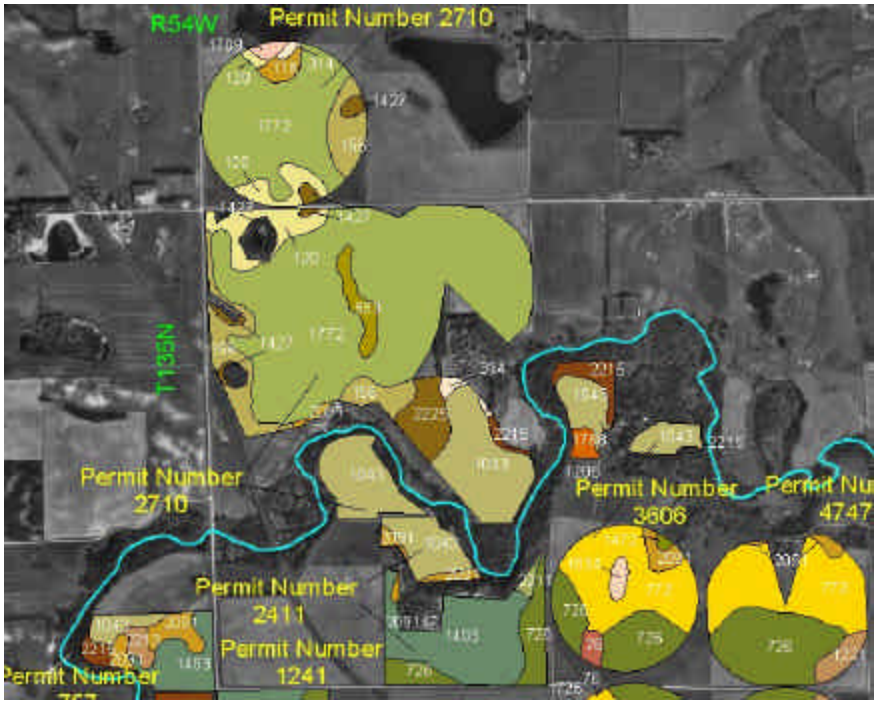

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EXECUTIVE SUMMARY

BACKGROUND

Salinity (expressed as Total Dissolved Solids, TDS) and sodicity (expressed as Sodium Adsorption Ratio, SAR) hazards are assessed on irrigated lands potentially affected by two constructed outlet alternatives proposed to reduce flood damage around Devils Lake, ND, as well as the No Action (natural spill) alternative. Both constructed outlet alternatives would release water from West Bay of Devils Lake to the Sheyenne River during a May 1 through November 30 operating window. Operations would cease if the elevation of Devils Lake drops below 1441.6 feet above sea level (fASL). Discharge of Devils Lake water would be constrained by flow and water quality parameters under the 300 cfs Constrained Outlet alternative. The 480 cfs Unconstrained Outlet alternative would release Devils Lake water through the same constructed outlet with no constraints. The No Action (natural spill) alternative assumes that the level of Devils Lake will rise until it naturally spills from Stump Lake through the Tolna Coulee to the Sheyenne River downstream of Warwick, ND.

Continued irrigation by permittees in North Dakota and Minnesota who would appropriate river water mixed with Devils Lake water is a concern because elevated levels of TDS and SAR in the blended water could adversely affect yields and the use of irrigated lands. TDS can adversely affect soil productivity by increasing the salt content the root zone, adversely affecting plant health and lowering crop yields. Irrigation with water having a high SAR can adversely affect soil structure resulting in reduced hydraulic conductivity, poor seed germination, limited root penetration, stunted plant growth, and reduced yields.

METHODS

GIS techniques were used to establish the amount and distribution of specific soils on irrigated land potentially affected by the outlet alternatives. Digitized soil polygons were then combined with soil attribute data in a relational database to characterize, reduce, and summarize the irrigibility characteristics of the soils accounting for major soil components and minor inclusions.

Each soil was placed into an appropriate Irrigibility Group and Subgroup based on listings in Compatibility of North Dakota Soils for Irrigation (Franzen et al., 1996). Soils in each digitized soil polygon were associated with recommended maximum TDS and SAR values (TDSmax and SARmax) provided for each Irrigibility Subgroup. Irrigation water having TDS and SAR values below the recommended maximums would be suitable for supplemental irrigation without adversely affecting the soils, assuming that the irrigators apply proper management measures as recommended in Franzen et al., (1996).

HEC5Q water quality data traces including TDS and SAR data for several climatic scenarios for 8 control points along the Sheyenne and Red Rivers (Warwick, Cooperstown, Valley City, Lisbon, Kindred, Halstad, Grand Forks, and Emerson) was provided by the St. Paul District USACE. The Wet7 climatic scenario was selected as a conservative representation of the effects of the various outlet alternatives on predicted daily water quality (all control points) in the Sheyenne and Red Rivers and was then modified to better apply to irrigation appropriation timing and use. The effects of the outlet alternatives on duration of water quality impacts were assessed using all data representing the full growing season (May 1 through September 30) and

included both periods when baseflow predominates and periods of outlet operation when irrigation water would consist of varying amounts of blended Devils Lake/Sheyenne River water.

Because the effects of the alternatives must be placed in the context of the entire planning period, procedures that assess impacts use the entire growing season but included analysis of 2 datasets: (1) the entire dataset (hereafter cumulatively referred to as *"Baseflow-plus-Blended-Water"*), and (2) the portion of the dataset containing only blended Devils Lake/Sheyenne River water (hereafter referred to as "*Blended-Water-Only"*).

Percent exceedance tables and graphs were developed to determine the percentage of time predicted TDS and SAR values would rise above recommended TDSmax and SARmax levels for each soil listed in the database. Acreage and percent exceedance were calculated on a individual soil map unit basis for major soil components and listed inclusions, permitting the summarization of the percent exceedance data on an acreage basis by permit, county, river, and state.

In order to present the data in the context of salinity and sodicity hazards. A salinity/sodicity hazard ranking system based on the percentage of time predicted TDS and SAR in the Wet7 water quality datasets would be above recommended maximums. The categories None/Slight, Low, Moderate, and High represent 0-5, >5-25, >25-50, and >50% exceedances of TDS and SAR recommended maximums, respectively. Category limits represent the probability that an individual irrigator would be using irrigation water on specific soils that is above the recommended limits. For example placement into the High (>50 percent) hazard category indicates that an irrigator appropriating river water for irrigation under the various outlet alternatives would be more likely than not to use water above the limits recommended in Franzen et al. (1996) for his specific soils.

This ranking is conservative because the TDS and SAR recommended maximums provided on a per soil and Irrigibility Subgroup basis in Franzen et al. (1996) assume a relatively constant quality of water, whereas blended Devils Lake/Sheyenne water will vary in TDS and SAR. TDS and SAR values predicted from the Wet7 climatic scenario are frequently below the recommended maximums. The rankings can be applied at any level from an individual soil map unit to the entire project. The discussion summarizes the data by river, state, and project.

RESULTS

IRRIGATION WATER QUALITY

Distribution statistics including mean, median, standard deviation, minimum, maximum, and range were determined for HEC5Q predicted TDS and SAR values (all control points, all outlet alternatives) under the Wet7 climatic scenario. Distribution statistics for the outlet alternatives were restricted to the *"Blended Water Only"* dataset to avoid misinterpretations due to dilution with baseflow values. Predicted TDS and SAR values were also plotted on a template similar to the salinity/sodicity irrigation water classification system of the National Soil Salinity Laboratory (NSSL), again for all control points and all outlet alternatives. The data indicated that (1) the magnitude of TDS and SAR decreased with increasing distance from the point of insertion, (2) predicted mean TDS and SAR values for the 300 cfs Constrained and the 480 cfs Unconstrained outlet alternatives were quite similar and were uniformly below 1000 mg/l TDS and SAR of 4, and (3) dilution reduced TDS and SAR values dramatically in the Red River. TDS

and SAR values predicted under the No Action (natural spill) alternative were far greater, with a high TDS mean of 1616 mg/l for the Cooperstown dataset, and a high mean SAR of 6.98, again for the Cooperstown dataset.

NSSL irrigation hazard plots indicated that while TDS and SAR values under the alternatives are elevated along the Red River, dilution of blended water with Red River water reduced TDS and SAR levels to the point where the water quality stayed within the baseline NSSL category, even under the No Action (natural spill) alternative. However, irrigation hazards along the Sheyenne River resulting from increased TDS and SAR in blended Devils Lake/Sheyenne River water were indicated to a moderate degree for the 300 and 480 cfs constructed outlet alternatives, and to a much greater degree under the No Action (natural spill) alternative. At the most elevated levels of TDS and SAR, the decline in the quality of the irrigation water compromises its use for irrigation.

IRRIGATION-INDUCED SALINITY AND SODICITY HAZARDS

In the discussion that follows, the tabulated acreages in the hazard classes do not include acres in the Non-Irrigible or No Group categories (338.6 out of 13241 total acres), and data provided under the No Action (natural spill) alternative does not include the 75 acres for North Dakota permit Number 2206 that is upstream of the Tolna Coulee and would be unaffected by the natural spill.

Irrigation-Induced Salinity & Sodicity Hazards under Baseline Conditions

Under baseline conditions, irrigation-induced salinity and sodicity hazards are negligible. Of the 12903 acres of irrigated land along the Sheyenne and Red Rivers, 12815 acres (99.3 percent) fall in the None/Slight salinity hazard class. None of the irrigated land on either river exceeds the None/Slight hazard class for sodicity.

Irrigation-Induced Salinity & Sodicity Hazards for Entire Project under 300 cfs Constrained and 480 cfs Unconstrained Outlet Alternatives

Irrigation-induced salinity hazards for both the 300 cfs Constrained and the 480 cfs Unconstrained Outlet alternative were found to be low for the entire project (i.e. Sheyenne and Red River irrigation combined). Under each constructed outlet alternative (using either the complete *Baseflow-plus-Blended-Water* or the *Blended-Water-Only* dataset) over 95 percent of the 12903 irrigated acres fell in the None/Slight category for salinity hazards. Irrigation-induced salinity hazards were slightly lower under the 300 cfs Constrained Outlet versus the 480 cfs Unconstrained Outlet. For both constructed outlet alternatives on an entire project basis, all of the irrigated soil acreage fell in the None/Slight sodicity hazard, regardless of whether the *Baseflow-plus-Blended-Water* or *Blended-Water-Only* dataset was used.

These results seem to indicate that, on an entire project basis, TDS and SAR values in irrigation water under both constructed outlet alternatives are higher than baseline conditions but low enough in most areas to permit ongoing irrigation under appropriate management of salinity or sodicity. As discussed in the Mitigation Measures section, irrigators in areas with salinity hazard

classes above None/Slight may need to emphasize more intensive management measures as recommended in the North Dakota Irrigation Handbook (e.g. salinity monitoring, leaching). Using the more conservative *Blended-Water-Only* dataset, the total acreage potentially requiring intensive salinity management and possible mitigation would be approximately 515 and 569 acres for the 300 cfs Constrained and 480 cfs Unconstrained Outlet alternatives, respectively. It should be noted that intensive irrigation management is indicated for all conditional soils in Franzen et al. (1996).

Irrigation-Induced Salinity & Sodicity Hazards for Entire Project under No Action (Natural Spill) Alternative

On an entire project basis, the No Action (natural spill) alternative represents a substantially higher salinity and sodicity hazard than the baseline condition or either constructed outlet alternative. Using the more conservative *Blended-Water-Only* dataset, 2750 of the 12903 irrigated acres along the Sheyenne River and Red Rivers combined (21.3 percent) would fall in the Low, Moderate or High salinity hazard classes. Similarly, using the *Blended-Water-Only* dataset, 2416 of the 12903 irrigated acres along the Sheyenne River and Red Rivers combined (18.7 percent) would fall in the Low, Moderate or High sodicity hazard classes. In comparison to the 300 cfs Constrained and the 480 Unconstrained Outlet alternatives, salinity hazards for the entire project under the No Action (natural spill) alternative would affect approximately 4.83 and 5.34 times as much irrigated acreage, respectively (i.e. 2750 versus 515 and 569 acres, respectively). On an entire project basis, the No Action (natural spill) alternative would generate new sodicity hazards on 2416 acres that would have a sodicity hazard class of None/Slight under the constructed outlet alternatives.

Irrigation-Induced Salinity & Sodicity Hazards on the Red River

Of 12,902 irrigated acres evaluated for the entire project (exclusive of the Non-Irrigible or No Group acreage), 9207 acres, or 71 percent lie along the Red River. When Sheyenne River water enters the Red River, salinity and sodicity levels are so reduced by dilution that the outlet alternatives generate few exceedances of TDS and SAR maximums for soils downstream. Accordingly, the potential for irrigation-induced salinity or sodicity hazards on irrigated acreage along the Red River was found to be very low.

With the *Baseflow-plus-Blended-Water* dataset, all irrigated soils examined along the Red River fell in the None/Slight risk category for salinity and sodicity under all outlet alternatives, including the No Action (natural spill) alternative. With the more conservative *Blended-Water-Only* dataset, 53.6 acres irrigated under the 480 cfs Unconstrained Outlet alternative went from the None/Slight to the Low salinity hazard class, and 206.4 acres irrigated under the No Action (natural spill) alternative went from the None/Slight to the Low salinity hazard class. For the Red River, sodicity hazards were in the None/Slight hazard class for all irrigated acreage along the Red River under all alternatives, regardless of whether the *Baseflow-plus-Blended-Water* or *Blended-Water-Only* dataset was used.

Irrigation-Induced Salinity & Sodicity Hazards on the Sheyenne River

Of 12902 irrigated acres evaluated for the entire project (exclusive of the Non-Irrigible or No Group acreage), 3695 acres (29 percent) lie along the Sheyenne River. Both salinity and sodicity hazards were found to be substantially greater on the Sheyenne than the Red River. Using the more conservative *Blended-Water-Only* dataset, both constructed outlet alternatives would increase salinity hazards over baseline conditions on approximately 428 acres along the Sheyenne River. The 480 cfs Unconstrained Outlet alternative had a somewhat higher salinity hazard than the 300 cfs Constrained Outlet alternative. On the Sheyenne River, the No Action (natural spill) alternative generated much more significant salinity and sodicity hazards than baseline conditions or either constructed outlet alternative.

Irrigation-Induced Salinity & Sodicity Hazards on the Sheyenne River under 300 cfs Constrained and 480 cfs Unconstrained Outlet Alternatives

Using the complete *Baseflow-plus-Blended-Water* dataset for the Sheyenne River only, the 300 cfs Constrained Outlet alternative would result in 3180, 11, 495, and 9 acres falling in the None/Slight, Low, Moderate, and High salinity hazard classes, respectively. The 480 cfs Unconstrained Outlet alternative with the *Baseflow-plus-Blended-Water* dataset would generate slightly higher salinity hazards, with 3181, 10, 495 and 10 acres falling in the None/Slight, Low, Moderate, and High salinity hazard classes, respectively. Thus, all of the Moderate salinity hazard acreage under the 300 cfs Constrained Outlet alternative (495 acres) would move into the High salinity hazard class under the 480 cfs Unconstrained Outlet alternative. The *Blended-Water-Only* dataset generates virtually identical salinity hazard results for the Sheyenne River under both constructed outlet alternatives.

Neither constructed outlet alternative represents a sodicity hazard for irrigated lands along the Sheyenne River. As under baseline conditions, all 3695 irrigated acres along the Sheyenne River fall in the None/Slight sodicity hazard class under either constructed outlet alternative.

Soil salinization hazards appear to be a direct concern for irrigators appropriating water from the Sheyenne River under the constructed outlet alternatives. Under either of these alternatives, approximately 515 acres of irrigated land would have salinity hazard classifications ranging from Low to High. This represents an increase of 428 acres from the 87 acres in these hazard classes under baseline conditions. The magnitude of the salinity hazard under these alternatives appears to be low enough to be managed and mitigable. Sodicity hazards are similar to those for baseline conditions and should not be a substantial concern under either of the constructed outlet alternatives.

Irrigation-Induced Salinity & Sodicity Hazards on the Sheyenne River under No Action (Natural Spill) Alternative

Using the complete *Baseflow-plus-Blended-Water* dataset for the Sheyenne River only, the No Action (natural spill) alternative would result in 1098, 2375, 147 and 0 acres falling into the None/Slight, Low, Moderate and High salinity hazard classes, respectively. This represents a substantially higher salinity hazard than the baseline condition or either constructed outlet alternative. Use of the *Blended-Water-Only* dataset yielded even higher salinity hazards, with 1077, 1159, 830 and 554 acres falling in the None/Slight, Low, Moderate and High salinity hazard classes, respectively.

The No Action (natural spill) alternative also appears to represent a much higher sodicity hazard than either of the constructed outlet alternatives. Using the complete *Baseflow-plus-Blended-Water* dataset for the Sheyenne River only, the No Action (natural spill) alternative would result in 1241, 2378, 0 and 0 acres falling into the None/Slight, Low, Moderate and High sodicity hazard classes, respectively. Use of the *Blended-Water-Only* dataset yielded even higher sodicity hazards, with 1185, 126, 1860 and 449 acres falling in the None/Slight, Low, Moderate and High sodicity hazard classes, respectively.

The No Action (natural spill) alternative appears to represent a significant salinity and sodicity hazard for irrigated lands along the Sheyenne River. Using the more conservative *Blended-Water-Only* dataset, 2543 of the 3695 irrigated acres along the Sheyenne River (68.8 percent) would fall in the Low, Moderate or High salinity hazard classes. Similarly, using the *Blended-Water-Only* dataset, 2435 of the 3695 irrigated acres along the Sheyenne River (65.9 percent) would fall in the Low, Moderate or High sodicity hazard classes. Accordingly, under this alternative, intensive salinity and sodicity management and possible mitigation would be needed on the majority of the irrigated land along the Sheyenne River. A portion of that acreage may be rendered non-irrigable. However, the significant salinity/sodicity hazards observed under the No Action (natural spill) alternative, Wet7 climatic scenario occur for approximately 23% of the 45-year outlet operations planning period, but are essentially continuous for the duration of that period.

MITIGATION

Effective mitigation of salinity/sodicity hazards under the outlet alternatives involves a program of (1) initial detailed assessment of soil irrigibility to establish baseline conditions, (2) monitoring TDS and SAR in blended water and irrigated soils to minimize the use of poor quality irrigation water and to determine impacts before they become serious problems, and (3) mitigating impacts as they occur. The following mitigation strategies could apply and are discussed in more detail in the text.

- *Monitor TDS and SAR contents in Sheyenne River water*.
- *Assess soil irrigibility characteristics of potentially affected irrigated land to establish baseline salinity/sodicity.*
- *Test soils for sodium and salinity and regularly monitor crops/plants for salinization/sodification impacts.*
- *Fall-apply excess irrigation water to leach salts out of the root zone in soils found to be affected by salinity.*
- *Ensure that adequate drainage exists for leaching to occur.*
- *Practice irrigation scheduling.*
- *Plant salt-tolerant crops.*
- *Apply calcium amendment on lands found to have irrigation-induced sodicity problems.*
- *Cease irrigation.*

Professional Soil Scientists licensed to practice in the States of North Dakota and Minnesota should perform initial soil assessments. Irrigators using mixed Sheyenne River/Devils Lake waters for irrigation under any of the outlet alternatives are strongly advised to consult with

NDSU Extension Service representatives while irrigating under the outlet alternatives and prior to mitigating for perceived salinity/sodicity problems.

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1. INTRODUCTION

The US Army Corps of Engineers, St. Paul District (USACE) has contracted with Peterson Environmental Consulting, Inc. (PEC) to assess soil salinization hazards associated with alternatives to reduce flood damage in the Devils Lake Basin. One set of alternatives would reduce flooding by discharging Devils Lake water through a constructed outlet to the Sheyenne River. The following report examines salinization hazards associated with appropriation of blended Devils Lake/Sheyenne River/Red River surface water that would result from such alternatives for major crop, turf, lawn and garden irrigation in North Dakota and Minnesota.

1.1. BACKGROUND

1.1.1. Setting

Devils Lake is a large (greater than one hundred thousand acres) closed basin that has been filling since the early 1990s in response to pluvial conditions in the upper Midwest. The lake has risen approximately 24 feet between 1993 and 1999. Problems with infrastructure (e.g. roads) and the flooding of residences, farm fields and pastures have become worse as the lake rises. The lake would discharge through a natural outlet from Stump Lake to the Sheyenne River if lake water reaches 1459 feet above sea level (fASL). Salinity is variable depending upon lake stage and position within the lake chain. Salinity is highest in Stump Lake, which is the lowest in elevation of the Devils Lake chain of basins. Lake water and bottom sediment salinity is generally lowest in West Bay, and is intermediate in the intervening bays. Solution chemistry is dominated by sodium sulfate.

The geologic and hydrologic setting of Devils Lake, a summary of flooding issues, and prior reports are summarized along with selected hydrologic and chemical data in an in-house summary recently released by the USACE (the Devils Lake Emergency Outlet Project; National Environmental Policy Act (NEPA) Process, USACE In-House Summary, No Date).

Options to mitigate the ongoing Devils lake flooding have been legislatively mandated at the national level, with environmental impacts of proposed options to be assessed through the preparation of an Environmental Impact Statement.

1.1.2. Salinization/Sodium Hazards Associated with Devils Lake Flood damage reduction alternatives

Currently there are two options being considered to reduce the impacts of Devils Lake flooding: (1) enhancing storage in the upper basin watershed (Upper Basin Storage Alternative), and (2) removing water from the lake through a created outlet (Outlet Alternatives). The alternatives have the potential to result in secondary soil salinization and possibly aggravated sodic conditions (defined as the anthropogenic creation of saline/sodic situations or the anthropogenic aggravation of existing saline/sodic conditions, respectively). Salinity, sodicity, and associated terms are defined in more detail in Section 1.2, below.

The impacts of these alternatives will be evaluated in the context of a third alternative (the No Action (natural spill) alternative). For the purposes of the salinity study, the No Action (natural spill) alternative assumes that continued wet conditions will result in progressive increases in the stage of Devils Lake to the natural overflow point through the Tolna Channel from Stump Lake to the Sheyenne River. All alternatives will be compared to existing baseline conditions. The Report that follows examines the effect of the outlet alternatives on soil salinization associated with permitted irrigation that uses water from the Sheyenne and Red Rivers.

1.1.2.1. Constructed Outlet Alternatives

The constructed outlet alternatives would, under two potential operating scenarios, release 300 and 480 cfs of Devils Lake water (extracted from West Bay) through a constructed outlet to the Sheyenne River. Discharge to the Sheyenne River would essentially raise the average level of the Sheyenne River during outlet operation and increase the salinity and sodicity of the blended water. Outlet operation parameters have a strong effect on the volumes of Devils Lake water delivered to the Sheyenne River from the West Bay of Devils Lake and the resulting levels of TDS and SAR in the mixed water.

1.1.2.1.1. Alternative 1: 300 cfs Constrained Outlet

Releases of Devils Lake water to the Sheyenne River under the 300 cfs Constrained Outlet alternative will be constrained by five factors:

1. The outlet would be operated whenever the level of Devils Lake exceeded 1441.6 fASL.

2. Outlet operation could occur during a 7-month May-November window.

3. Maximum pumping capacity will be 300 cfs.

4. Combined flow of Sheyenne River and outlet water will not exceed 600 cfs at the point of insertion on the Sheyenne River.

5. The release rate will not cause the blend of river and outlet water to exceed 450 mg/L sulfate.

Pumping under the Constrained Outlet alternative will cease whenever the combined flow and sulfate limits in (4) and (5), respectively, are exceeded or the outlet operation is successful in lowering the level of Devils Lake below 1441.6 fASL. Previous work has indicated that the Constrained Outlet alternative will not result in overbank flooding during pump operation and normal stages of the river. However, during natural flooding periods blended water could overtop the banks.

1.1.2.1.2. Alternative 2: 480 cfs Unconstrained Outlet

The 480 cfs scenario (Unconstrained Outlet Alternative) represents an unconstrained flow limited only to the 7-month May through November operation window. The outlet would be operated whenever the level of Devils Lake exceeded 1441.6 fASL. Computer modeling performed by the St. Paul District USACE has indicated that the Unconstrained Outlet can be

effective at lowering the level of Devils Lake below the 1441.6 elevation; thus outlet operation could be more intermittent when compared to the 300 cfs Constrained Outlet alternative.

1.1.2.2. Alternative 3: Natural Spill from Stump Lake to the Sheyenne River through the Tolna Channel, the No Action (natural spill) alternative

Alternative 3 assumes that continued wet conditions result in increases in the level of Devils Lake to the point where the lake naturally drains through Stump Lake and the Tolna Channel to the Sheyenne River. The No Action (natural spill) alternative has essentially the same salinity hazards of soil salinization as those associated with the 300 cfs Constrained and 480 cfs Unconstrained Outlet alternatives. However, the magnitude of the associated salinization hazards is greater because of the high levels of salinity associated with Stump Lake water discharged through the Tolna Channel. Again, computer simulations have indicated that a natural spill would not result in continuous discharge of Devils Lake water to the Sheyenne River. Outflow would be intermittent depending upon the climatic conditions used in the modeling run. Irrigation hazards would essentially be confined only to periods of Stump Lake overflow.

In the present report, the No Action (natural spill) alternative will be assessed using the same procedures associated with the constructed outlet alternatives.

1.1.2.3. Irrigation Salinization and Sodium Hazards Associated with the Alternatives

Continued irrigation by permittees in North Dakota and Minnesota appropriating river water mixed with Devils Lake water to irrigate nearby fields is a particular concern because this water has been shown to be more saline and have a higher sodium adsorption ratio (SAR, defined in Section 1.2, below) than normal river-water. Assessment of the hazards associated with irrigation would involve soil/water compatibility issues requiring knowledge of the soil characteristics of irrigated lands combined with the total dissolved solids (TDS) content (defined in section 1.2, below) and SAR characteristics of the water. Assessing irrigation-related soil salinization hazards is complicated by the fact that irrigation is not consistently used unless abnormally dry conditions prevail; thus the timing of irrigation and volumes applied vary from year to year and cannot be predicted.

However, salinity related soil and water compatibility issues have been addressed and to a large degree quantified in North Dakota. Important chemical parameters have been identified in irrigation water that can be related to specific soil characteristics to determine the compatibility of irrigated soils with irrigation water having specific ranges in salinity and sodicity. It is possible to identify salinization and sodification hazards associated with irrigation water of differing quality dependent upon the characteristics of the irrigated soils.

1.2. APPLICABLE SOIL SALINITY AND SODICITY ISSUES AND CONCEPTS

1.2.1. Soil Salinity

Soluble salts in general are the products of rock and soil weathering processes (Bresler et al., 1982). In the Northern Plains the interaction of near surface pore water and constituents in surficial sediments results in unique groundwater chemistries dominated by sulfates of calcium,

magnesium and sodium (Groenewald et al., 1983; Hendry et al., 1986). Soil salinity in the Devils Lake area is associated with sodium and magnesium sulfates released through the weathering of shale and dolomite rock constituents of the local glacial sediments. Evapotranspiration can concentrate the constituents to high levels in soils, especially under conditions of inadequate drainage and the presence of naturally high watertables.

Soluble salts are defined as salts more soluble than gypsum, which has a solubility of approximately 2 grams per liter. There are eight ions commonly associated with soluble salts. Cations consist of calcium (Ca), magnesium (Mg), sodium (Na), and potassium (K), whereas anions consist of alkalinity (carbonate, CO_3; bicarbonate, HCO_3, and carbonic acid; H_2CO_3), sulfate (SO_4) and chloride (Cl). *Soil salinity* is essentially the sum total of soluble salts in the soil, generally limited to the root zone, and is operationally defined by the electrical conductivity of a soil saturation-paste extract (ECspe), expressed in deci-Siemens per meter (dS/m). Other units for describing salinity in soils and water are described in Section 1.3.2.1 below. Elevated salt content in the rooting zone of a soil reduces crop yields by competing with plants for water (Bresler et al., 1982).

A *salinity hazard* is generally associated with landscape positions characterized by groundwater discharge and shallow water tables (Seelig and Richardson, 1991; Franzen et al., 1994). Soil salinity can be described by the interaction between soil-specific "critical depth" and "critical salinity" parameters. *Critical depth* is generally defined as the maximum amount that watertables with a given salinity can rise without resulting in salinization of the soil surface. *Critical salinity* is defined as the minimum amount of salt content that near-surface groundwater can have without resulting in salinization of the soil surface, regardless of the watertable depth (Maianu, 1981). Specific critical depth and critical salinity values have not been developed for North Dakota Soils; however, the concepts explain soil salinization in the presence of shallow watertables (Seelig et al., 1987).

A *salinity risk* is the probability that a salinity hazard will become a problem (Bui et al., 1996). Areas at risk of salinization after alteration of watertable dynamics are those areas where stored salt is likely to be remobilized and redeposited by rising groundwater tables. Assessing the risk of salinization requires an estimate of preexisting hydrology/salinity and the effects of the altered hydrology induced by elevated watertables.

Irrigation can aggravate a salinity risk by raising watertables above a critical depth, resulting in evaporative concentration of dissolved salts in the root zone. Irrigation can also aggravate salinity by adding dissolved salt in the irrigation water. The risk is greatest under conditions of inadequate drainage and limited soil leaching due to the presence of fine textures and slow permeability.

1.2.2. Soil Sodicity

Soil sodicity is defined by the concentration of monovalent sodium relative to the concentrations of divalent calcium and magnesium on both the soil cation-exchange complex (yielding an exchangeable sodium percentage, or ESP) and in the soil solution (yielding a SAR). SAR is defined in more detail in Section 1.3.2.2 below.

Elevated concentrations of sodium disrupt soil structure resulting in a “gumbo” type soil. Sodium-affected soils are hard and massive when dry. When wet, sodium-affected soils are structureless and dispersed, with reduced hydraulic conductivity, poor seed germination, and limited root penetration and distribution through the soil. Nutrient uptake can be affected as well as water availability to the plant due to limited root distribution (U.S. Salinity Laboratory Staff, 1954; Bresler et al., 1982).

Salinity and sodicity frequently coexist, resulting in sodic-saline soils; however, the deleterious effects of sodium are mitigated somewhat at high levels of salinity. Many areas of sodic and saline-sodic soils may be associated with groundwater discharge through underlying Pierre shale or through tills with high shale contents. The deleterious effects of both sodicity and salinity are also associated with texture, with fine textured soils being more severely affected than coarse textured soils (U.S. Salinity Laboratory Staff, 1954; Seelig and Richardson, 1991).

Salinity and sodicity are naturally occurring conditions in the Devils Lake watershed and along the Sheyenne River. Irrigation soil-water compatibility issues involving salinity and sodicity are well-known, regional considerations for agriculture generally and irrigated agriculture specifically. A considerable body of applicable research exists that assesses salinization/sodium hazards in area soils, techniques to mitigate the effects, and the tolerance of commonly grown crops (U.S. Salinity Laboratory Staff, 1954; Bresler et al., 1982; Franzen et al., 1996; Scherer et al., 1996).

1.2.3. Soil Salinization Processes

Soil salinity and sodicity are predictable soil characteristics. Natural salt accumulation in North Dakota is associated with specific hydrogeologic settings generally associated with groundwater discharge, shallow groundwater depths, and infrequent ponding (Seelig and Richardson, 1991); for example, areas adjacent to semipermanent wetlands and broad, low-relief flats (Arndt and Richardson, 1989; Holm and Henry, No date). Dissolved salts move with saturated and unsaturated groundwater flow. Areas of persistent groundwater recharge are leached, whereas areas of persistent groundwater discharge can have a range of salinities depending on the salinity and depth of the groundwater in question (Lissey, 1971; LaBaugh, 1988; Arndt and Richardson, 1989; Knuteson et al., 1989; Seelig and Richardson, 1994; van der Kamp and Hayashi, 1998). Salts accumulate in the vadose (i.e. unsaturated) zone when unsaturated flow brings groundwater containing dissolved salts into the rooting zone. The attendant evapotranspirative withdrawal of pure water leaves the salts to accumulate. Although saline soils are the product of long term hydrogeologic conditions, salts are readily mobilized when groundwater hydrology changes (LaBaugh, 1988; Steinwand and Richardson, 1989; Arndt and Richardson, 1993). Irrigation can dramatically change natural patterns of salt accumulation by altering groundwater hydrology.

1.3. SALINITY, SODICITY, AND IRRIGATION IN NORTH DAKOTA AND MINNESOTA

Irrigation as practiced in along the Sheyenne and Red Rivers in North Dakota and Minnesota is called "supplemental irrigation" because it does not substitute for, but augments growing season rainfall to provide a dependable crop yield every year. Irrigation is also used on crops where water stress affects the quality of the yield, such as flowers, vegetables, and fruits, and to maintain golf greens and fairways.

Knowledge of soil and water characteristics is very important for successful irrigation in North Dakota. Unsuitable irrigation water can have an adverse effect on the chemical and physical properties of the soil resulting in progressive soil deterioration and subsequent crop yield reductions. Determining the suitability of land for irrigation requires a thorough evaluation of the soil properties, the topography of the land within the field and the quality of water to be used for irrigation.

Much of the information that follows comes from a number of North Dakota State University Agricultural Extension Service (NDSU-AES) circulars that deal exclusively with soil salinity and irrigation in North Dakota. Most of this information has been compiled into an Irrigation Handbook available from the NDSU-AES.

1.3.1. Important Topographic and Soil Properties Affecting Irrigability

Features that affect the irrigability of soils are essentially those properties that influence soil water movement and watertable depth relationships.

1.3.1.1. Slope

Slope is an important landform characteristic that determines to a large degree the water runoff potential from a field. Slope is a major feature of soils as described in the soil survey. Water and soil losses from runoff are directly related to percent slope. Generally, more run-off will occur on fine textured soils compared to coarser textured soils on similar slope. Slope also figures prominently in the selection of an irrigation system.

1.3.1.2. Soil depth

Soil depth depends on the potential rooting depth of plants to be grown and any restrictions within the soil that may hinder rooting depth. The rooting depth of potatoes may be as shallow as 2 feet, while for alfalfa the rooting depth may be over 5 feet. Rooting depths for soybeans, edible beans, and corn range from 2.5 to 3.5 feet (Lundstrom and Stegman, 1988). Discontinuities in the soil from layers of sand, gravel or bedrock may serve to physically limit rooting depth.

1.3.1.3. Soil Texture and Structure

Soil texture (the percentage of sand, silt and clay sized particles in the soil) influences other properties such as water holding capacity, infiltration rate and internal drainage. Fine textured soils usually have slow infiltration rates unless the soil structure is good. Leaching irrigation water through fine textured soils may be difficult. Limited leaching capacity increases a soil salinity hazard for irrigated soils.

Also important for water movement is soil structure. Soil particles are arranged into structural aggregates through the action of weather, organic matter bridging and coating, soil mineral composition, time and outside physical forces such as compaction, root growth and animal activities. Soils containing aggregates unstable under irrigation (for example sodium affected soils) may require special management. Movement of water into and within soils is partially dependent on soil structure. Fine textured soils with strong, stable structure can have very good water infiltration and permeability characteristics similar to coarser textured soils.

1.3.1.4. Water holding capacity

Water holding capacity is defined as the soil water retained between a moist soil at field capacity (0.1-0.5 bars tension) and permanent wilting point (15 bars water tension). Water held between these two moisture contents values is regarded as plant-available water. A silt loam soil holds about 2.25-2.5 inches of water per foot of soil, while a sandy loam can hold only about 1 inch of water per foot. Soils with higher organic matter generally hold more water than a soil with lower organic matter.

1.3.1.5. Infiltration rate and Internal Drainage

Infiltration rate is the relative rate that water penetrates and moves into the soil. When combined with permeability and moisture content, infiltration rates describe the movement of water in soils. A faster infiltration rate allows for less runoff than soil with slower rates. More water penetrates into the soil promoting better drainage and leaching characteristics.

Internal drainage describes the degree and persistence of soil wetness and is influenced by slope, soil infiltration rate, soil texture (percent gravel, sand, silt and clay), depth to water table and depth to impermeable layers. Soils with poor internal drainage that remain wet may cause accumulation of salts by capillary rise of groundwater into the root zone. Soils with good internal drainage respond well to irrigation. Irrigation water is retained for use by crops, while allowing sufficient movement of water within the soil to minimize saturation of pore space.

1.3.1.6. Salinity and Sodicity

Soil salinity and sodicity can be affected by irrigation, but also affect the irrigibility of soils subject to salinization and sodification. High levels of soil salts are typically associated with high water tables and “wet” soils. Irrigation can aggravate existing saline/sodic conditions by both adding salt and raising water tables. Salinity moves with the water and can change in magnitude and distribution relatively quickly with time compared to other more stable soil properties such as texture.

Sodium (Na) affects the physical condition of the soil by dispersing aggregates. The soil becomes pasty when wet and develops a condition called "puddling", where water remains on the surface for an extended period. The soil becomes hard when dry, and its permeability to water and air is reduced. If irrigation causes sodium salts to accumulate near the soil surface, increased sodium levels may cause yield reductions. Sodium buildup usually occurs slowly and may not be easily detected from one year to the next. Sodium buildup is one of the most serious long-term dangers to crop productivity decline due to irrigating some soils, and frequently requires regular soil testing to determine long-term trends in sodium accumulation.

1.3.1.7. Soil Series, Soil Survey Map Units, and Inclusions

Soil texture, structure, permeability, salinity, sodicity, topography, and slope discussed above are relatively consistent properties that, among other characteristics, are associated with soil series designations. North Dakota has 264 soil series as mapped and described in the county soil surveys. Soil mapping units as provided in the county soil surveys consist of varying mixtures of these soil series. Some map units (consociations) identified in the soil survey consist of one

dominant soil with included similar soils. More frequently complexes consist of two or more dissimilar soils occurring in a known and definable pattern are mapped. The pattern is so complex that individual components cannot be delineated at the scale of the mapping. Complexes are usually designated by the names of the dominant soil series (major components).

A minor percentage of each map unit consists of soils that are not included in the name of the map unit. These minor soil inclusions are discussed in the map unit description in the hardcopy soil survey, and are identified in the digital database products (Soil Survey Geographic Database or SSURGO) and Map Unit Interpretations Record or MUIR) available from the Natural Resources Conservation Service (NRCS). Percentages of included soils are provided in the database products; however, links to attribute data for the included soils are not provided.

Many map units in irrigated lands along the Sheyenne and Red Rivers consist of complexes of several soils with inclusions. In some cases inclusions can be accounted for if detailed attribute data is not required. However, in many cases, the properties of inclusions are not addressed in the digital database products available from the NRCS. The specific method for dealing with inclusions will be provided in the text that follows.

1.3.2. Important Chemical Properties of Irrigation Water Affecting Irrigability

Irrigation water must be compatible with both the crops and soils to which it will be applied. Salt content is the major factor that determines the quality of water for irrigation purposes. An analysis of water for irrigation includes electrical conductivity and basic ion composition, including the cations: calcium, magnesium, and sodium, and the anions: bicarbonate, carbonate, sulfate, and chloride. The primary chemical characteristics that characterize salinity and sodicity in soil and water are the Electrical Conductivity (EC) and the Sodium Adsorption Ratio (SAR).

1.3.2.1. Electrical Conductivity and Total Dissolved Solids (TDS) Conversions

The ability of solutions to conduct electricity is directly proportional to the number of ions in solution, which can also be expressed as total dissolved solids. Both TDS and EC are commonly used when assessing soil and water salinity; however, the relationship between them is not direct, and interpretation using one unit must be converted when available data utilize the other. EC can be expressed a number of ways dependent upon the units used. The following are most commonly seen in the literature:

millimhos per centimeter (mmhos/cm),

deci-Siemens per meter (dS/m) or

micromhos per centimeter (umhos/cm)

where:

1000 mmhos/cm = 1 mmho/cm = 1 dS/m

Most of the irrigation salinity literature uses EC units of umho/cm because there is a close numeric relationship between EC expressed as umho/cm and chemical analyses that provide TDS values as parts per million (ppm) or milligrams per liter (mg/l). The relationship deviates somewhat dependent upon the type of solute species involved, however, in sulfate dominated systems the following relationship has been used.

TDS = 0.65*EC (EC in umho/cm) Equation 1

This relationship between TDS expressed as mg/l and EC as umho/cm was used in previous reports (Downstream Surface Water Users Study, Barr Engineering, March 1999), is in common use in North Dakota Soil Testing Laboratories, and will thus be used for the present report.

For the purposes of interpretation, North Dakota Soil Water Compatibility recommendations and NSSL salinity/sodicity hazard ratings that use EC ranges will be converted to TDS values using equation 1. When applicable, parenthetical reference will be made to the EC equivalent as umho/cm.

1.3.2.2. Sodium Adsorption Ratio (SAR)

The influence of sodium on soil properties depends on the relative amount of monovalent sodium cations with respect to divalent calcium and magnesium cations. The adverse effects of sodium on dispersing soil structure are mitigated by the presence of divalent cations that help hold soil particles together. The most accepted method of comparing sodium to calcium and magnesium is by calculating the sodium adsorption ratio (SAR). The SAR may be determined for soil extracts or irrigation water.

The concentrations of calcium, magnesium and sodium must be determined or estimated in a soil extract of water sample. After analysis, the SAR can then be calculated using the following formula:

$$SAR = \frac{Na+}{\sqrt{\frac{[Ca^{2+}]+[Mg^{2+}]}{2}}}$$ Equation 2

where:

Na^+ is the concentration of sodium in milliequivalents per liter of soil extract or meq/liter of irrigation water.

Ca^{2+} and Mg^{2+} are the concentrations of calcium and magnesium, respectively in meq/liter of soil extract or irrigation water.

A saturated-soil extract with a SAR of greater than 13 is usually an indication of sodium problems and not generally recommended for irrigation. More detailed analyses of SAR can incorporate mineral equilibria between carbonate, sulfate, and calcium species in solution yielding an adjusted SAR; however, the resulting modifications to SAR and salinity/sodicity interpretations are minor. For the purposes of the present report, SAR as estimated by relative concentrations of Ca, Mg, and Na in the HEC5Q water quality analyses will be used. The derivation of the HEC5Q TDS and SAR estimates are discussed in more detail in Section 2.1.1 below.

Texture also modifies the effect of SAR relative to management. Although a SAR of 13 indicates significant clay dispersion in both a clay loam and sandy loam soil, the actual effect of the dispersion on soil properties is less in the sandy loam. Soils with a relatively low SAR may

become dispersed depending on the amount of clay particles held together in part by the attraction of calcium to other clay particles and the dispersing action of sodium which counteracts the aggregation process.

1.3.2.3. Salinity designations of irrigation water:

The United States Salinity Laboratory (NSSL) rates irrigation water salinity in terms of a scale from C1-C4 (Figure 1, after Richards, 1954).

(Insert Figure 1 about here)

The definitions of the scale are described below.

C1 — (Low-salinity water, < 250 umho/cm; 160 mg/l TDS) Little likelihood that soil salinity will develop. Some leaching may be required, but not more than normal leaching from standard irrigation practices unless the soils are extremely low in permeability.

C2 — Medium-salinity water, 250 – 750 umho/cm EC (160 – 490 mg/l TDS) Water can be used if a moderate amount of leaching is used. Plants with moderate tolerance to salinity can be grown without special practices for salinity control.

C3 — High-salinity water, 750 – 2250 umho/cm (490 – 1460 mg/l TDS) Cannot be used on soils with restricted drainage. Special management is required even with good drainage. Plants with good salt tolerance must be selected.

C4 — Very high-salinity water, > 2250 umho/cm (> 1460 TDS) Not suitable for irrigation except under very special conditions which include permeable soils, adequate drainage, excess water for leaching and very salt-tolerant crops.

1.3.2.4. Sodium designations of irrigation water:

The sodium level in the soil in relation to calcium and magnesium (sodicity), as well as the sodium content of the irrigation water is important to the long-term productivity and health of the soil. The amount of sodium in the soil and in irrigation water are also factors which influence sodification on irrigated lands. The use of high sodium water depends on the level of salinity and sodicity in the soil and water as described in Figure 1.

Richards (1954) further defines sodicity in terms of a scale from S1-S4. The definitions of each class are described below. SAR ranges are not provided because the classification reflects the fact that sodium hazards are indirectly related to salinity. Thus, for a given level of sodicity, the hazard is greater in less saline irrigation water. See Figure 1 for ranges.

S1 — (Low sodium water) Can be used on nearly all soils with little danger of sodium buildup to the soil, although levels may still be high enough to injure sodium sensitive plants.

S2 — (Medium sodium water) May present a potential sodium buildup on fine-textured soils with low permeability especially if available calcium levels are low. Class S2 water is suited to irrigate coarse textured soil with good permeability.

S3 — (high sodium water) May cause sodium buildup in most soils and requires special management, including providing for good drainage, applying excess water for leaching and

organic matter additions. Soils with very high levels of free calcium may not develop problems. Chemical additions (e.g. gypsum or more soluble calcium salts) may be required to replace soil sodium. Chemical additions may not be practical if salinity of irrigation water is high.

S4 — (very high sodium water) Unsuitable for irrigation water except if the water is low or medium salinity (C1 or C2). With irrigation waters low in salinity, addition of soluble calcium salts to the irrigation water may make use of S4 water possible.

1.4. CLASSIFICATION OF NORTH DAKOTA SOILS FOR IRRIGATION SUITABILITY

Soil series in North Dakota are classified for irrigation suitability in Franzen et al. (1996). Franzen et al. (1996) suggest that an on-site determination by professional soil scientists of mapping unit inclusions and major component soil series should be considered when making irrigation management decisions.

However, because on-site investigations are not feasible for the present analysis, the percentage of major soil series components and map unit inclusions were estimated by determining the average percentages listed in the SSURGO and MUIR databases for each map unit. The databases provide estimated percentages of inclusions based on extensive transecting of soil map units during the field survey. Inclusion percentages are provided as representative of the overall map unit composition. It is important to include inclusions in the assessment of the effects of the alternatives on potential soil salinization because when combined, inclusions can account for a significant portion of the map unit. The following information summarizes information on the North Dakota Soil Water Compatibility classification system in Franzen et al. (1996).

1.4.1. Irrigation Suitability Groups

Franzen et al. (1996) group soil series into three irrigation categories – Non-irrigable (N), Conditional (C), and Irrigable (I). Groups are further subdivided into subgroup categories with similar soil characteristics important to irrigation and irrigation management. Ranges in maximum recommended EC and SAR in irrigation water are provided at the subgroup category only for conditional and irrigable subgroups.

Management of irrigated soils to sustain soil productivity and maximize crop yields is similarly dependent upon soil characteristics and varies by irrigation suitability groups and subgroups. Management could include soil specific irrigation scheduling, annual soil testing for sodium and salts, addition of calcium amendments, need for surface or subsurface drainage, or other special activities.

1.4.1.1. Non-Irrigable (NI)

Irrigation is precluded by severe limitations due to slope, sodicity, salinity, excessively slow permeability and/or root restrictive subsoil layering. If irrigated, soil quality will be degraded and the productivity of the soils reduced. Different phases of each soil series will modify irrigation recommendations. Franzen et al. (1996) do not provide recommended maximum EC and SAR values for soil series placed in non-irrigable groups.

1.4.1.2. Conditional Soils (C)

Conditional soils can be irrigated under a high level of management. Irrigation without high levels of management may degrade soil quality, but conditional soils can be successfully irrigated if recommendations are followed. Soil phases of each soil series listed as conditional may modify irrigation recommendations. Included soils may exist in small portions of irrigated fields. Inclusions that are less suited to irrigation or are non-irrigable will respond poorly to irrigation and may show up as bare spots, areas of chlorotic (yellowed) plants, and stunted crops.

Ranges in maximum recommended EC and SAR in irrigation water are provided at the subgroup category only for conditional and irrigable subgroups, and range from low values of EC from 1000 umho/cm (650 mg/l TDS) and SAR values of 6 to high ranges of 3000 umho/cm (1950 mg/l TDS) and SAR values of 12. Reasons for placement of conditional soils into the lower EC (TDS) and SAR ranges include fine-textures, restricted drainage, potential existing salinity and sodicity, high watertables, restrictive subsoil, slow permeability, and the need for supplemental or subsurface drainage, among others.

1.4.1.3. Irrigable Soils (I)

Soils in the upper ranges of EC and SAR fall into the irrigable category and are typically well drained, moderately coarse textured, well structured soils with high infiltration and permeability rates, and fair water holding capacity. Irrigable soils generally need less management than conditional soils. However, even though the soils are in an irrigable class, good irrigation management is essential. Use of lower quality water than recommended can lower the productivity of the soils from salts and sodium. Different phases of each soil series may modify irrigation recommendations.

Ranges in EC (TDS) and SAR for the irrigated soils identified in the present study will be examined in detail and summarized by group in the Results section, below.

1.5. MANAGEMENT AND MITIGATION OF SOIL SALINITY

Salt and sodium in soils can limit their use, reduce crop yields, and influence management (Bresler et al., 1982; Franzen et al., 1994; Holm and Henry, No date). Soils that have an EC greater than 4 dS/m are considered saline (U.S. Salinity Laboratory Staff, 1954). Depending on crop salt tolerance, significant yield reductions of intolerant crops occur beyond an EC of 4 dS/m. Crop tolerances to soil salinity/sodicity have been quantified (Francois, 1994, 1996) and management techniques to reduce the negative impacts of soil salinity are known (Johnsgard, 1967; Franzen et al., 1994). Many of these techniques are already in general use on saline/sodic soils in the region (Bresler et al., 1982; Franzen et al., 1994; Maianu, 1983, 1984, 1985). Secondary soil salinization has a negative economic impact that can be quantified through an assessment of increased management costs, limits to use, and reduced crop yields. Soil water compatibility issues involving irrigation are well documented, requiring a knowledge of applicable soil/groundwater characteristics, irrigation water chemistry, and irrigation rates (U.S. Salinity Laboratory Staff, 1954; Franzen et al., 1996; Scherer et al., 1996). Given a knowledge of soil type and irrigation water quality, salinity hazards can be identified and mitigated or accounted for.

Common management techniques use adapted crops and manipulate watertables and groundwater flow to minimize soil salinization in sensitive areas. Land and water management practices that can help producers to reduce the risk of dryland salinization include but are not limited to:

- increasing minimum tillage or no-tillage
- increasing the area of forages, pastures, and tree crops
- reducing summer-fallow area
- including crops that are more salt-tolerant in rotations
- using inputs such as mineral fertilizers and animal manure more effectively
- use precision farming
- ensure adequate drainage
- install interceptor forage strips or strategic subsurface tile drainage. (Eilers et al., 1997; Eilers et al., 2000)

2. METHODS

A quantitative, predictive assessment of salinization hazards in the study area is precluded by the magnitude of the area to be assessed; the complexity of the geomorphic, sedimentologic, pedologic, and geochemical factors involved; and the design level of the outlet alternatives. However, resources and technology are available that permit a qualitative/semiquantitative assessment of irrigation salinization hazards.

2.1. ASSESSMENT OF SALINITY HAZARDS ASSOCIATED WITH IRRIGATION USING BLENDED DEVILS LAKE/SHEYENNE RIVER WATER

The hazards associated with irrigation with potentially substandard blended Devils Lake/Sheyenne River water are routinely assessed in irrigated agriculture using accepted methods. The following sequence of procedures was used to assess irrigation-related soil salinization hazards associated with the alternatives.

1. Select a representative water quality trace based on several HEC5Q water quality predictions for the 50-year planning period.
2. Modify the representative HEC5Q water quality dataset to better assess soil salinization hazards.
3. Determine the location of the lands irrigated with Sheyenne and Red River water and digitize irrigated soils.
4. Create a soil-attribute database to relate acreage of soils by irrigibility class and subclass (North Dakota Soil/water Compatibility Classification) to irrigation water quality characteristics under the alternatives.
5. Determine the cumulative percentage of time in the representative water quality trace that predicted levels of EC and SAR rise above unsuitable levels for the specific irrigated soils.
6. Identify potential effects on irrigators and land use.
7. Present potential mitigation measures.

A detailed description of methods and the reasoning behind method selection follows.

2.1.1. Selection and Modification of a Representative Water Quality Trace

Stochastic models developed to assess the environmental and economic impacts of the Alternatives produced 10000 traces (or “futures”) predicting flow and water quality estimates for the Sheyenne and Red Rivers under various climatic and outlet operational conditions. The original set of 10000 traces was developed to statistically evaluate the economic impacts of the proposed alternatives; however, a statistical analysis employing all 10000 traces is not indicated due to time, data and methodology constraints. A subset of these traces representative of dry, moderate, and wet climatic scenarios has been used by the USACE and its contractors to assess applicable environmental concerns, including downstream water quality. The development of water quality parameters and traces for representative scenarios is discussed in detail in the

USACE report Water Quality Effects: Devils Lake Water Quality Simulations, Sheyenne and Red Rivers (USACE, St Paul District, No Date). The salient features of the water quality modeling include:

- Water quality simulations were run under the HEC 5/5Q model that consists of both flow and water quality simulation modules.
- Modeled water quality parameters consider mixing of Devils Lake and Sheyenne River water at varying ratios dictated by pumping volumes and Sheyenne River flow rates at the point of insertion, progressively altered by evaporation and dilution of tributary inflows downstream.
- TDS, sulfate, chloride, hardness, and a conservative tracer in the Devils Lake water were directly modeled under the HEC 5Q analysis.
- The conservative tracer was used to model indirectly the concentrations of calcium, magnesium, and sodium based on initial calcium, magnesium, and sodium concentrations in unblended Devils Lake and Sheyenne River water. The combined effects of mixing, evapotranspiration, and dilution with tributary waters were then modeled using the HEC 5Q program.
- Calcium, magnesium, and sodium concentrations were assumed to be conservative (i.e. not affected by precipitation and adsorption reactions).
- The sodium adsorption ratio was calculated as described in Section 1.3.2.2 based on milliequivalent weights.

Water quality traces for TDS, SAR, and associated water quality data for selected control points along the Sheyenne and Red Rivers were provided by the St. Paul District for use in the current study. Data representing Moderate (Moderate50 and Moderate55) climatic traces along with a wet trace (Wet7) for control points (CP) at Warwick (CP1408), Cooperstown (CP1317) Valley City (CP1253), Lisbon (CP1162), and Kindred (CP1068) along the Sheyenne River in North Dakota, and Halstad (CP375), Grand Forks (CP296), and Emerson (CP99) along the Red Rivers in North Dakota and Minnesota were provided (Figure 2). For the rest of the report references to the Control Point locations will be by their city description. The selection of the representative trace is discussed in detail in the Results Section.

(Insert Figure 2 here)

2.1.1.1. Modifications to the Original TDS and SAR Dataset

The assessment of soil salinization hazards associated with irrigation using blended Devils Lake/Sheyenne river water is complicated by two factors:

- Irrigation as practiced in North Dakota is supplemental. Irrigation applications depend upon crop moisture stress and climatic factors that cannot be predicted with certainty, and cannot be temporally correlated to the quality of blended Devils Lake/Sheyenne River water under the alternatives.

- Irrigation soil/water compatibility recommendations generally assume relatively consistent TDS and SAR values for the irrigation water. However, when combined

with climatic variations, outlet operations under the 300 cfs Constrained and 480 cfs Unconstrained alternatives and variable rates of discharge of Devils Lake water under the No Action (natural spill) alternative ensure that the quality of blended Devils Lake/Sheyenne River will be quite variable.

Original TDS and SAR data as supplied by the Corps include: (1) daily values for the entire 365-day year and extending from November 1, 2000 through September 30, 2050, and (2) baseline data reflecting natural conditions (same climatic conditions as the Alternatives, but with no Devils Lake inputs). Several modifications were made to the dataset to make it more applicable to the assessment of soil salinization hazards under the outlet and no action alternatives.

1. Because irrigators appropriate water from the Sheyenne and Red Rivers during the growing season, the dataset as supplied was reduced to the period extending from May 1 through September 30, which approximates the growing season during which water appropriation would occur.

2. The entire 50-year planning period represented by the original dataset begins November 1, 2001 and extends through September 30, 2050. However, outlet operations do not begin until May 1, 2005. In order to limit the dataset to only that period during which outlet operations would occur, all data from November 1, 2000 through May 1, 2005 were removed from the dataset. Thus the plan period discussed in the present report represents a 45-year period beginning May 1, 2005 with the initiation of outlet operations, and continuing through September 30, 2050.

3. The alternative's TDS and SAR datasets for the period May 1 through September 1 include several periods during which baseflow conditions dominate due a lag in downstream movement of the mixed water after insertion, or because outlet operations cease because the level of Devils Lake dropped below the 1441.6 fASL elevation. Inclusion of these values under the scenario would result in a dilution of the TDS and EC values for the given alternative dataset when running distribution statistics. In order to account for this dilution effect, only values representing mixed Sheyenne River/Devils Lake water having greater than 1 unit of dye tracer were used to statistically describe the data for the alternatives. One unit of dye tracer was chosen as a lower limit because mixing in the Lake Ashtabula results in the presence of very low amounts of Devils Lake water downstream of Lake Ashtabula for a considerable period after outlet operations cease. Small amounts of Devils Lake water in the Sheyenne River would have no affect on irrigation water quality.

4. Because the effects of the alternatives must be placed in the context of the 45-year portion of the planning period during which outlet operations were modeled (see point 2, above), procedures that assess impacts (e.g. exceedance curves and hazard classes) will include 2 evaluations.

    - An analysis of percent exceedances and acreage by hazard class for the entire dataset (hereafter cumulatively referred to as *"Baseflow-plus-Blended-Water"*) that includes all daily values provided in the HEC 5Q dataset for the growing season.

    - An analysis of the dataset restricted to only blended Devils Lake/Sheyenne River water (hereafter referred to as *"Blended-Water-Only"*) using the dye tracer method

discussed in point 3, above. Thus the *Blended Water Only* dataset is restricted to the portions of the growing season when Devils Lake flows are in the Sheyenne River.

This assessment of the impacts of the alternatives on soils irrigated with blended Devils Lake/Sheyenne River water emphasizes both the temporal and the overall impacts on irrigation water quality. Overall impacts of the alternatives are described by a statistical evaluation of TDS and SAR values comparing water quality associated with base conditions to water quality associated with the alternatives. The distribution statistics (Minimum, maximum, mean, and standard deviation) evaluate water quality under the alternatives for only that portion of the growing season where the Sheyenne River contains blended water. The temporal evaluation of the impacts of the alternatives considers the percentage of time recommended maximum TDS and SAR values are exceeded during the growing season. This analysis evaluates both the magnitude and duration of the impacts of the alternatives on irrigation water quality on the lands currently irrigated with Sheyenne River water.

2.1.2. Location and Digitization of Irrigated Land

An inventory of active water appropriation permits for irrigation using Sheyenne and Red River surface water was conducted by Barr Engineering (Barr Engineering, March 1999). However, the inventory emphasized water use and potential crop responses, and provided little specific information on irrigated soils that could be used to assess potential soil salinization hazards. Using this information as a base, basic data for irrigation permits was obtained from the North Dakota State Water Commission (NDSWC) and the Minnesota Department of Natural Resources, Division of Waters (MDNR).

Soils vary widely in their salinization potential under irrigation. In order to assess the impacts of the alternatives on soil salinization potential, permit-specific soils information was necessary to compare with predicted water quality parameters for a representative water quality trace.

Offices of the NDSWC and the MDNR were visited to obtain detailed location information for the lands to be irrigated under each permit. The boundaries of irrigated lands obtained from plan diagrams in the permit files were digitized into a GIS to determine the distribution of soils applicable to an analysis of soil characteristics important for irrigation. Many of the permit locations were in areas that have spatial digital soil data. In these cases, the digital boundaries of the irrigated lands were merged with the digital soil layer to determine the acreage of potentially affected soils under each permit. In cases where digital soil data were lacking, applicable map sheets from county soil surveys were scanned, geo-referenced and entered into the GIS. Soil polygons were then digitized from the georeferenced map sheets.

2.1.3. Creation of a Soil-Attribute Database

The NRCS has developed the MUIR database that contains virtually all of the soil attribute information in a standard soil survey, including soil map unit composition and the percentages of major components and inclusions broken down by soil series. Physical, chemical, and interpretative data are included as well. Digital MUIR soil attribute information obtained on a county basis via internet download was condensed into a database to be used for this project and others involving soil salinization hazards under the proposed alternatives.

Soil series in North Dakota are classified for irrigation suitability based on irrigation water quality (EC and SAR) and specific soil characteristics in Franzen et al. (1996) (see Section 1.4 above for a detailed description). Irrigibility group and subgroup data and recommended ECmax, TDSmax, and SAR data for all North Dakota soils were combined into the relational soil attribute database in order to provide these values for all soil series applicable to a specific irrigation water appropriation permit.

2.1.3.1. Project-specific Modifications to the North Dakota Classification.

The North Dakota classification places several soils into both Non-irrigable and Conditional classes based primarily on slope (e.g. groups 1A/3D, 1A/10, 1A/4A, and 1A/9). Because the analysis is restricted to soil salinity on lands already irrigated that would have limited slope restrictions, when an option was provided to place a soil series in a Non-Irrigible or Conditional group and ECmax and SARmax data were provided, the soil was placed in the conditional category.

There were a few soil series in Minnesota and North Dakota that were not on the North Dakota list. Where soil series names were provided for these soils, they were placed in the most appropriate category based on their texture, drainage class, water holding capacity, and other characteristics available from NRCS series descriptions and in the attribute database. These soils are indicated as "added" in the Subgroup table of the database developed for the project.

Some soil inclusions from the attribute database in Minnesota did not provide enough information to determine placement into a Irrigibility Group or Subgroup. For example, some minor inclusions in Polk County Minnesota are designated as "soils with lesser or greater slopes." Such soils were placed into a separate category ("?" in the group and subgroup table) indicating that insufficient information was provided to determine the Irrigibility Group or Subgroup.

2.1.3.2. Applicability of the North Dakota Irrigibility Group Classification

Most assessments of soil/water compatibility provide general recommendations and very broad categories regarding irrigation water quality and soil characteristics that do not lend themselves to a semi-quantitative assessment. However, the North Dakota irrigibility classification described in Section 1.4 presents recommended maximum EC and SAR values in irrigation water for all North Dakota soil series. The North Dakota classification system assumes that the quality of irrigation water will remain constant, that irrigation will be supplemental rather than continuous, and that appropriate management will be used, with intensive management indicated for irrigation of conditional soils (e.g. irrigation scheduling, periodic soil testing, and drainage if necessary).

The conditions under which permittees will irrigate under the constructed outlet and No Action alternatives are different than standard irrigation practice because the quality of the irrigation water will not be constant, but will vary both within a given growing season and throughout the planning period. As an example, HEC5Q water quality data for the No Action (natural spill) alternative indicates that the impacts on downstream water quality may be severe and could preclude the use of Sheyenne River water for irrigation on many soils during the period when overflow occurs. However, several scenarios suggest that a natural spill would last for only a

short portion of the planning period. In contrast, several water quality scenarios run for the 300 cfs Constrained Outlet alternative indicate much lower increases in SAR and TDS. However, outlet operation continues for the duration of the planning period resulting in milder but much longer impacts when compared to the No Action (natural spill) alternative.

Duration and magnitude of the changes in TDS and SAR associated with the outlet alternatives will impact the interpretations using the North Dakota classification because the classification assumes a relatively constant irrigation water quality. This issue will be addressed by considering the percent exceedance in SAR and TDS during the growing season over the entire May 1, 2005 through November 30 planning period. However, it is impossible to quantitatively assess the combined effects of magnitude and duration of water quality changes under the alternatives on soil salinization hazards. In order to account for the fact that irrigation water quality is not constant under the alternatives, the interpretations in this report qualitatively account for the magnitude and duration of the predicted changes in TDS and SAR by comparing *Baseflow plus Blended Water* and *Blended-Water-Only* datasets.

2.1.4. Quantification of Impacts

Acreage of all irrigated soils including major components and inclusions were determined using GIS and database methods and summarized by project, river, state, county, and individual permit. All soils were then grouped into their respective irrigibility subgroup and associated TDS and SAR recommended maximums for irrigation water quality. Percent exceedances of recommended TDS and SAR maximums were determined from percent exceedance graphs prepared for the representative water quality trace by control point.

A hypothetical example for TDS will illustrate the process. Permitee X irrigates an area of 100 acres consisting of one soil map unit with one component soil series, Soil A. Soil A is in irrigability Subgroup 2B that has a maximum TDS of 650 mg/l (North Dakota classification). The permit is closest to the Kindred control point. Percentage exceedance tables developed for Kindred indicate that a TDS of 650 in Sheyenne River Water is exceeded 63 percent of the time under the 480 cfs Unconstrained Outlet alternative, 28 percent of the time under the 300 cfs Constrained Outlet alternative, and is not exceeded at any time under baseflow conditions. Thus Permit X represents 100 acres of soil where the recommended TDS maximum is exceeded 63, 28 and 0 percent of the time during the growing season for the 2 outlet and the No Action (Natural Spill) alternatives, respectively. These data indicate that salinity increases could occur under both outlet alternatives, but that salinization hazards would be greatest under the 480 cfs Unconstrained Outlet alternative.

How significant a hazard is a 63 percent exceedance of EC? An exact determination is difficult to quantify because irrigation usually supplements precipitation and is intermittently applied, but the relative hazard is apparent: irrigation water exceeds the recommended limits in TDS 63 percent of the time under the 480 cfs alternative increasing the potential for soil salinization when compared to the 300 cfs alternative and base flow.

The process is similar for the determination of the impacts of the outlet alternatives on SAR exceedances. Determinations are made for all soil series (major components and inclusions) in

the database that then can be used to reduce and summarize the dataset by permit, irrigibility group and subgroup, river, county, and state.

A quantification of irrigation salinity hazards is complicated by the fact that irrigation water in North Dakota is applied only under a crop moisture deficit and is not usually relied upon as the sole source of water. Thus irrigation water quality in the Sheyenne River would not make difference during wet periods when irrigation is not needed, but would be very important during dry periods. In other words predicting future irrigation applications is not feasible. In order to quantify and summarize the salinity and sodicity hazards associated with the alternatives, hazard classes were developed that reflect the probability that an irrigator will use water that is outside the recommended maximum limits during the 45-year planning period during which outlet operation can occur. None/Slight, Low, Moderate, and High hazards are indicated when percentage exceedances range from 0-5%, >5-25%, >25-50%, and >50%, respectively. The hazard percentages are somewhat arbitrary and were developed to compare alternatives and indicate the percentage of time that the irrigator could potentially apply substandard water during the growing season.

Duration issues will be addressed by evaluating the patterns of outlet operation evident in *Baseflow-plus-Blended-Water* datasets separate from datasets representing *Blended-Water-Only*.

2.1.5. Identify Potential Effects of the projects under All Alternatives

The methods described above yield percent exceedance in recommended maximum TDS and SAR for all irrigated soils within the project area for the three alternatives. The hazard classification permits the exceedance data to be summarized by alternative, state, river, county, and permit. These data are discussed in terms of soil salinization hazards.

2.1.6. Present Mitigation Measures

Mitigation measures are described for irrigated soils found to be potentially salinized under the various outlet alternatives in Section 3.4.6, below.

3. RESULTS AND DISCUSSION: SALINIZATION HAZARDS ASSOCIATED WITH CONSTRUCTED OUTLET DISCHARGE (300 AND 480 CFS) AND THE NO ACTION (NATURAL SPILL) ALTERNATIVE (NATURAL SPILL)

The assessment of irrigation soil salinization hazards associated with the outlet alternatives and the No Action (natural spill) alternative depend upon TDS and SAR characteristics of the mixed Sheyenne River/Devils Lake water, combined with physical and chemical characteristics of irrigated soils available from NRCS databases and county soil surveys. A detailed evaluation of the TDS and SAR characteristics of mixed Sheyenne/Devils water in a conservative yet representative climatic scenario is necessary to assess soil salinization hazards associated with the outlet alternatives and the No Action (natural spill) alternative.

3.1. SELECTION OF THE WET7 TRACE TO ASSESS THE IMPACTS OF OUTLET ALTERNATIVES

A comparison of 50 year TDS and SAR traces between the Wet7, Moderate50 (Mod50) and Moderate55 (Mod55) scenarios illustrates: (1) the effects of operational parameters and water quality characteristics important in the assessment of soil salinization hazards associated with outlet alternatives, and (2) the reasoning behind the selection of the Wet7 trace for use in the assessment of soil salinization hazards. Fifty-year traces of predicted TDS and SAR for Cooperstown and Kindred using the 300 cfs constrained outlet alternative are provided in Appendix A1.

3.1.1. TDS and SAR Relationships in MOD50, MOD55, and Wet 7 Traces

Fifty-year traces of TDS under the 300 cfs Alternative, Mod50, Mod55, and Wet7 climatic scenarios for the Cooperstown and Kindred are in Appendix A1, Figures A1-1 through A1-3 and A1-4 through A1-6, respectively. Fifty-year traces of SAR under the 300 cfs Alternative, Mod50, Mod55, and Wet7 climatic scenarios for the Cooperstown, and Kindred are in Appendix A1, Figures A1-7 through A1-9 and A1-10 through A1-12, respectively. The data indicate the following:

1. While TDS and SAR vary greatly between baseline and outlet alternative scenarios, there is little variability in the magnitude of TDS or SAR values between the climatic scenarios. Where differences do occur, values are slightly higher under the Wet7 climatic scenario. Scenario TDS ranges uniformly between 300-1050 ppm for the Mod50, Mod55, and Wet7 scenarios developed for Cooperstown; and between 300 and 900 ppm for the same scenarios developed for Kindred. Scenario SAR ranges uniformly between 1.5 and 4.5 for the Mod50, Mod55, and Wet7 scenarios developed for Cooperstown and Kindred. Overall TDS values are slightly lower in the Kindred dataset due to the dilution of mixed Sheyenne River/Devils Lake water by tributary and groundwater inflows and mixing in Lake Ashtabula. SAR values remain essentially the same because the SAR value is calculated as the ratio between sodium ions and calcium and magnesium ions, which are assumed to be conservative in the HEC5Q model used to predict TDS and SAR values,

and the magnitudes of each constituent do not change sufficiently to cause large differences.

2. While ranges in TDS and SAR are essentially the same between climatic scenarios for a given control point, differences in the duration of outlet operation result in varying amounts of time during which scenario and baseline TDS and SAR values differ between the climatic scenarios. Because the outlet does not lower the level of Devils Lake to below the shut-off elevation, outlet operation is essentially continuous under the Wet7 scenario, 300 cfs Constrained Outlet alternative. Intermittent operation under the Mod50 and Mod55 scenarios indicates periods during which the outlet is shut off because the combination of outlet operation and a drier climatic scenario result in a predicted lowering of the Devils Lake to below the outlet shut-off elevation.

As a result of the similarities in SAR and TDS between climatic scenarios, this report will utilize the "Wet7" trace in further analyses of the impacts of the outlet alternatives on potential salinization hazards associated with river water appropriation for irrigation. The Wet7 trace has advantages for detailed study because it:

1. Represents a conservative, "worst case" estimate of salinization hazards,

2. Represents conditions that would result in a continuation of outlet operations for the projected 45-year life of the project, and

3. Is a member of the "wet class" of futures that represents a continuation of the current pluvial (wet) period.

3.2. EFFECTS OF ALTERNATIVES ON SURFACE WATER TDS AND SAR FOR THE WET7 TRACE

While not strongly affected by climatic scenario, the quality of mixed Sheyenne River/Devils Lake water is strongly affected by outlet alternatives, outlet operation, and downstream distance from the point of insertion. In order to assess the effects of outlet operation parameters and the no-action "Natural Spill" alternative on water quality and soil salinization hazards, distribution statistics (Table 1, Table 2), exceedance plots (Appendix A2), and plots of TDS vs SAR overlaid onto the NSSL hazard classification of irrigation waters (Appendix A3) were developed for the Wet7 scenario provided by the Corps. TDS (in parts per million or mg/l) will be considered equivalent to 0.65*EC (umho/cm) for the purposes of this report (see Section 1.3.2.1).

3.2.1. Determination of Water Quality Parameters to Assess Soil Salinization Potential

The effects of outlet operations on TDS and SAR need to be understood in order to put the temporal and spatial nature of these parameters into the proper context.

3.2.1.1. Operational Parameters of the Wet7 trace

The climatic drivers for the HEC5Q model assume that the wet years of 1993 to 1999 will repeat until Devils Lake rises to the level of a natural spill, whereupon the climatic data from 1981 to 1999 are used repeatedly to the end of the 50-year forecasting period.

All traces including the Wet7 trace were developed under the following outlet operation parameters:

1) Constrained Outlet. Outlet pumping is constrained to 300 cfs dependent upon sulfate levels (blended water no greater than 450 ppm sulfate at the point of insertion), and channel capacity (flow rate of blended water no greater than 600 cfs at the point of insertion),

2) Unconstrained Outlet. The outlet operates at 480 cfs with no constraints.

3) Outlet operation for both the unconstrained and constrained outlet ceases when the level of Devils Lake drops below 1441.6 fASL (NGVD 83).

4) No Outlet. Devils Lake rises to a natural spill from Stump Lake to the Sheyenne River. The natural spill occurs via the Tolna Coulee downstream of the Warwick Control Point (CP1408). Under the Natural Spill Alternative, points upstream of the confluence of the Tolna Coulee and the Sheyenne River, including Warwick, will be unaffected. The Warwick Control Point will not have data for the No Action (natural spill) alternative.

Both the 300 cfs Constrained Outlet and the 480 cfs Unconstrained Outlet alternatives assume pumping for a 7-month period beginning May 1 and ending November 30. The 50-year traces developed for the project begin May 1, 2001 and end with the end of the planning period on September 30, 2050. Pumping operations begin May 1, 2005 and extend intermittently or continuously, depending upon scenario and conditions to the end of the planning period.

3.2.2. TDS and SAR Distribution Statistics

Variability in the TDS and SAR of irrigation water is important for irrigators who typically appropriate water on a supplemental basis during the growing season and depend on having a reliable water source with a consistent water quality. The following analysis of distribution statistics describes the distribution (mean, median, standard deviation, maximum, minimum, range, and count) of TDS and SAR for baseflow, and mixed Sheyenne River and Devils Lake waters by control point.

Distribution statistics for TDS and SAR, Wet7 Climatic Scenario for all alternatives are provided for representative control points along the Sheyenne and Red Rivers in Tables 1 and 2, respectively. Graphs of mean TDS and SAR values for the same data are presented in Figures 3 and 4, respectively. Warwick data are absent for the No Action (natural spill) alternative because the natural spill of Devils Lake through the Tolna Channel is downstream of the Warwick Control Point. It should be noted that TDS and SAR values for the alternatives represent only samples with mixed Sheyenne River/Devils Lake water. Base flows were removed from this

dataset to represent only the periods where TDS and SAR values were above base-flow values. The data show the following.

(Insert Table 1 here)

(Insert Table 2 here)

(Insert Figure 3 here)

(Insert Figure 4 here)

3.2.2.1. TDS

1. There is a progressive increase in mean TDS values from Baseflow, the 300 cfs Constrained, the 480 Unconstrained, and the No Action (natural spill) alternatives for each control point (Figure 3). This increase represents (1) increasing proportions of Devils Lake water drawn from West Bay between the 300 and 480 cfs alternatives, and (2) significant amounts of more saline water from Stump Lake in the No Action scenario.

2. Exclusive of Warwick (for which the No Action (natural spill) alternative does not apply) TDS values generally decrease with increasing distance from the point of insertion, most likely caused by the influence of dilution from tributary and groundwater inflows and mixing in the Lake Ashtabula reservoir. The effect is particularly evident in the TDS data for control points along the Red River (Halstad, Grand Forks, and Emerson) which show only small increases in TDS values due to the various outlet alternatives. The control points fall into three groups: Warwick and Cooperstown have the highest values, TDS values for Valley City, Lisbon, and Kindred are quite similar because of proximity and the fact that they are downstream of the Lake Ashtabula reservoir. The Lake Ashtabula reservoir acts to "dampen" the variability in TDS and SAR values as well as extending the period when blended water is in the Sheyenne River. Finally Halstad, Grand Forks, and Emerson show a large dilution effect after mixing with Red River water at the confluence and progressive dilution as the water moves downstream.

3. Mean TDS values for the 300 and 480 cfs outlet alternatives are uniformly below 1000 mg/l. When compared to the No Action, natural spill alternative these values are quite close to baseline conditions. However, TDS values are much higher under the No Action (natural spill) alternative when compared to baseline, and are at or near 1000 mg/l throughout the reach of the Sheyenne River.

4. Maximum, minimum, and standard deviation values provided by control point in Table 1 indicate a fairly broad range in predicted TDS values. This suggests that significant periods of time will occur during the growing season where values will be both higher and lower than the mean values, suggesting that substantial temporal variability in irrigation water quality exists and needs to be evaluated. Percentage exceedance curves were developed to estimate the impact of the alternatives on the temporal variability of Sheyenne River water quality for irrigation (see Section 3.2.3).

TDS distribution statistics for the alternatives under the Wet7 scenario graphically illustrate a strong relationship to alternative and control point. These relationships will become important in the discussion of soil salinization hazards that follows. However, soil salinization responds to fairly broad ranges in TDS, and most groundwater used for irrigation in North Dakota as well as near surface groundwaters and subsoil saturation extracts have TDS values in the range of 1000 mg/l or higher. Much of the irrigation water in North Dakota is classified into the C2 to C3 salinity range; however, in general, any water with an EC greater than 2000 umho/cm (TDS > 1300 mg/l) is not recommended for continuous irrigation in North Dakota (Franzen et al., 1996).

3.2.2.2. SAR

As expected, relationships between SAR, control point and alternative (see Figure 4), essentially mirror the relationships examined in detail for TDS, above. Baseflow SAR values range from 1.5 to just over 2.0, with progressive increases in SAR due to increased proportions of Devils Lake water and decreasing distance from the point of insertion. Maximum mean SAR values reflect the additions of highly sodic Stump Lake water in the No Action (natural spill) alternative along with proximity to the point of insertion for the Natural Spill. Thus mean SAR values are highest for Cooperstown (mean SAR of 6.98 for the No Action (natural spill) alternative), and decrease progressively downstream. Minimum, maximum, and standard deviation values for SAR by control point (Table 2) suggest that the SAR values are not as variable as those provided in Table 1 for TDS. This is likely the result of increases in calcium and magnesium offsetting increases in sodium, whereas with TDS the increases are cumulative and do not offset each other. With the exception of the No Action (natural spill) alternative, most values are well under recommended maximum values for irrigation water.

Again, SAR distribution statistics for the alternatives under the Wet7 scenario indicate strong relationships to alternative and control point location that are important in the discussion of soil salinization hazards that follows. However, soil salinization responds to fairly broad ranges in both TDS and SAR, and groundwater used for irrigation in North Dakota as well as near surface groundwaters and subsoil saturation extracts can have SAR values in the range of 2-4. Franzen et al. (1996) and Springer et al. (1999) recommend that any water with a SAR greater than 5-6 not be used for continuous irrigation. However, a SAR of 10-12 may be used in cases where irrigation is sporadic and soils are suitable (Franzen et al., 1996).

3.2.3. Temporal Variability in TDS and SAR: Percentage Exceedance Curves

The operational parameters of outlet alternatives result in considerable temporal variability in the TDS and SAR values of Sheyenne River water. Most of the variability would occur during the growing season. Temporal variability in TDS and SAR values is particularly important for irrigators who require a reliable water source with consistent quality. If, because of water quality considerations, irrigators cannot use a water source when their crops require irrigation, the crop will suffer, yields will be reduced, and an economic impact could result.

In order to assess the temporal variability in TDS and SAR values, percentage exceedance graphs plotting the percentage of time that TDS or SAR exceeds a given value were developed for each Alternative and control point using data for the Wet7 climatic scenario. These graphs

are presented for the Warwick, Cooperstown, Valley City, Lisbon, Kindred, Halstad, Grand Forks, and Emerson control points in Figures A2-1 through A2-16, respectively.

Percent exceedance curves are the reverse of percentage accumulation curves commonly used to assess patterns and relationships in datasets. Several patterns in the exceedance curves provided in Appendix 3 relate to outlet operation characteristics and are consistent from control point to control point.

1. A break in the curve to steeper curve slopes for the 480 cfs Unconstrained Outlet alternative at about 65 percent exceedance represents the period of time where the outlet was in operation under this alternative. An analysis for the presence of Devils Lake dye tracer for the growing season data indicates that blended water was present in 69 percent of the daily predicted water quality values. Under the 480 cfs Wet7 scenario there are significant periods of time (i.e. 30 percent) where the outlet is not operated because the predicted level of Devils Lake has dropped below 1441.6 fASL.

2. A similar break in the No Action (natural spill) alternative at about 25 percent represents the period of natural overflow of Stump Lake water. An analysis for the Devils Lake dye tracer showed that blended water was present for only 23 percent of the daily growing season values. Natural overflow occurs for only approximately 23 percent of the time under the Wet7, No Action (natural spill) alternative. During the remainder of the time no natural overflow occurs and water quality in the Sheyenne River is essentially baseflow.

3. The percentage of time the outlet is operating differs between the 300 cfs Constrained and the 480 cfs Unconstrained Outlet alternatives. Even though the 300 cfs Constrained Outlet alternative is limited by streamflow and sulfate concentrations at the point of insertion, outlet operation is essentially continuous over the entire period considered in this study. While the 480 Unconstrained Outlet and No Action (natural spill) alternatives result in poorer quality water, there are more periods where baseflows prevail.

4. When considered across the entire period beginning with outlet operation May 1, 2005 and extending through the remainder of the planning period, there are significant periods of time during the growing season where TDS and SAR for the alternatives are similar to baseflow values. These periods, generally at the higher percentage-exceedance ranges, are separated by only a few hundreds of mg/l or 0.5 SAR units for the upstream control points and less than this in the control points located along the Red River.

5. Timing is an important consideration, especially under the No Action (natural spill) alternative. The Wet7 climatic scenario predicts that a natural spill from Stump Lake will occur for only a portion of the planning period. However, the data indicate that TDS and SAR values are very high for the natural spill, and that these values would persist continuously for several years.

The percentage exceedance curves presented in Figures A2-1 through A2-16 as well as the tabular data that they graphically represent reflect TDS/SAR relationships for the entire growing season during the planning period but after outlet operation was initiated. To see the effect of the duration of outlet operation and the natural spill on percentage exceedance curves an additional

dataset was created that was restricted to the period when the presence of dye tracers indicated the presence of blended water. A comparison example of the two datasets is presented in Figure 5 prepared for the Valley City HEC5Q water quality dataset.

(Insert Figure 5 here)

These figures indicate that percent exceedances based on the entire dataset may be misleading under some climatic scenarios. For example, a TDS of 1000 produces a percent exceedance of 56 percent in the *Blended-Water-Only* dataset, but only 12 percent for the *Baseflow-plus-Blended-Water* dataset. The implications for the economic impact of irrigation salinization are multifaceted.

Under the No Action (natural spill) alternative Stump Lake discharges to the Sheyenne River for only 23 percent of the WET7 climatic scenario growing season values, but during that time the water is unsuitable for irrigation of most soils. However, during the long period when Devils Lake is not overflowing the water is essentially at baseflow conditions, and is suited for irrigation of most soils. From the standpoint of the full plan period, water under the No Action (natural spill) alternative seems quite favorable; however, there is a significant, multi-year period where irrigation is not favored based on water quality. Similar but much more moderate patterns are evident in the Wet7 480 cfs Unconstrained Outlet alternative trace.

In conjunction with the NSSL irrigation water hazard classification and North Dakota soil water compatibility recommendations, percentage exceedance data for *Baseflow-plus-Blended-Water* and data restricted to *Blended-Water-Only* will be used to evaluate salinization hazards for irrigated agricultural soils along the Sheyenne and Red Rivers.

3.2.4. NSSL Salinity Hazard Classifications for Wet7 TDS and SAR data by Control Point and Alternative

TDS and SAR data are plotted on graphs that include NSSL irrigation water salinity/sodicity hazard classifications (Richards, 1954) in Appendix A3. Graphs present data from the HEC5Q model for the Warwick, Cooperstown, Valley City, Lisbon, Kindred, Halstad, Grand Forks, and Emerson control points in Figures A3-1 through A3-8, respectively. The NSSL salinity hazard classifications are described in detail in Section 1.3.2.3 above. NSSL hazard classifications based on EC have been converted to TDS values applicable to the HEC5Q dataset. Pertinent characteristics of the data by control point and alternative include the following.

1. Base values for control point locations along the Sheyenne and Red Rivers fall into the high end of the C2-S1 and the low end of the C3-S1 categories indicating low to medium salinity water with low sodicity.

2. In general, salinity/sodicity hazard increases with increasing amounts of Devils Lake water added to Sheyenne River water; thus hazards are least under the 300 cfs Constrained Outlet alternative, intermediate under the 480 cfs Unconstrained Outlet alternative, and greatest under the No Action (natural spill) alternative. However, it should be noted that for the purposes of NSSL salinity hazard classification, the 300 cfs Constrained and the 480 cfs Unconstrained outlet alternatives have essentially the same

hazard classification for any control point. From the standpoint of salinity hazard classification, the constructed outlet alternatives are very similar.

3. In general for any given alternative, salinity/sodicity hazards are greater nearer the point of insertion and decrease downstream.

4. Baseflow TDS and SAR data for the Warwick, Cooperstown, Valley City, Lisbon, and Kindred control points straddle the border between the C2-S1 and C3-S1 groups. Baseflow TDS and SAR data for the Halstad, Grand Forks, and Emerson control points are similar but have even lower SAR values.

   Category C1 indicates medium-salinity water that can be used for irrigation without a salinity hazard if soils are moderately leached. Category S1 indicates low sodium water that can be used on nearly all soils with little danger of sodium buildup in the soil.

5. The mixing of progressively larger amounts of more saline and more sodic Devils Lake water with Sheyenne River water under the 300 cfs Constrained and 480 cfs Unconstrained outlet alternatives results in a movement of water quality further into the C3-S1 category. Several datasets show values approaching C3-S2 and C4-S2 categories.

   Category C3 indicates high salinity water that may be detrimental in soils with restricted drainage. However, C3 water may be used for irrigation under high levels of management and may require planting crops with good salt tolerance. Category S2 indicates medium sodium water that may present a sodium hazard on fine-textured soils with low permeability, especially in soils that lack free calcium (e.g. lack free calcium carbonate). Most groundwaters that are used for irrigation in North Dakota are in the C3-S1 category.

6. Under the No Action (natural spill) alternative, TDS and SAR values for Kindred and Lisbon and Valley City move well into the C4-S2 and C4-S3 categories. For the Cooperstown control point upstream of Lake Ashtabula and closer to the point of insertion, TDS and SAR values for the No Action (natural spill) alternative move into the extremes of the C4-S3 category. However, even under the No Action (natural spill) alternative, dilution with Red River and other tributary and groundwaters results in predicted TDS and SAR values for Red River water remaining in the C2-S1 and C3-S1 categories at the Halstad, Grand Forks, and Emerson control points.

   Category C4 indicates high salinity water that cannot be used on soils with restricted drainage. Special management is required even with good drainage, and crops with good salt tolerance must be selected. Categories S2 and S3 indicate medium and high sodium waters, respectively. S2 water will present an appreciable sodium hazard in fine textured soils with restricted drainage. High sodium (S3) water can present an appreciable sodium hazard (loss of structure, poor plant-water characteristics) on most soils unless they are gypsiferous (contain high levels of soluble calcium). Soils irrigated with such water will require special management.

3.3. GENERAL COMMENTS ON THE ASSESSMENT OF SOIL SALINIZATION HAZARDS USING WATER QUALITY AND SOILS DATA

The assessment of soil salinization hazards on lands irrigated with mixed Sheyenne River/Devils Lake water is confounded by several factors, including a lack of site-specific chemical and physical soil information that limits the assessment to the information contained in the county soil surveys. Soil map units in county soil surveys are frequently complexes that contain one or more dissimilar soil series that may have different irrigation suitability for irrigation water of a certain quality. Virtually all map units also contain included soils that are present in such small amounts that they cannot be physically be mapped. For this reason, Franzen et al. (1996) recommend that a site specific soil investigation be performed on land proposed for irrigation; however, this is not a requirement and documentation of site specific soil investigations is not included in the irrigation files in either North Dakota or Minnesota.

The analyses that follow account for complexes and inclusions using database and GIS technology. Estimated percentages of component soil series and inclusions that permit a determination of the percentages of components in soil map units are provided in the MUIR and SSURGO databases. To more completely characterize the irrigibility groups for the irrigated soils, soil inclusions were added in the database that resulted in percentage sums for component soils and included soils to 100 percent. However, quantitative data is provided only for major components, not inclusions, and the values provided are broad averages based on representative map units. Such values may not relate well to the soils as distributed on the landscape for any specific area.

The incorporation of inclusions into the dataset more accurately characterizes the whole digitized soil map unit and provides a better, broad-scale representation of soil characteristics important in the assessment of salinization hazards. It is important to understand that specific maps developed or data provided in this report represent estimated values based on available data, and **should not be substituted for a site specific analysis**. The GIS permits an accurate determination of the acreage of digitized polygons. However, if the initial drawings are approximate, the calculated acreage will similarly be approximate, even though exact numbers are provided. Similarly, an on-site investigation of any one of the irrigated soils identified in this report could find soil component series present in different percentages than those listed, or could find them missing entirely.

3.4. IRRIGATION SOIL SALINIZATION HAZARDS ASSOCIATED WITH OUTLET DISCHARGE (300 AND 480 cfs DISCHARGE) AND THE NO ACTION ALTERNATIVE (NATURAL SPILL)

Soil salinization hazards were assessed for lands irrigated with Sheyenne River Water in North Dakota, and with Red River water in North Dakota and Minnesota. Salinization hazards associated with the alternatives were addressed in less detail in a previous report (Downstream Users Report, Barr Engineering, March, 1999). In general, the data on irrigators in North Dakota and Minnesota in this report comports well with the listings of irrigation water-appropriation permittees in the Barr Downstream Users report. However, the Barr report includes several outdated permits that have been cancelled, voided, or incorrectly designated to irrigation use.

3.4.1. Acreage and Location Data by State, River, County, and Applicable Water Quality Control Point

A summary breakdown by state, river, county, permit and water quality control point of location and acreage data for irrigators appropriating irrigation water from the Sheyenne and Red Rivers is in Table 3. Water quality control point data is provided because HEC5Q predictions of the 50 year TDS and SAR water quality data used to assess soil salinization hazards under the Wet7 scenario was provided for these control points by the St. Paul District USACE.

In all, the effects of the alternatives on 86 water appropriation permittees were evaluated, totaling approximately 13,240 acres of irrigated and permitted lands. The majority of the irrigated acreage (48 permits, 9461 acres) involves water appropriations from the Red River: 31 permits for 6266 acres in North Dakota and 17 permits for 3195 acres in Minnesota. All water appropriation from the Sheyenne River is in North Dakota (38 permits, 3779 acres), with the majority of the Sheyenne River appropriations occurring in Ransom County (19 permits, 2945 acres). Counties with significant appropriations of Red River water include Polk County in Minnesota (15 permits, 2663 acres), and Grand Forks (22 permits, 4353 acres) and Walsh (6 permits, 1328 acres) counties in North Dakota.

The majority of the acreage involved in Sheyenne River and Red River water appropriation permits issued for irrigation in North Dakota and Minnesota are for major crop irrigation using center pivot and traveling gun sprinkler irrigators. When considered on an acreage basis, major crop irrigation is by far the most significant use of water appropriated for irrigation. However, permits were issued to 5 golf courses for irrigation of fairways and greens, and several permits were issued for lawn, garden, and vegetable use. The assessment of soil salinization hazards in this report emphasizes irrigation of major crops that form the bulk of the irrigation use acreage. Soil salinization hazards for lawns and turfgrass are similar to those associated with major crop irrigation.

3.4.2. Soils Maps of Irrigated Acreage by Permit

A descriptive legend for the soils is provided by permit number in Appendix B-1. Soil maps including the permit boundary and map units are provided by permit in Appendix B2. The figures in Appendix B2 represent digitized data that will be made available to the St. Paul District USACE.

Data presented in the descriptive legend include:

1. Permit Number
2. State Authority
3. County
4. Applicable water quality control point. Percent exceedances in TDS and SAR for irrigated soils were determined based on water quality data from the nearest control point.
5. Soil Map Unit identifier as seen in the county soil survey.

6. Component soil series, including major components and inclusions as listed in the NRCS databases.
7. Percent map unit composition of all soil series listed in NRCS databases. All sum to 100 percent.
8. Irrigibility group and subgroup from the North Dakota Soil Water Compatibility classification (Franzen et al., 1996).
9. ECmax from the ND classification.
10. TDSmax calculated as EC (umho/cm) * 0.65.
11. SARmax, from the ND classification system.

Acreage of the designated map units were determined by query of the spatial dataset and was combined with attribute data to analyze the distribution of the soils by Irrigibility Subgroup and their associated TDSmax and SARmax.

3.4.3. Irrigated Soils by Irrigibility Group and Subgroup

An acreage breakdown of soils for the entire project area by Irrigibility Group and Subgroup is in Table 4. An examination of specific subgroup characteristics follows. Soils on the entire project area totaled 13240 acres.

3.4.3.1. Project Soils in the Non-Irrigible or Unclassified categories (338 acres)

Non-irrigable soils form a minor percentage of the total irrigated acreage, which is to be expected as the areas considered represent land covered by active irrigation-water appropriation permits. Most of the non-irrigable soils represent realistic estimates of minor non-irrigable included soils that would be commonly found in the listed amount. The majority of the non-irrigated lands were located in permitted acres immediately adjacent to the Red River and the Sheyenne River where the soil surveys indicated (1) the potential for steep land, and (2), saline and sodic soils as inclusions in broad fine-textured map units in the Red River Valley.

Several soil map units in Minnesota had inclusions listed for which there was insufficient information to place into a irrigibility group or subgroup. Most of these soils were listed as miscellaneous land types such as “soils with greater or lesser slopes.” These areas were treated as unclassified in the salinity hazard assessment. Because non-irrigable soils and “unclassified” areas do not have TDSmax and SARmax data provided in the North Dakota Classification, acreages were accounted for; however, unclassified soils are not considered in the hazards analysis.

Soils fell into the following non-irrigable or unclassified categories

1A. Non-irrigable because of slope (38 acres).

1B. Non-irrigable because of sodicity (37 acres, Cavour, Ryan and Miranda soils dominant).

1C. Non-irrigable because of salinity (151 acres; Ojata, Bearden, and Colvin soils dominant).

1A/1D. Non-irrigable because of extremely slow permeability (57) acres.

1E. Non-irrigable because of restrictive subsoil layering (6 acres).

2A. Non-irrigable because of high salts in the subsoil (28 acres; Cresbard soils dominant).

3C. Non-irrigable because of shallow depth to bedrock and lateral seepage hazard. (11 acres)

? Insufficient information to determine subgroup of included soils. (10 acres)

3.4.3.2. Project Soils in the Conditional Category (9785 acres)

The majority of the irrigated soils identified in this report fall into the Conditional categories. A summary of reasons for placement into the conditional category was provided in Section 1.4.1.2 above. A specific discussion regarding acreage in specific subgroups follows. Representative soils comprising the greatest acreage within their subgroup are provided as subgroup examples.

3.4.3.3. Subgroup 2B: Fine-textured, well and moderately drained soils with moderate or slow permeability and high available water capacity (356 acres)

The dominant soils in Subgroup 2B are the Nutley and Sinai soils found adjacent to the Sheyenne River in Barnes County, North Dakota. These soils are classified conditional because of salinity hazard and poor internal drainage. When irrigated with poor quality irrigation water, salts can build up in the soils because it is difficult to leach salts out of fine-textured, slowly permeable soils. Water quality recommendations for soils in subgroup 2B reflect the need for low salinity irrigation water, a maximum allowable EC (ECmax) of no greater than 1000 umhos/cm (TDSmax of 650 mg/l) and a maximum allowable SAR (SARmax) no greater than 6. These waters would fall into the C2-S1 (medium salinity, low sodium) and the less saline end of the C3-S1 (high salinity, low sodium) salinity hazard classification groups. Soil salinity should be monitored periodically when using C3-S1 type irrigation water that is near the ECmax and SARmax. Irrigation scheduling management (Lundstrom and Stegman, 1988) is recommended to maximize crop yields and maintain soil quality.

3.4.3.4. Subgroup 2C: Fine textured soils with poor and very poor drainage and slow, very slow permeability and high available water capacity (952 acres)

The majority of the soils in Subgroup 2C are Fargo, Hegne, and Lindaas soils that occur on fine-textured lacustrine sediments in the Red River Valley in North Dakota and Minnesota. Soils in subgroup 2C are conditional because of a potential salinity hazard, poor internal drainage, and a high watertable. Soils in group 2C frequently require drainage to reduce seasonal wetness and to manage salinity buildup, however, when drained, these soils can be quite productive. Soils in subgroup 2B have irrigation water quality requirements of a maximum allowable EC (ECmax) of no greater than 1000 umho/cm (TDSmax of 650 mg/l) and a maximum allowable SAR (SARmax) no greater than 6, and usually require surface or subsurface drainage. Irrigation scheduling management is recommended to maximize crop yields and maintain soil quality.

3.4.3.5. Subgroup 3A: Medium to moderately fine textured, well drained to moderately well drained soil with moderate to slow permeability and high available water holding capacity (1172 acres)

Soils in group 3A are similar to those in Group 2A but with coarser textures that result in a higher tolerance for irrigation water salinity. The majority of Group 2A soils are Bygland and Overly soils that occur in the Red River Valley. Group 3A soils are conditional due primarily to

the hazard of salt buildup. Group 3A soils have irrigation water quality requirements of an ECmax of no greater than 1500 umhos/cm (980 mg/l TDS) and a maximum allowable SAR no greater than 6.

Salinity of the root zone in Group 3A soils should be monitored every three to five years. Extra water may be required to periodically leach out salts if soil moisture conditions during the fall through early spring do not provide for water movement through the soil. Leaching should be done in the fall or early spring when crop requirements for water are low. The application of 3/4 inches of water in excess of field capacity should pass through the crop root zone.

3.4.3.6. Subgroup 3B: Medium, moderately fine and fine textured, moderately well drained to poorly drained soils with slow to moderately slow permeability and high water holding capacity (5145 acres)

By far the most dominant Irrigibility Subgroup in the dataset, Group 3B soils are rated conditional because of the need for supplemental surface and subsurface drainage, and are found primarily in the Red River Valley adjacent to the Red River and the Sheyenne River in Cass County, North Dakota. Dominant soils in the dataset included the Bearden, Cashel, Wahepeton and Perella series. Soils in subgroup 2B have irrigation water quality requirements of a ECmax of no greater than 1500 umhos/cm (980 mg/l TDS) and a SARmax no greater than 6. Group 3B soils should be monitored for salinity every 3-5 years.

3.4.3.7. Subgroup 3D: Medium and moderately fine textured soils, well drained with soft bedrock at 20 to 40 inches, moderate and moderately slow permeability, and high water holding capacity (519 acres)

These soils are conditional due to slow internal drainage and the hazard of salinity buildup, and are found primarily on till plains above the Sheyenne River in Ransom County, North Dakota. The dominant soils in Subgroup 3D include the Barnes and Svea soil series. Soils in subgroup 2B have irrigation water quality requirements of an ECmax of 1800 umhos/cm (1170 mg/l TDS) and a SARmax of 6. Extra water may be required for leaching if fall through spring precipitation does not provide at least 3/4 inches of water in excess of field capacity passing through the root zone.

3.4.3.8. Subgroup 4B: Medium textured, somewhat poorly drained and poorly drained with moderate permeability and high water holding capacity (1415 acres)

A significant component of the dataset, Group 4B soils are rated conditional because of the need for supplemental surface and subsurface drainage and are primarily Glyndon soils in Grand Forks County, North Dakota. The presence of coarser textures and lower amount of natural salinity result in an elevated ECmax of 2250 umhos/cm (1460 mg/l TDS) which is higher than previous groups. The SARmax is 6.

3.4.3.9. Subgroup 5A: Coarse and moderately coarse textured, well to moderately drained soils with glacial till or lake sediments at 20 to 40 inches, moderately slow permeability and moderate water holding capacity (71 acres)

A minor Irrigibility Subgroup consisting primarily of Towner and Swenoda soils found on sand mantled till adjacent to the Sheyenne River in Ransom County, North Dakota, Subgroup 5A soils are rated conditional due to subsoil stratification restricting drainage. ECmax is 1800 (1170 mg/l TDS) and SARmax is 9. The recommended SARmax is elevated because coarse textures do not have as high of a sodium dispersion hazard. Salinity should be monitored every 3 to 5 years to ensure that salts do not build up within the root zone. Drainage systems may be required for adequate drainage through the crop root zone.

3.4.3.10. Subgroup 6C: Medium textured, somewhat poorly drained and poorly drained soils with coarse sand and gravel at or just below the rooting zone, moderate to moderately rapid permeability and moderate to low water holding capacity (20 acres)

A minor Irrigibility Subgroup consisting primarily of Divide soils found on outwash terraces along the Sheyenne River in Ransom County, North Dakota, Group 6C soils are rated conditional because of rapid water movement and need for supplemental drainage which is required to reduce wetness during the growing season. ECmax is 3000 umho/cm (1950 mg/l TDS) with a SARmax of 6.

3.4.3.11. Subgroup 7B: Medium and moderately coarse textured, somewhat poorly drained and poorly drained soils with moderately rapid permeability and low to moderate water holding capacity (117 acres).

Soils in subgroup 7B consist primarily of Tiffany, Arveson, and Wyndmere soils in deltaic deposits in Ransom County, North Dakota. These soils are rated conditional due to rapid water movement and the need for subsurface drainage. Soils in group 7B are similar to soils in group 7A. Maximum allowable EC is 3000 umho/cm (1950 mg/l TDS), with a SARmax of 12.

3.4.3.12. Subgroup 8B: Coarse textured, somewhat poorly drained and poorly drained soils with rapid permeability and low water holding capacity (17 acres)

An Irrigibility Subgroup found on sandy deltaic deposits along the Sheyenne River in Ransom County, ND. Soils in Subgroup 8B are rated conditional because of the requirement for supplemental drainage. Soils in group 8B have a maximum allowable EC of 3000 umho/cm (1950 mg/l TDS) and a SARmax of 12.

3.4.4. Project Soils in the Irrigible category (3117 acres)

A substantial portion of the soils identified for the project are soils in the irrigated category. A summary of reasons for placement into the irrigated category was provided in Section 1.4.1.3 above. A specific discussion regarding acreage in specific subgroups follows. Representative soils comprising the greatest acreage within their subgroup are provided as subgroup examples.

3.4.4.1. Subgroup 4A: Medium and moderately fine textured, well and moderately well drained soils with moderate permeability and high water holding capacity (2004 acres)

Subgroup 4A forms a significant portion of the irrigable soils in the data set. Dominant soils consist of the Fairdale series found in deep alluvium on low terraces and flood plains adjacent to the Sheyenne River in Ransom County, North Dakota, and Gardena soils mapped adjacent to the Red River in Polk County, Minnesota. These soils show few limitations for irrigation and have an maximum allowable EC of 2250 umhos/cm (1460 mg/l TDS) and a maximum allowable SAR <6.

3.4.4.2. Subgroup 6A: Medium textured, well and moderately well drained soils with coarse sand and gravel at 10 to 20 inches, moderate or moderately rapid permeability, and low water holding capacity (155 acres)

Soils in Subgroup 6A consisted primarily of Renshaw and Brantford soils on outwash terraces adjacent to the Sheyenne River in Ransom County, North Dakota. Coarser textures, good drainage, and low levels of inherent salinity permit the use of poorer quality irrigation water without appreciably lowering crop yields or adversely affecting soil tilth and quality. Maximum allowable EC is 3000 umho/cm (1950 mg/l TDS) with a SARmax of 9.

3.4.4.3. Subgroup 6B: Medium textured, well drained soils with coarse sand and gravel at 20 to 40 inches, moderate or moderately rapid permeability, and moderate or low water holding capacity (232 acres)

Soils consisted primarily of Fordville soils on outwash deposits in Ransom County, ND. Again coarser textures, good drainage, and low levels of inherent salinity permit the use of poorer quality irrigation water without appreciably lowering crop yields or adversely affecting soil tilth and quality. Maximum allowable EC is 3000 umho/cm (1950 mg/l TDS) with a SARmax of 9.

3.4.4.4. Subgroup 7A: Moderately coarse textured, well and moderately well drained soils with moderately rapid permeability and moderate water holding capacity (87 acres).

Soils in subgroup 7A consist primarily of Embden soils in deltaic deposits in Ransom County, North Dakota. Soils in group 7A are similar to soils in group 6B, but are coarser textured and are less susceptible to sodium effects. Such soils do require management to prevent excessive leaching and potential groundwater contamination. Maximum allowable EC is 3000 umho/cm (1950 mg/l TDS), with a SARmax of 12.

3.4.4.5. Subgroup 8A: Moderately coarse and coarse textured, somewhat excessively to moderately well drained soils with rapid permeability and low water holding capacity (417 acres).

Representative soils in subgroup 8A consist primarily of Arvilla, Mattock, Hecla, and Binford soils on outwash terraces in Eddy, Nelson, and Ransom Counties, ND. Some soils may be shallow to gravel. Soils in group 8A may require special management to prevent excessive leaching and potential groundwater contamination. Irrigation scheduling is recommended to

minimize leaching while maintaining adequate moisture for crop needs. Maximum allowable EC is 3000 umho/cm (1950 mg/l TDS), with a SARmax of 12.

3.4.4.6. Subgroup 9A: Coarse textured soils with rapid permeability, low water holding capacity (193 acres)

Typical soils in subgroup 9A consist primarily of Lohnes soil on outwash in Ransom County, ND. Coarse textures and rapid drainage requires frequent irrigation of Group 9A soils. Soils in group 9A may require special management to prevent excessive leaching and potential groundwater contamination. Irrigation scheduling is recommended to minimize leaching while maintaining adequate moisture for crop needs. Maximum allowable EC is 3000 umho/cm (1950 mg/l TDS), with a SARmax of 12.

3.4.4.7. Subgroup 10: Medium to coarse textured, excessively and well drained soils with coarse sand and gravel at less than 10 inches, rapid permeability and very low water holding capacity (30 acres)

The primary soil in subgroup 10 was the Sioux series on outwash in Ransom Eddy, and Barnes Counties, North Dakota. Subgroup 10 soils have similar irrigibility characteristics as those in subgroup 9A. Irrigation scheduling is recommended to minimize leaching while maintaining adequate moisture for crop needs. Maximum allowable EC is 3000 umho/cm (1950 mg/l TDS), with a SARmax of 12.

3.4.5. Results: Acreage Breakdown of Soil Salinization Hazards associated with No Action (Natural Spill) and Constructed Outlet Alternatives

Irrigated acreage summaries by salinity/sodicity hazard group are provided for the entire project as well as by state, river, county and irrigation permit in Appendix B2, Tables B2-1 through B2-4. Table 5 summarizes TDS salinity hazards for the full dataset by state, river and county for all outlet alternatives (all growing season data, 45-year outlet operation). The full dataset combines Sheyenne River baseflow-only periods with periods when Devils Lake and Sheyenne River Water are blended (hereafter cumulatively referred to as "*Baseflow-plus-Blended-Water*"). Table 6 summarizes the portion of the dataset limited to blended Devils Lake and Sheyenne River water (hereafter referred to as "*Blended-Water-Only*"). Tables 7 and 8 summarize in identical fashion SAR sodicity hazards for *Baseflow-plus-Blended-Water* and *Blended-Water-Only* datasets, respectively. The significance of the *Blended-Water-Only* dataset is that it best accounts for the temporarily elevated salinity and sodicity levels associated with intermittent releases of Devils Lake water. Limiting the assessment to *Baseflow-plus-Blended-Water* could "mask" or dilute potential impacts associated with short-term elevated salinity and sodicity levels primarily observed under the No Action (natural spill) alternative.

Figures 6 and 7 provide graphic representations of TDS Salinity Hazards and SAR Sodicity Hazards for the entire project under all outlet alternatives for both the *Baseflow-plus-Blended-Water* and *Blended-Water-Only* datasets. Figures 8 and 9 illustrate in identical fashion TDS Salinity Hazards and SAR Sodicity Hazards for the Sheyenne River only.

In the discussion that follows, the tabulated acreages in the hazard classes do not include acres in the Non-Irrigible or No Group categories (338.6 acres out of 13241 total). Data provided under the No Action (natural spill) alternative does not include the 75 acres for North Dakota Permit Number 2206 that is upstream of the Tolna Coulee and would be unaffected by the natural spill.

(Insert Tables 5 through 8 here)

(Insert Figures 6 through 9 here)

3.4.5.1. Irrigation-Induced Salinity & Sodicity Hazards Under Baseline Conditions

Under baseline conditions, irrigation-induced salinity and sodicity hazards are negligible. Of the 12903 acres of irrigated land along the Sheyenne and Red Rivers, 12815 acres (99.3 percent) fall in the None/Slight salinity hazard class (see Figures 6A and 6B). A total of 87 acres of irrigated land, all on the Sheyenne River, currently would fall in the Low and Moderate salinity hazard classes. None of the irrigated land along either river falls above the None/Slight hazard class for sodicity (see Figures 7A and 7B).

3.4.5.2. Irrigation-Induced Salinity & Sodicity Hazards for Entire Project under 300 cfs Constrained and 480 cfs Unconstrained Outlet Alternatives

Irrigation-induced salinity hazards (TDS) for both the 300 cfs Constrained and the 480 cfs Unconstrained Outlet alternative were found to be low for the entire project (i.e. Sheyenne and Red River irrigation combined). Under each constructed outlet alternative (using either the complete *Baseflow-plus-Blended-Water* or the *Blended-Water-Only* dataset) over 95 percent of the 12903 irrigated acres fell in the None/Slight category for salinity hazards. Under the 300 cfs Constrained Outlet alternative with the *Baseflow-plus-Blended-Water* dataset, 12388, 10, 495 and 10 acres fell in the None/Slight, Low, Moderate, and High salinity hazard classes, respectively (see Figure 6A). Under the 480 cfs Unconstrained Outlet alternative, 12388, 11, 0 and 503 acres fell in the None/Slight, Low, Moderate, and High salinity hazard classes, respectively (see Figure 6A).

Baseflow-plus-Blended-Water and *Blended-Water-Only* datasets yielded virtually identical salinity hazard results for the 300 cfs Constrained Outlet alternative. With the 480 cfs Unconstrained Outlet alternative, use of the *Blended-Water-Only* dataset moved 54 acres from the None/Slight salinity hazard class into the Low and Moderate classes. Irrigation-induced salinity hazards were somewhat lower under the 300 cfs Constrained Outlet alternative versus the 480 cfs Unconstrained Outlet alternative (11, 495, and 9 acres versus 11, 0, and 503 acres in the Low, Moderate and High salinity hazard classes, respectively)(see Figures 6A and 6B).

For both constructed outlet alternatives on an entire project basis, all of the irrigated soil acreage fell in the None/Slight sodicity hazard (SAR). *Baseflow-plus-Blended-Water* and *Blended-Water-Only* datasets yielded identical sodicity hazard results for both constructed outlet alternatives (see Figures 7A and 7B).

These results seem to indicate that, on an entire project basis, TDS and SAR values in irrigation water under both constructed outlet alternatives are higher than baseline conditions but low enough in most areas to permit ongoing irrigation with less intensive management of salinity or sodicity. As discussed in the Mitigation Measures section, irrigators in areas with salinity hazard classes above None/Slight would need to implement appropriate management measures as recommended in Franzen et al. (1996), such as regular monitoring of salinity/sodicity and monitoring of crops. Using the more conservative *Blended-Water-Only* dataset, the total acreage requiring such intensive salinity management would be approximately 515 and 569 acres for the 300 cfs Constrained and 480 cfs Unconstrained Outlet alternatives, respectively.

3.4.5.3. Irrigation-Induced Salinity & Sodicity Hazards for Entire Project under No Action (Natural Spill) Alternative

On an entire project basis (i.e. Sheyenne and Red River irrigation combined), salinity (TDS) hazards were found to be greater under the No Action (natural spill) alternative than either constructed outlet alternative. Using the complete *Baseflow-plus-Blended-Water* dataset for this alternative, 10305, 2375, 147, and 0 acres fell in the None/Slight, Low, Moderate, and High salinity hazard classes, respectively (see Figure 6A). Unlike either of the constructed outlet alternatives, use of the *Blended-Water-Only* dataset yielded higher salinity hazards than with use of *Baseflow-plus-Blended-Water*. Using *Blended-Water-Only*, 10077, 1366, 830 and 554 acres fell within the None/Slight, Low, Moderate and High salinity hazard classes, respectively (see Figure 6B).

One obvious anomaly observed in the salinity data was that, using the entire *Baseflow-plus-Blended-Water* dataset, 503 acres in the High salinity hazard class under the constructed outlet alternatives dropped to zero acres under the No Action (natural spill) alternative (see Figure 6A). Intuitively, the No Action (natural spill) alternative should generate more acres in the High salinity hazard class due to the higher salinity of Stump Lake water versus the West Bay of Devils Lake. The figures mentioned above are an artifact of using *Blended-Plus-Baseflow* water for the No Action (natural spill) alternative, which reflects that Stump Lake discharges would only occur during 23 percent of the growing season, with the remaining portion of the growing season representing base flow conditions only. This anomaly disappears when the *Blended-Water-Only* dataset is used.

The distribution of Sodicity (SAR) hazards for the entire project was similar to that of salinity hazards. Using the complete *Baseflow-plus-Blended-Water* dataset, 10085, 2743, 0, and 0 acres fell in the None/Slight, Low, Moderate, and High sodicity hazard classes, respectively (see Figure 7A). As with salinity, use of the *Blended-Water-Only* dataset yielded higher sodicity hazards than with use of *Baseflow-plus-Blended-Water*. Using *Blended-Water-Only*, 10411, 126, 1841 and 449 acres fell within the None/Slight, Low, Moderate and High sodicity hazard classes, respectively (see Figure 7B).

On an entire project basis, the No Action (natural spill) alternative represents a substantially higher salinity and sodicity hazard than baseline conditions or either constructed outlet alternative. Using the more conservative *Blended-Water-Only* dataset, 2750 of the 12903 irrigated acres along the Sheyenne River and Red Rivers combined (21.3 percent) would fall in the Low, Moderate or High salinity hazard classes. Similarly, using the *Blended-Water-Only*

dataset, 2416 of the 12903 irrigated acres along the Sheyenne River and Red Rivers combined (18.7 percent) would fall in the Low, Moderate or High sodicity hazard classes. In comparison to the 300 cfs Constrained and the 480 Unconstrained Outlet alternatives, salinity hazards for the entire project under the No Action (natural spill) alternative would affect approximately 4.83 and 5.34 times as much irrigated acreage, respectively (i.e. 2750 versus 515 and 569 acres, respectively). On an entire project basis, the No Action (natural spill) alternative would generate new sodicity hazards on 2416 acres that would have a sodicity hazard class of None/Slight under the constructed outlet alternatives.

Notwithstanding the above-described conclusions regarding the project as a whole, several inconsistencies and patterns were found in the HEC5Q Wet 7 dataset that suggested that the Sheyenne and Red Rivers differed substantially in their potential for irrigation-induced salinity and sodicity hazards. This was presumably due to the smaller baseflow of the Sheyenne River alone and the substantial dilution of Sheyenne River water upon its entry into the Red River. To clarify the magnitude of this effect and refine conclusions, salinity and sodicity hazards along the two rivers were analyzed separately.

3.4.5.4. Irrigation-Induced Salinity & Sodicity Hazards on the Red River

Of 12900 irrigated acres evaluated for the entire project (exclusive of the Non-Irrigible or No Group acreage), 9210 acres, or 71 percent lie along the Red River. The potential for irrigation-induced salinity or sodicity hazards on irrigated acreage along the Red River was found to be very low. When Sheyenne River water enters the Red River, salinity and sodicity levels are so reduced by dilution that the outlet alternatives generate few exceedances of TDS and SAR maximums for soils downstream.

With the *Baseflow-plus-Blended-Water* dataset, all irrigated soils examined along the Red River fell in the None/Slight risk category for salinity and sodicity under all outlet alternatives, including the No Action (natural spill) alternative. With the more conservative *Blended-Water-Only* dataset, 53.6 acres irrigated under the 480 cfs Unconstrained Outlet alternative went from the None/Slight to the Low salinity hazard class, and 206.4 acres irrigated under the No Action (natural spill) alternative went from the None/Slight to the Low salinity hazard class (see Table 6).

For the Red River, sodicity hazards were in the None/Slight hazard class for all irrigated acreage along the Red River under all alternatives, regardless of whether the *Baseflow-plus-Blended-Water* or *Blended-Water-Only* dataset was used (see Tables 7 and 8).

Based on the foregoing analysis, soil salinization and sodification hazards do not appear to represent a significant concern for irrigators appropriating water from the Red River under any of the outlet alternatives. Low salinity hazards were indicated on only 53.6 acres under the 480 cfs Unconstrained Outlet alternative and 206.4 acres under the No Action (natural spill) alternative. However, saline and sodic inclusions are indicated in several soil map units along the Red River in the Lake Agassiz Basin. Soils are relatively fine textured, with low permeability and frequently high watertables (e.g. Irrigibility Subgroups 3A, 3B, 2C). Under these conditions, intensive irrigation management is indicated for irrigation along the Red River as a matter of course.

3.4.5.5. Irrigation-Induced Salinity & Sodicity Hazards on the Sheyenne River

Of 12902 irrigated acres evaluated for the entire project (exclusive of the Non-Irrigible or No Group acreage), 3695 acres (29 percent) lie along the Sheyenne River. Both salinity (TDS) and sodicity hazards were found to be substantially greater on the Sheyenne than the Red River. Using the more conservative *Blended-Water-Only* dataset, both constructed outlet alternatives would increase salinity hazards over baseline conditions on approximately 428 acres along the Sheyenne River (see Figure 8B). Salinity and sodicity hazards of the constructed outlet alternatives were similar, although the 480 cfs Unconstrained Outlet alternative had a somewhat higher salinity hazard than the 300 cfs Constrained Outlet alternative. On the Sheyenne River, the No Action (natural spill) alternative would generate much more significant salinity and sodicity hazards than baseline conditions or either constructed outlet alternative (Figures 8 and 9).

3.4.5.5.1. Irrigation-Induced Salinity & Sodicity Hazards on the Sheyenne River under 300 cfs Constrained and 480 cfs Unconstrained Outlet Alternatives

Using the complete *Baseflow-plus-Blended-Water* dataset for the Sheyenne River only, the 300 cfs Constrained Outlet alternative would result in 3180, 11, 495, and 9 acres falling in the None/Slight, Low, Moderate, and High salinity hazard classes, respectively (see Figure 8A). The 480 cfs Unconstrained Outlet alternative with the *Baseflow-plus-Blended-Water* dataset would generate slightly higher salinity hazards, with 3181, 10, 495 and 10 acres falling in the None/Slight, Low, Moderate, and High salinity hazard classes, respectively (see Figure 8A). Thus, all of the Moderate salinity hazard acreage under the 300 cfs Constrained Outlet alternative (495 acres) would move into the High salinity hazard class under the 480 cfs Unconstrained Outlet alternative. The *Blended-Water-Only* dataset generates virtually identical salinity hazard results for the Sheyenne River under both constructed outlet alternatives (see Figures 8A and 8B).

Neither constructed outlet alternative represents a sodicity hazard for irrigated lands along the Sheyenne River. As under baseline conditions, all 3695 irrigated acres along the Sheyenne River fall in the None/Slight sodicity hazard class under either constructed outlet alternative, regardless of whether the *Baseflow-plus-Blended-Water* or *Blended-Water-Only* dataset is used (see Figures 9A and 9B).

Based on the foregoing analysis, soil salinization and sodification hazards appear to be a concern for irrigators appropriating water from the Sheyenne River under the constructed outlet alternatives. Under either of these alternatives, approximately 515 acres of irrigated land would have salinity hazard classifications ranging from Low to High. This represents an increase of 428 acres from the 87 acres in these hazard classes under baseline conditions. The magnitude of the salinity hazard under these alternatives appears to be low enough that it appears to be mitigable (see Mitigation section below). Sodicity hazards are the same as under baseline conditions and do not appear to be a significant concern under either of the constructed outlet alternatives.

3.4.5.5.2. Irrigation-Induced Salinity & Sodicity Hazards on the Sheyenne River under No Action (Natural Spill) Alternative

Using the complete *Baseflow-plus-Blended-Water* dataset for the Sheyenne River only, the No Action (natural spill) alternative would result in 1098, 2375, 147 and 0 acres falling into the None/Slight, Low, Moderate and High salinity hazard classes, respectively (see Figure 8A). This represents a substantially higher salinity hazard than the baseline condition or either constructed outlet alternative. Use of the *Blended-Water-Only* dataset yielded even higher salinity hazards, with 1077, 1159, 830 and 554 acres falling in the None/Slight, Low, Moderate and High salinity hazard classes, respectively (see Figure 8B).

The No Action (natural spill) alternative also appears to represent a much higher sodicity hazard than either of the constructed outlet alternatives. Using the complete *Baseflow-plus-Blended-Water* dataset for the Sheyenne River only, the No Action (natural spill) alternative would result in 1241, 2378, 0 and 0 acres falling into the None/Slight, Low, Moderate and High sodicity hazard classes, respectively (see Figure 9A). Use of the *Blended-Water-Only* dataset yielded even higher sodicity hazards, with 1185, 126, 1860 and 449 acres falling in the None/Slight, Low, Moderate and High sodicity hazard classes, respectively (see Figure 9B).

The No Action (natural spill) alternative appears to represent a significant salinity and sodicity hazard for irrigated lands along the Sheyenne River. Using the more conservative *Blended-Water-Only* dataset, 2543 of the 3695 irrigated acres along the Sheyenne River (68.8 percent) would fall in the Low, Moderate or High salinity hazard classes. Similarly, using the *Blended-Water-Only* dataset, 2435 of the 3695 irrigated acres along the Sheyenne River (65.9 percent) would fall in the Low, Moderate or High sodicity hazard classes. Accordingly, under this alternative, intensive salinity and sodicity management would be needed on the majority of the irrigated land along the Sheyenne River and a portion of that acreage may be rendered non-irrigable.

3.4.6. Mitigation

The data on TDS/SAR relationships discussed above indicate that irrigators along the Red River will experience few problems with soil salinity or sodicity under the 300 cfs Constrained, the 480 cfs Unconstrained, or the No Action (natural spill) alternatives. Under the constructed outlet alternatives, exacerbated salinity and sodicity problems would be expected upstream of the confluence of the Red and Sheyenne Rivers. Salinity and sodicity of the blended Sheyenne/Devils Lake water will be higher in the Sheyenne versus the Red River due to less dilution and closer proximity to the point of insertion. Irrigators forced to use low quality water under the No Action (Natural Spill) alternative, could experience serious problems along the Sheyenne River.

Accordingly, wise management of irrigation is an important mitigation measure if additional salinization and sodafication is to be prevented under the outlet alternatives.

Important considerations include:

1. Irrigation as practiced in North Dakota is supplemental irrigation. In other words, irrigation is applied to augment natural precipitation under dry conditions. Continuous irrigation is not usually needed in the subhumid climate in North Dakota. During wet periods irrigation is infrequent.

2. If no leaching occurs, salt will build up in the soil in direct proportion to the amount and salinity/sodicity of the applied irrigation water. Thus it is usually necessary to leach or drain irrigated soils. Natural leaching will occur in medium and coarse textured soils that are moderately to well or excessively drained; however, somewhat poorly drained to poorly drained soils and slowly permeable soils can have salinity/sodicity problems unless artificially drained.

The following discussion presents procedures to assess initial soil salinity/sodicity conditions prior to outlet operation, monitor soil salinity/sodicity conditions during outlet operation, and mitigate for irrigated soils that are affected by salinity or sodicity under the outlet alternatives.

3.4.6.1. Monitor TDS Contents and SAR levels in the Sheyenne River

Irrigators appropriating Sheyenne River water must know the current TDS and SAR status of the river water when they desire to irrigate. It is recommended that chemical monitoring stations be set up at appropriate locations to monitor water quality on a periodic basis (no less than weekly monitoring during the growing season). Irrigators should have quick access to the data, either through phone or internet access.

3.4.6.2. Initial Assessment of Applicable Soil Characteristics of Irrigated Soils

Mitigation measures are based on a detailed knowledge of the irrigated soils, especially focusing on texture, drainage class, and existing, in-situ salinity/sodicity. Under any alternative, it is necessary that the impacted irrigators have a detailed soil assessment performed to assess these parameters. Field assessments of soils for the purposes of establishing soil irrigibility are usually needed at a level that is more detailed than that found in the county soil survey. Most irrigators have such an assessment performed prior to application for an appropriation permit. A professional Soil Scientist licensed to practice in the States of North Dakota and Minnesota can perform such assessments.

3.4.6.3. Regular Soil Testing and Crop Monitoring

Regular routine soil tests should be performed on irrigated lands potentially salinized by surface water irrigation under the outlet alternatives. This would include at a minimum the measurement of soil EC and SAR. These tests are recommended for all irrigators in order to ensure that salts do not become a problem in irrigated fields. EC and SAR tests on representative and problem areas could be augmented with analyses for saturation-extract soluble ions including tests for calcium, magnesium, sodium, potassium, alkalinity, chloride and sulfate. Franzen et al. (1996) recommend such testing for several listed irrigability groups that have potential salinity/sodicity problems resulting from high water tables and slow permeability.

An alternative would be periodic testing using an electromagnetic conductivity meter. While the availability of this instrument is limited its use is becoming more common. It does have the advantage of performing quick, relatively accurate measurements on several field locations in a short time, and should become the preferred method for assessing soil salinity in the future.

3.4.6.4. Leaching

Assuming that adequate drainage can be provided, methods to determine the amount of additional water required to maintain desirable salinity levels in the root zone have been developed and are in common use. The leaching requirement is defined as the fraction of irrigation water that must be leached through the root zone to control soil salinity at any specified level. The formula to determine the leaching requirement is:

$$Diw = \left(\frac{ECdw}{ECdw - ECiw} \right) Dcw \qquad \text{Equation 3}$$

Where Diw is the depth of irrigation water required, Dcw is the depth of drainage water, and ECdw and ECiw are the electrical conductivity of the drainage water and the irrigation water respectively. The salt tolerance of the crop is taken into account in the selection of ECdw values. If monitoring indicates that salts are building up in the soil due to insufficient leaching, the leaching requirement equation can be used in conjunction with EC data for the Sheyenne River to determine the amount of water required to leach salts into the subsoil. Obviously, the application of leaching to reduce root zone salinity is most effective in well drained situations. Leaching combined with drainage (if not already present) may be required in somewhat poorly, poorly, and very poorly drained soils that are affected by salt buildup in the rooting zone due to irrigation with poor quality water.

If testing and crop response indicate the need for leaching, it is most efficient to apply the irrigation water during fall after the crop has been removed. A fall application minimizes crop consumptive use and maximizes the efficiency of the leaching application. Leaching is extensively discussed in Richards (1954).

3.4.6.5. Drainage

Many soils in areas currently irrigated with Sheyenne and Red River water are listed in Franzen et al. (1996) as “Conditional” due to a need for artificial drainage (e.g. subgroups 2C, 3B, 4B, 7B, and 8B). Several of the soils comprising these groups have naturally high levels of salt because of a high water table. The presence of a high water table also limits the ability of water to leach to sufficient depths to reduce salinity in the rooting zone.

Irrigators currently using Sheyenne River water as supplemental irrigation of soils in the groups listed above may not have artificial drainage systems installed. If soil salinization occurs under the alternatives because of irrigation with low quality Sheyenne/Devils Lake water on undrained soils with a high water table, drainage may be necessary to prevent salinization and/or reclaim the affected soils. Artificial drainage is an expensive option. However, when combined with irrigation, artificial drainage provides the best control over salinization. There may be issues with disposal of the drained water, especially if the drainage water is saline. Several drainage options are available, with subsurface tile or perforated pipe drainage being the most effective with center pivot sprinkler irrigation. Drainage for irrigation is extensively covered in Richards (1954).

3.4.6.6. Irrigation Scheduling

Often the need for artificial drainage may be reduced or avoided altogether by the efficient management of irrigation water that is based on a detailed knowledge of soils conditions, local weather and climate, and specific crop needs. Franzen et al. (1996) recommend the Irrigation Scheduling Checkbook Method (Lundstrom and Stegman, January 1988). The method requires the irrigator to measure or obtain from local sources the maximum daily air temperatures. Crop water use can then be estimated from tables in Lundstrom and Stegman (1988). Water use is then tabulated on a soil moisture balance sheet to determine the soil moisture deficit. Irrigation is started at a crop and soil dependent predetermined moisture deficit value. Crop water use adds to the deficit while irrigation and rainfall reduces the deficit.

The irrigation Scheduling Checkbook method or a similar substitute is not required for irrigation in North Dakota or Minnesota. However, it maximizes efficient irrigation use and would minimize or prevent excessive irrigation, and thus would minimize soil salinization hazards under the outlet alternatives. In areas where low quality water is used to irrigate soils susceptible to salinization, it is essential that the checkbook method be combined with periodic salinity monitoring to evaluate the effects of irrigation on soil salinization.

The scheduling checkbook method is efficient and inexpensive; however, it requires daily input by the irrigator and periodic checks of field moisture and crop conditions combined with climatic data. The climatic data is available from North Dakota State University's North Dakota Automated Weather Network (NDAWN) via the NDSU Extension Network for a small annual fee.

3.4.6.7. Planting of Salt Tolerant Crops

Most growers in North Dakota are well acquainted with the effects of soil salinity on crop yields. Many North Dakota soils contain inclusions that are naturally saline. Under conditions of extensive salinity, growers can plant salt tolerant crops that provide good economic yields under conditions where soil salinity is high.

Several researchers have investigated the effects of salinity on crop yields. Extensive lists of crop salt tolerances exist in the literature and will not be reviewed here. Much unpublished research performed during the 1980s by Alex Maianu at North Dakota State University on the salt tolerance of common North Dakota crops is available through the NDSU Department of Soil Science. Other sources include Richards (1954), the Agricultural Research Service's United States Salinity Laboratory Staff and various State Universities and State Agricultural Extension offices in the Northern Plains States where salinity is a factor in crop production.

In general, most common crops in North Dakota are tolerant to root-zone salinity of up to 4 mmho/cm EC (4000 umho/cm or an approximate TDS value of 2600 mg/l). Above 4 mmho/cm crop yields decline, some faster than others. Potatoes are less salt tolerant while sunflowers are more tolerant. Wheat and soybeans maintain high yields up to 6-8 mmho/cm EC (see Seelig and Richardson, 1991).

Similarly, research exists on the relative salinity tolerance of turfgrasses. Harivandi (1991) ranked turfgrass salinity tolerance by soil EC (dS/m) and reported that most grasses are tolerant of soil salinity in the range of 3 to 6 dS/m (1950 to 3900 mg/l TDS). Harivandi et al. (1992) also

reported that turfgrasses are relatively sodium tolerant, indicating that SAR values of 3 to 9 would suggest a slight to moderate restriction on water use depending upon soil conditions. The inability to grow good turfgrass in soils containing high levels of sodium generally results not from direct sodium toxicity but instead from the negative impact that sodium has on the soil. A brief review of the data on turfgrass suggest that grasses respond to salinity similarly to a variety of agricultural crops. Recommendations for both should be similar regarding maintenance of salinity and sodicity levels by appropriate monitoring and management of soils irrigated to supplement natural precipitation.

Irrigators using mixed Sheyenne River/Devils Lake waters for irrigation under any of the outlet alternatives are strongly advised to consult with NDSU Extension Service representatives prior to choosing the planting of salt tolerant crops as mitigation for perceived salinity/sodicity problems.

3.4.6.8. Mitigation of Sodicity Hazards

The data suggest that sodicity hazards are secondary to salinity hazards under the constructed outlet alternatives. However, sodicity could be a serious problem under the No Action (natural spill) alternative especially due to the increased sodium load associated with releases of water from Stump Lake. Irrigators upstream of the natural confluence would be unaffected; however, downstream users along the Sheyenne would have to deal with water that may periodically have unacceptable levels of both salinity and sodicity. As with salinity, sodicity is a familiar hazard to growers in North Dakota. Saline and sodic soil inclusions are relatively common along the Sheyenne River (e.g. Ryan soils), the Red River Valley (e.g. Ryan soils in the Fargo-Ryan Association), and in till areas immediately above the Sheyenne River Valley (e.g. Cresbard Soils).

Sodium affects soil structure by breaking apart soil colloids resulting in a soil that is dispersed and "puddled" when wet and hard and massive when dry. One indicator of sodium-affected soils is the presence of large, massive soil clods in recently plowed fields. Poor plant-water relationships and poor crop root penetration result from the effects of excessive sodium in soils. Less water and nutrients are available for plant growth. Sodicity problems are reduced in coarse textured soils, soils high in soil organic matter, and soils that contain naturally high levels of the calcium-containing salts Calcium Carbonate (calcite or "lime") and gypsum.

Mitigation for the effects of sodicity involves the application of calcium-containing salts. The soluble calcium in these salts replace the more weakly held ("exchangeable") sodium ions that are adsorbed to soil particle surfaces. Various calcium amendments are available to counter the effects of sodium on affected soils, including calcium sulfate (gypsum), calcium chloride, and various other calcium sulfate salts; however, gypsum is usually not recommended for use on sodium affected soil in North Dakota (Dr. J.L. Richardson, Person. Comm.). Elemental sulfur may be used to convert naturally occurring calcium carbonate to calcium sulfate . The kind and amount of chemical amendment to be used depends upon the soil characteristics, the desired rate of replacement, and economic considerations. A list of potential chemical amendments and procedures for determining application rates is provided in Richards (1954). Further information specific to mitigating sodium problems in North Dakota irrigated soils is in Franzen et al. (October 1988). Soil inspection and analysis by a qualified, licensed soil science professional is recommended before any calcium amendments are applied to fields with sodicity problems. The

development of site-specific sodification management measures can be developed in conjunction with salinity management measures.

3.4.6.9. Cease Irrigation

Irrigation as practiced in North Dakota augments and does not replace precipitation sources. Thus the scheduling of irrigation is dependent upon short-term precipitation and crop needs. There are periods under the 480 cfs Unconstrained and the No Action (natural spill) alternative where elevated SAR and TDS values may preclude irrigation for extended periods depending upon actual as opposed to predicted conditions. For example, irrigation water quality is an issue for approximately 23 percent of the planning period (growing season basis) under the No Action (natural spill) alternative, and for 69 percent of the 480 cfs Unconstrained Outlet alternative. These percentages were calculated as percent of time Devils Lake dye tracers were listed as present in the Wet7 Climatic scenario trimmed to include only the May 1 through September 30 growing season for the period of outlet operation.

The water quality data for the No Action (natural spill) alternative, Wet7 scenario indicate that TDS and SAR values in the Sheyenne River can exceed recommended limits for extended periods during which Stump lake outflow is occurring. Based on the Wet7 climatic scenario data, such periods could occur for years at a stretch, with the exact length of time depending upon the climatic variations. Irrigation under these conditions may not be recommended due to potential soil salinization hazards. If extended periods where elevated TDS and SAR values preclude irrigation occur simultaneously with localized or regional drought conditions, crop yields and failure could result if water quality considerations render irrigation untenable.

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Figures

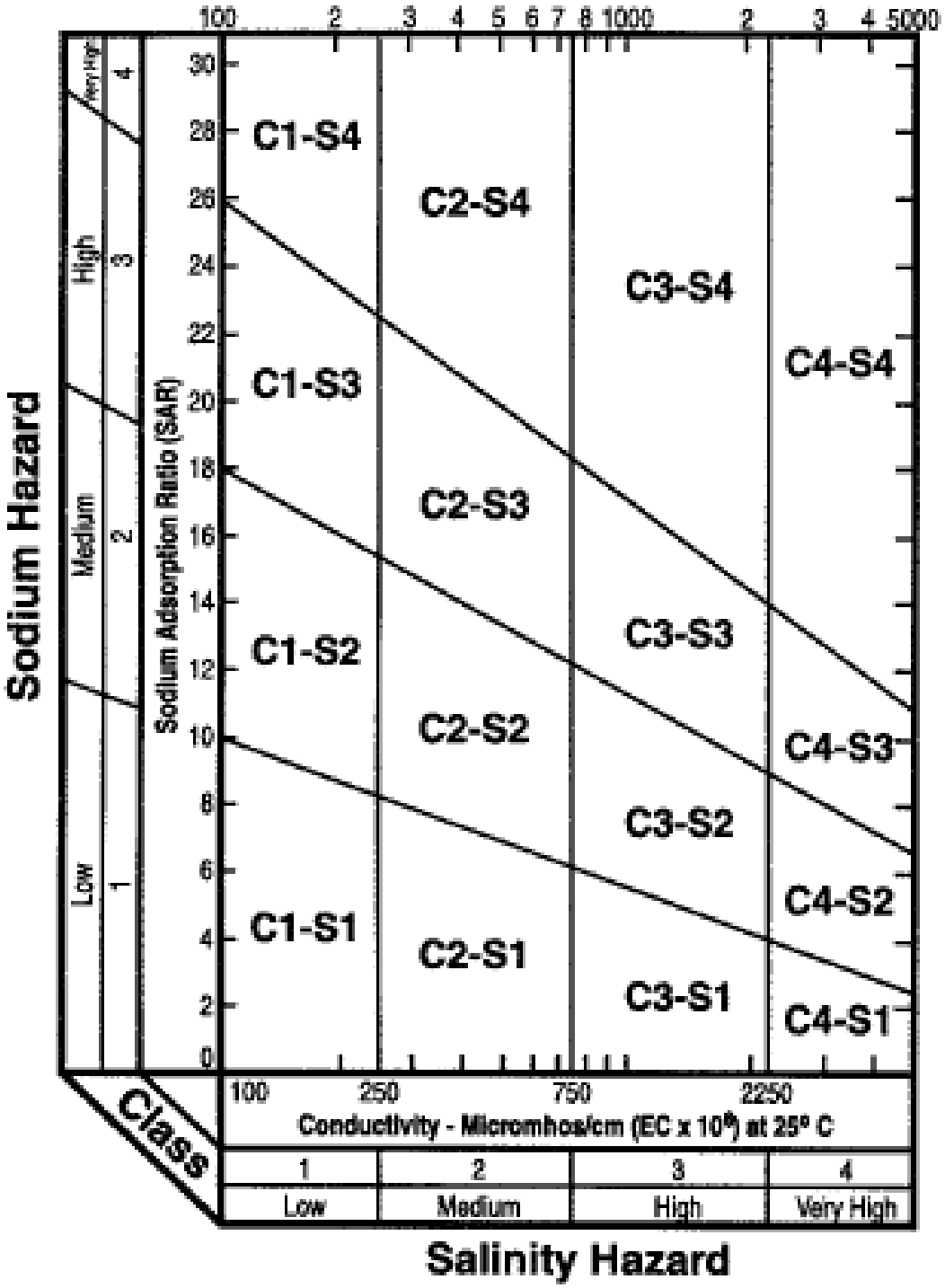
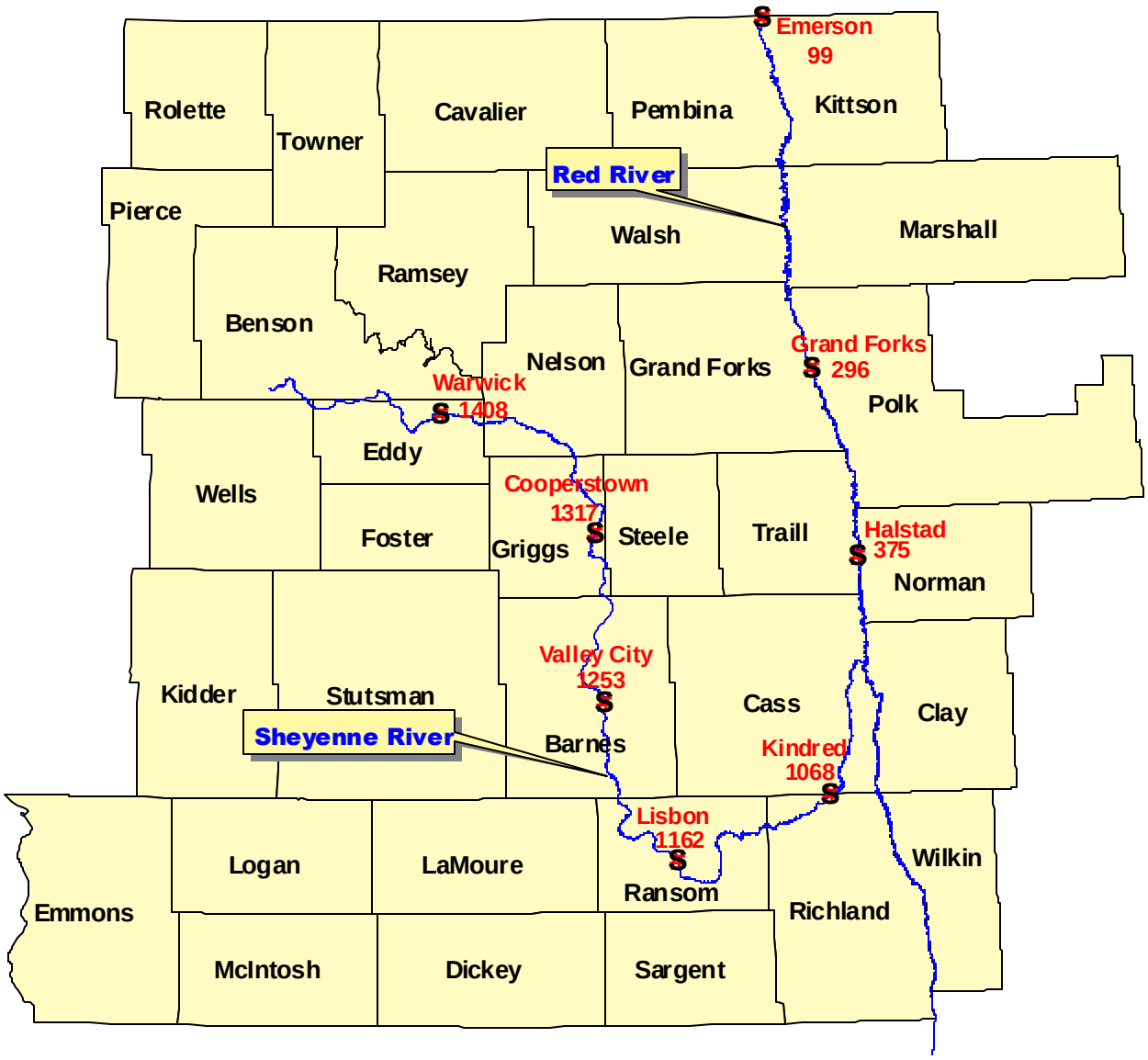


Figure 1. Classification of irrigation water (from Agriculture Handbook No. 60, USDA Salinity Laboratory, Riverside, CA).



Location of control points used in the assessment of irrigation salinity/sodicity hazards under the outlet alternatives. HEC5Q water quality predictions datasets were provided by the St. Paul District USACE for each control point.

Irrigation Control Points

Devils Lake Salinity Study, Irrigation Soil Salinization
Minnesota and North Dakota

N

FIGURE 2

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026

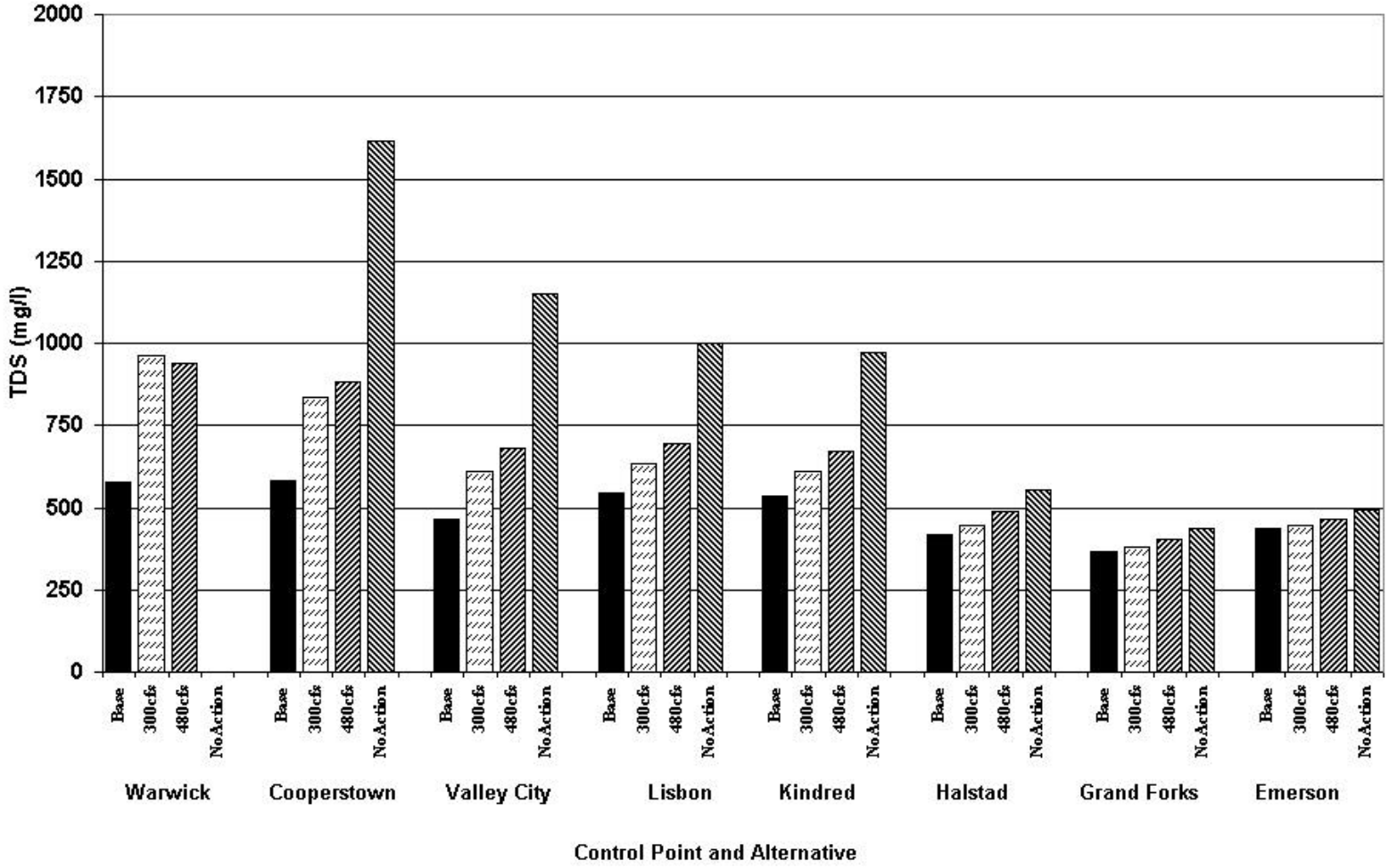


Figure 3. Mean TDS values for *Base Conditions* and *Blended-Water-Only* by outlet alternative and control point. Base conditions include all samples. Outlet alternatives were restricted to the Blended Water Only dataset (baseflow conditions removed). A detailed discussion of *Base Conditions*, *Blended-Water-Only*, and *Baseflow-plus-Blended-Water* designations for Sheyenne River water used in this report is in Section 2.1.1.1

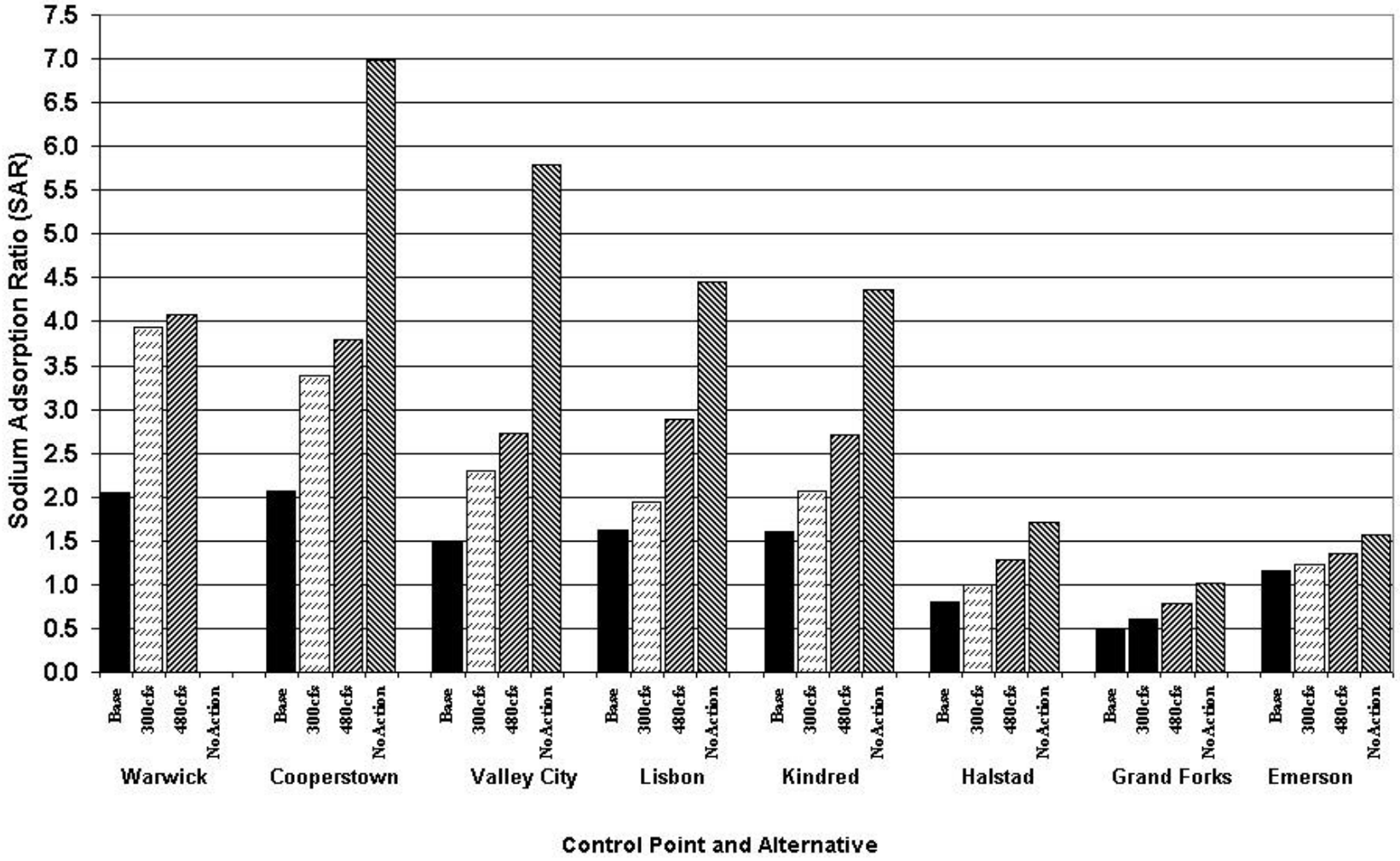
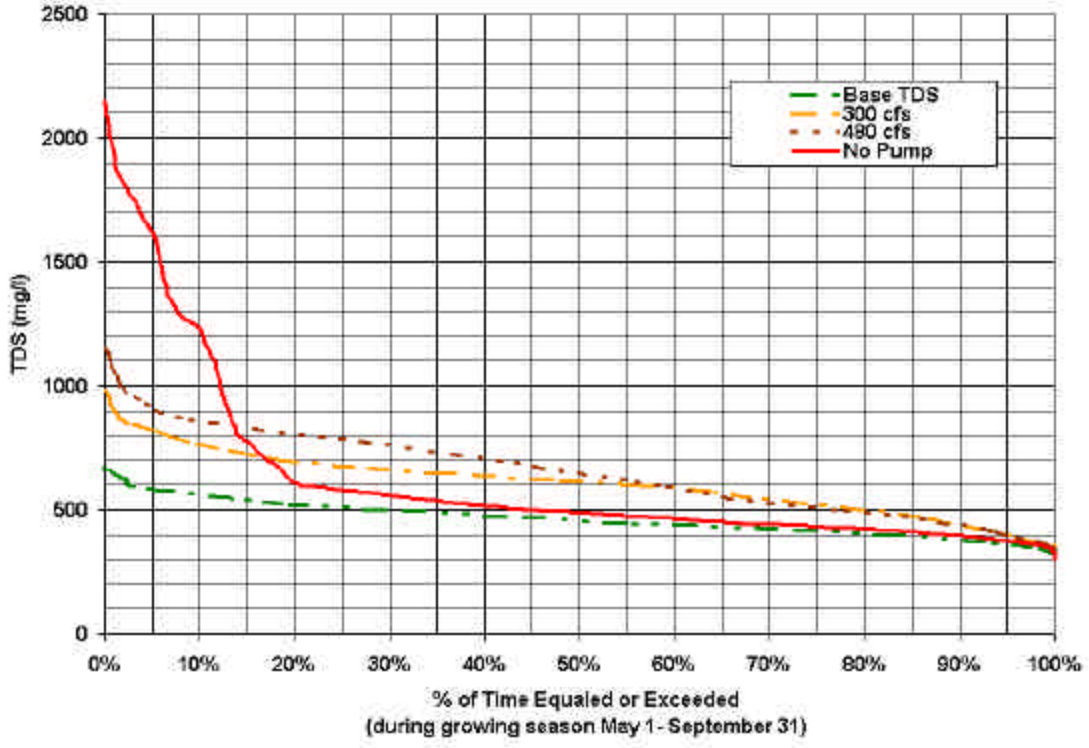
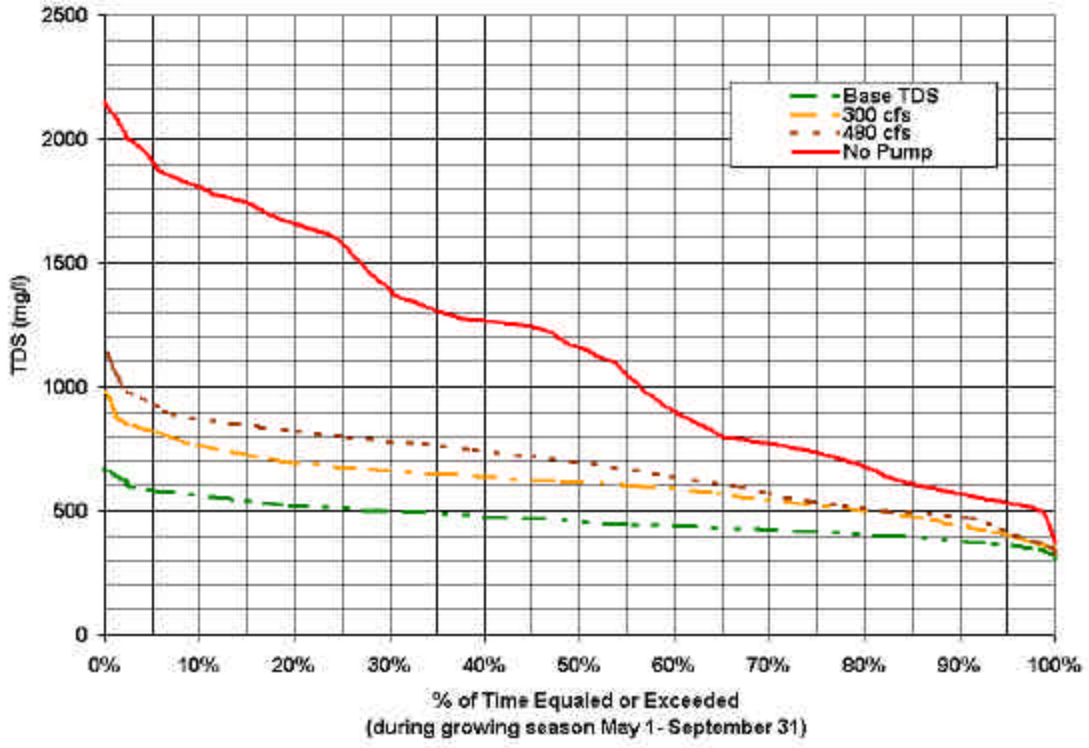


Figure 4. Mean SAR values for *Base Conditions* and *Blended Water Only* by outlet alternative and control point. *Base Conditions* include all samples. Outlet alternatives were restricted to the Blended Water Only dataset (Baseflow conditions removed).



(A)



(B)

Figure 5. TDS percent exceedance graphs for the Valley City control point. (A) was developed from the entire growing season datase. (B) Alternatives 300 cfs, 480 cfs, and No Pump were developed from a dataset restricted to blended water only. Note that a TDS of 1000 for the No Pump alternative would yield a percent exceedance of 56% in (B), but only 12% in (A). The difference is that the No Pump condition produces blended water for only 23% of the plan period.

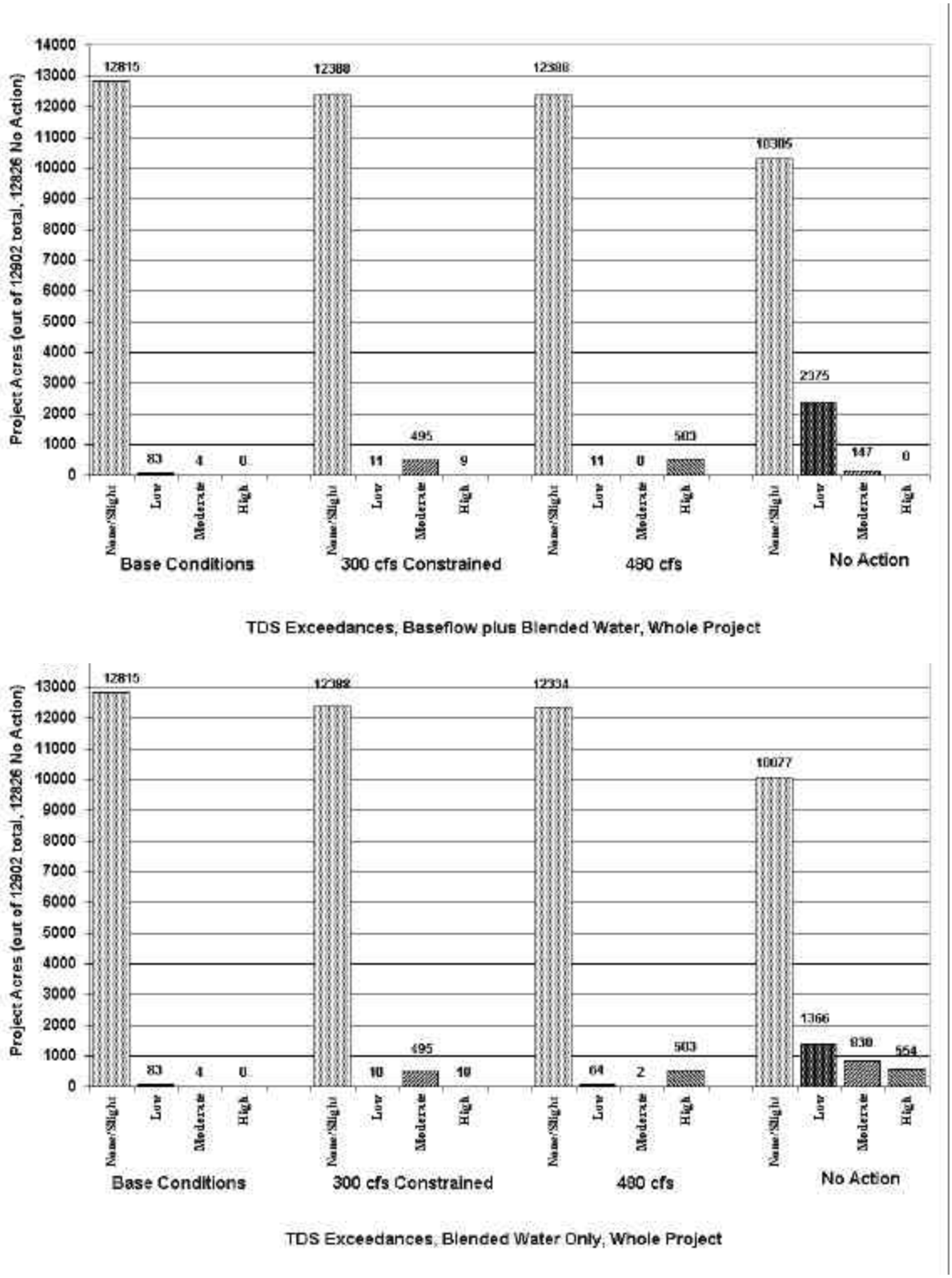
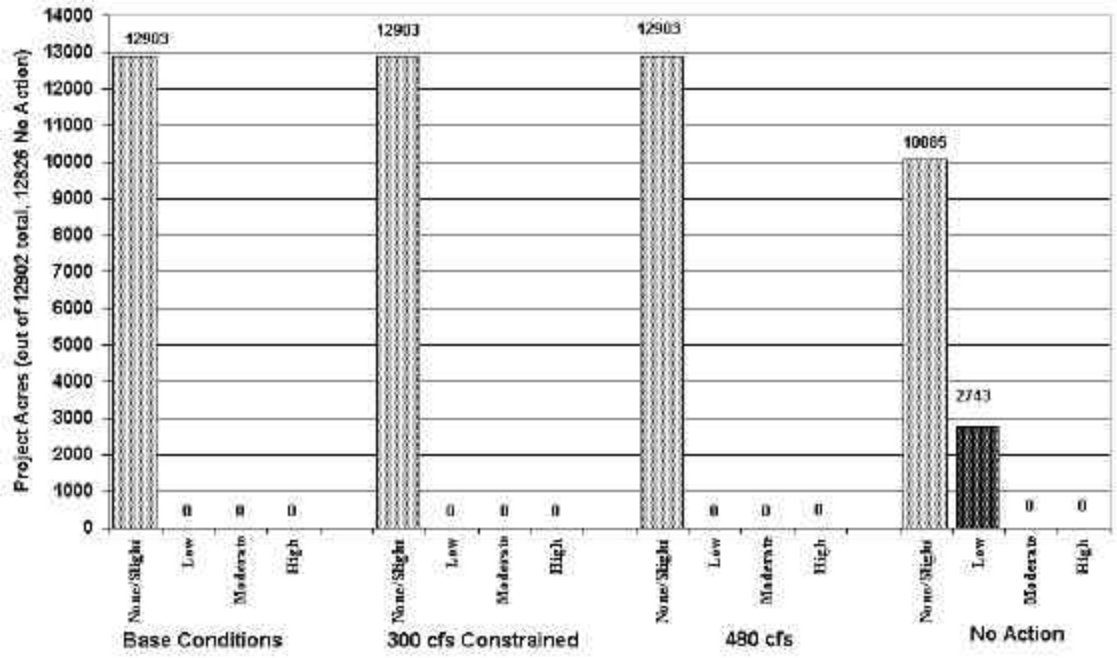
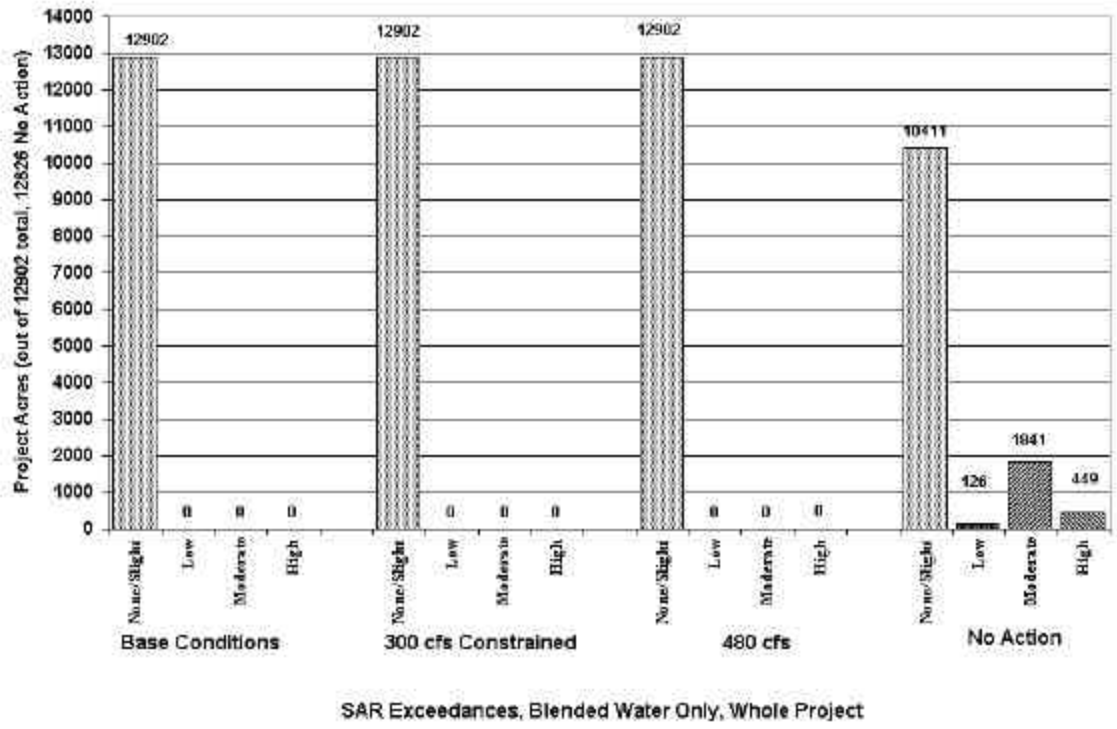


Figure 6. Full project acres by TDS hazard class and alternative including irrigated acreage assessed along the Red and Sheyenne Rivers in North Dakota and Minnesota. Graph (A) was developed from percent exceedance tables developed for the entire water quality dataset including TDS values for *Baseflow-plus-Blended-Water*. Graph (B) uses TDS values for *Blended-Only-Water* as discussed in Section 2.1.1.1. Note increase in severity associated with the No Action alternative between (A) and (B).

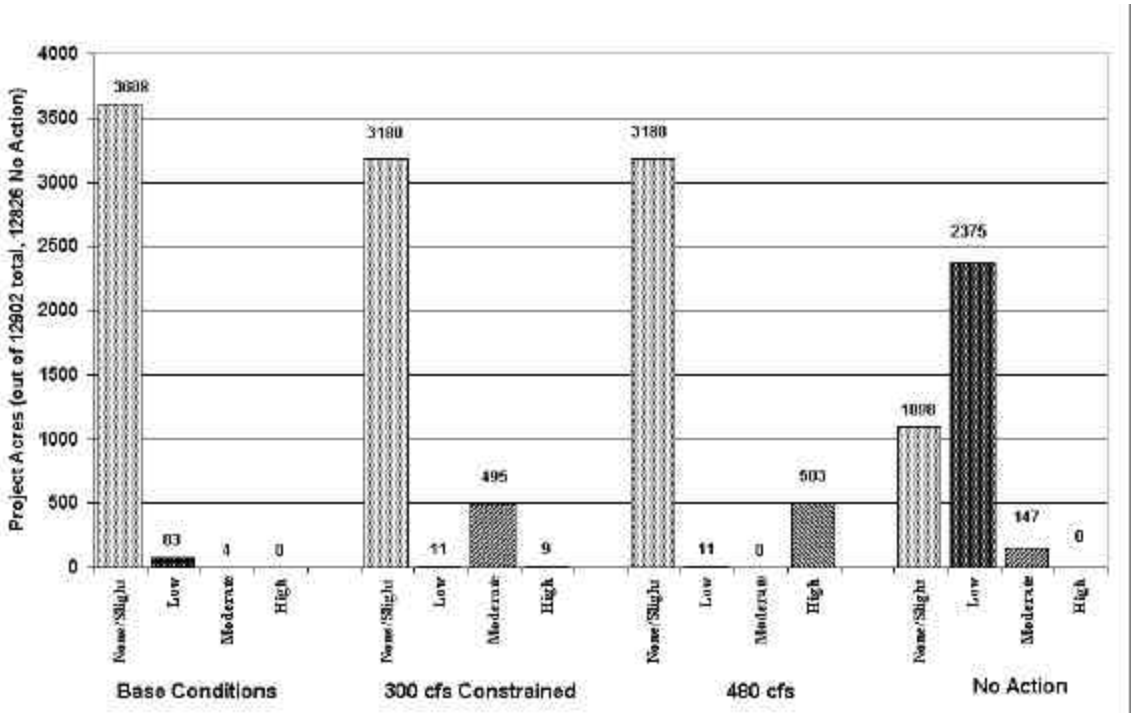


(A)

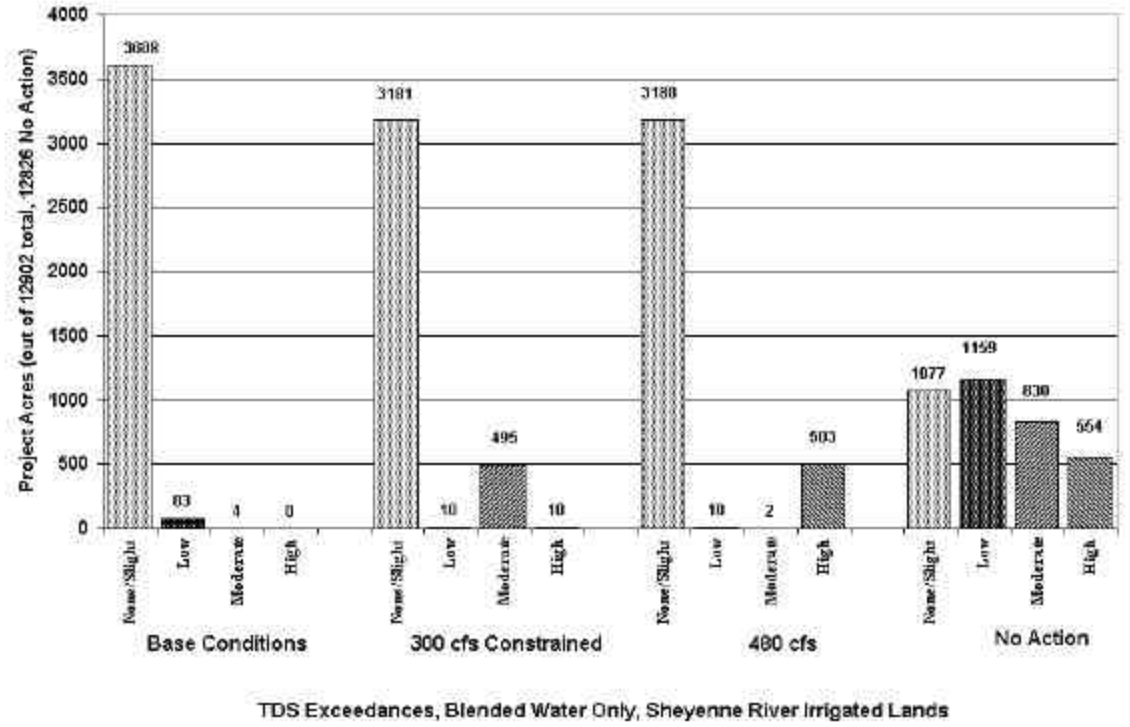


(B)

Figure 7. Full project acres by SAR hazard class and alternative including irrigated acreage assessed along the Red and Sheyenne Rivers in North Dakota and Minnesota. Graph (A) was developed from percent exceedance tables developed for the entire growing-season HEC5Q water quality dataset including SAR values for *Baseflow-plus-Blended-Water*. Graph (B) was developed from percent exceedance tables for the growing season but using SAR values for *Blended-Water-Only* as discussed in Section 2.1.1.1. Note increase in severity associated with the No Action alternative between (A) and (B).

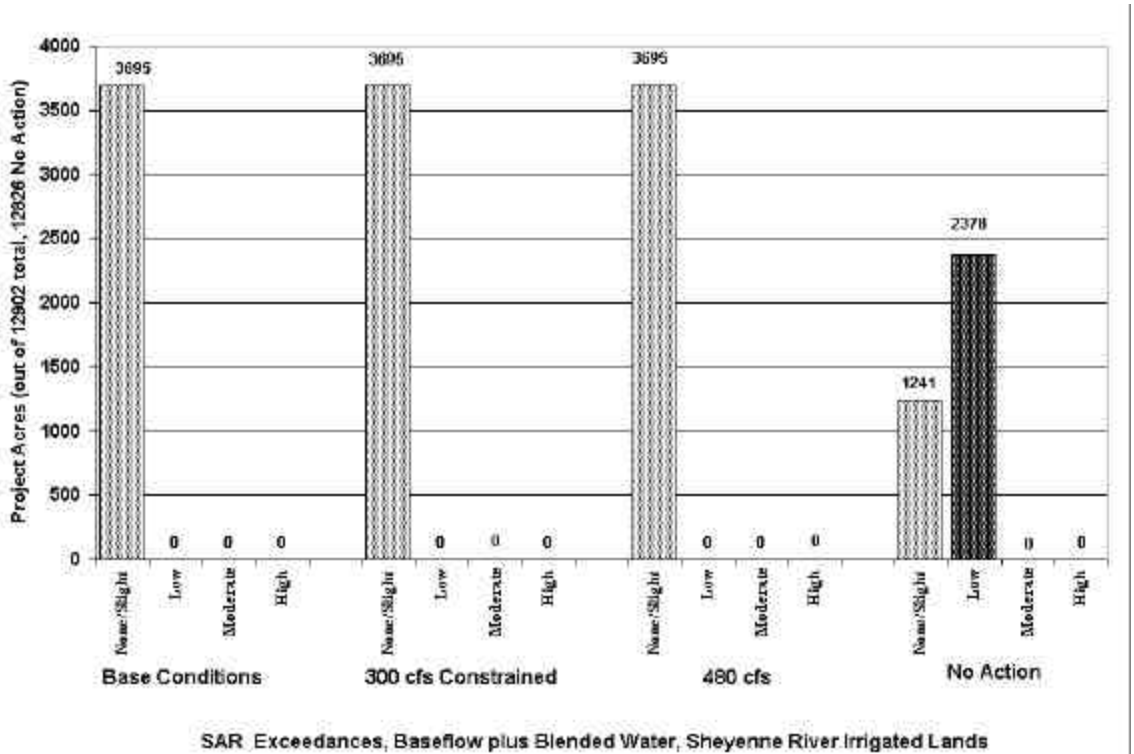


(A)

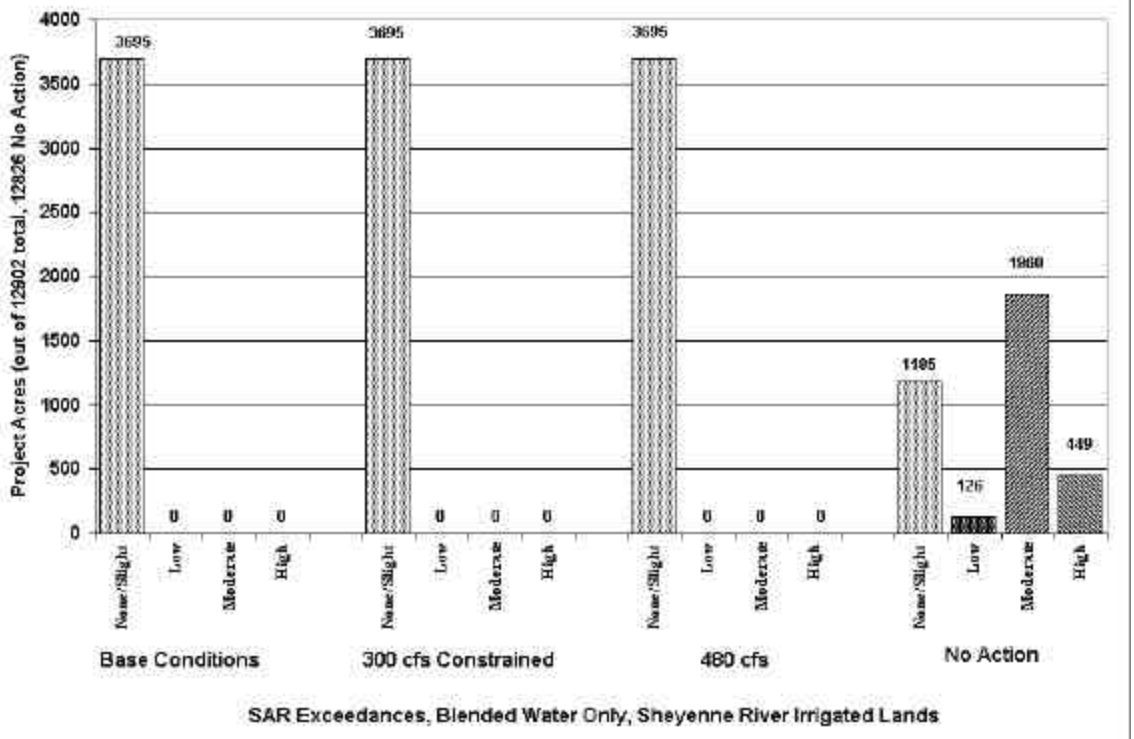


(B)

Figure 8. Irrigated acres along the Sheyenne River by TDS hazard class and alternative. Graph (A) was developed from percent exceedance tables developed for the entire growing-season HEC5Q water quality dataset including TDS values for *Baseflow-plus-Blended Water*. Graph (B) was developed using TDS values for *Blended-Water-Only* water as discussed in Section 2.1.1.1. Note increase in severity associated with the No Action alternative between (A) and (B), and the greater hazard associated with Sheyenne River water when compared to the full project.



(A)



(B)

Figure 9. Irrigated acres along the Sheyenne River by SAR hazard class and alternative. Graph (A) was developed from percent exceedance tables developed for the entire growing-season HEC5Q water quality dataset including SAR values for *Baseflow-plus-Blended Water*. Graph (B) was developed using SAR values for *Blended-Water-Only* as discussed in Section 2.1.1.1. Note increase in severity associated with the No Action alternative between (A) and (B), and the greater hazard associated with Sheyenne River water when compared to the full project.

Tables

Table 1. Selected distribution statistics for HEC5Q predicted TDS values, Wet7 climatic scenario dataset. All data represent predicted daily TDS values for the growing season extending from May 1 through September 30 for each year beginning with outlet operation May 1, 2005 and extending through September 30, 2050. Values for the 300 cfs Constrained (300) , the 480 cfs Unconstrained, (400) and the No Action (NoPump) alternatives are further restricted to *Blended Water Only*. Baseflow values (Base) include the entire *Baseflow-plus-Blended-Water* dataset.

Control Point	Alternative	Mean	Median	Standard Deviation	Minimum	Maximum	Count
Warwick	Base	579	570	123	244	1067	7038
	300	964	1004	146	269	1237	7010
	480	938	938	150	253	1279	4786
	NoPump	Upstream of Natural Spill					
Cooperstown	Base	584	595	74	296	894	7038
	300	836	862	135	347	1094	6937
	480	884	898	157	296	1270	4779
	NoPump	1616	1581	607	410	2886	1611
Valley City	Base	467	463	68	314	653	7038
	300	610	620	120	328	967	7017
	480	681	697	162	329	1150	5944
	NoPump	1149	1158	465	387	2147	1519
Lisbon	Base	543	527	102	314	816	7038
	300	632	638	121	328	966	7012
	480	697	716	146	328	1143	5853
	NoPump	1002	808	414	467	2028	1929
Kindred	Base	537	534	82	287	737	7038
	300	610	622	103	304	904	7009
	480	673	687	138	301	1109	5756
	NoPump	972	869	379	389	1894	1708
Halstad	Base	416	406	40	331	664	7038
	300	445	432	58	332	692	6802
	480	489	472	88	337	844	5343
	NoPump	553	505	141	354	1111	1716
Grand Forks	Base	365	363	28	291	499	7038
	300	381	376	32	293	506	6632
	480	405	397	46	294	615	5251
	NoPump	437	418	76	294	667	1611
Emerson	Base	435	426	54	317	703	7038
	300	447	439	56	324	724	6023
	480	464	461	59	324	720	5241
	NoPump	492	476	80	339	752	1579

Table 2. Selected distribution statistics for HEC5Q predicted SAR values, Wet7 climatic scenario dataset. All data represent predicted daily SAR values for the growing season extending from May 1 through September 30 for each year beginning with outlet operation May 1, 2005 and extending through September 30, 2050. Values for the 300 cfs Constrained (300) , the 480 cfs Unconstrained, (400) and the No Action (NoPump) alternatives are further restricted to the *Blended-Water-Only* dataset. Baseflow values (Base) include the entire *Baseflow-plus-Blended-Water* dataset.

Control Point	Alternative	Mean	Median	Standard Deviation	Minimum	Maximum	Count
Warwick	Base	2.06	2.05	0.219	1.34	2.8	7038
	300	3.95	4.08	0.526	1.41	4.6	7010
	480	4.08	4.20	0.563	1.46	5.0	4786
	NoPump	Upstream of Natural Spill					
Cooperstown	Base	2.07	2.10	0.134	1.48	2.6	7038
	300	3.38	3.44	0.613	1.60	4.5	6937
	480	3.79	3.92	0.646	1.48	5.0	4779
	NoPump	6.98	7.25	2.449	1.79	11.0	1611
Valley City	Base	1.50	1.50	0.108	1.23	1.8	7038
	300	2.30	2.29	0.496	1.33	3.8	7017
	480	2.72	2.86	0.782	1.33	4.6	5944
	NoPump	5.78	6.03	2.112	1.69	9.8	1519
Lisbon	Base	1.62	1.60	0.150	1.23	2.0	7038
	300	1.95	1.91	0.344	1.26	3.3	7012
	480	2.89	2.87	0.878	1.29	4.8	5853
	NoPump	4.46	4.13	2.242	1.37	9.2	1929
Kindred	Base	1.61	1.61	0.123	1.18	1.9	7038
	300	2.07	2.00	0.386	1.27	3.3	7009
	480	2.71	2.67	0.831	1.01	4.5	5756
	NoPump	4.37	4.24	1.934	1.37	8.5	1708
Halstad	Base	0.81	0.80	0.039	0.72	1.0	7038
	300	0.99	0.91	0.223	0.73	2.1	6802
	480	1.27	1.12	0.458	0.74	3.2	5343
	NoPump	1.71	1.48	0.815	0.75	4.6	1716
Grand Forks	Base	0.50	0.50	0.019	0.45	0.6	7038
	300	0.61	0.57	0.114	0.46	1.4	6632
	480	0.78	0.70	0.257	0.46	2.0	5251
	NoPump	1.02	0.87	0.476	0.47	2.6	1611
Emerson	Base	1.16	1.15	0.071	1.00	1.5	7038
	300	1.24	1.22	0.108	1.02	1.7	6023
	480	1.35	1.31	0.191	1.03	2.3	5241
	NoPump	1.57	1.45	0.380	1.03	2.8	1579

Table 3. Location and acreage* data for irrigators appropriating Sheyenne and Red River water for use in agricultural irrigation.

State	River	County	Permit Number	Acres	Section(s)	Township North	Range East	Applicable Water Quality Control Point
North Dakota (69 permits,10 045 acres)								
	Red River (31 permits, 6266 acres)							
		Grand Forks (22 permits, 4353 acres)						
			01305P	96	14	151	50	296
			1046	294	13,24	154	51	296
			1048	87	1	154	51	296
			1081	193	36	151	50	296
			4001	299	4	149	49	296
			4143	387	13	150	50	296
			4332	135	29	150	49	296
			4348	175	7,12	150	49,50	296
			4380	13	12	150	50	296
			4385	138	23	151	50	296
			4434	60	11	154	51	296
			4435	176	2	154	51	296
			4670	823	13	150	50	296
			4685	372	13	150	50	296
			4693	233	13	150	50	296
			4740	80	25	154	51	296
			4773	145	16	149	49	296
			4774	168	21	149	49	296
			4873	297	21	149	49	296
			4887	163	13	150	50	296
			4899	10	26	151	50	296
			617C	9	21	152	50	296
		Pembina (1, 250)						
			4403	250	25	159	51	99
		Traill (2, 335)						
			4328	201	36	148	49	375
			4364	134	36	148	49	375
		Walsh (6, 1328)						
			4190	136	12	158	51	99
			4282	129	26	158	51	99
			4325	396	13,24	158	51	99
			4335	130	25	158	51	99
			4689	253	25,30	155	51,50	296
			4736	284	24	155	51	296
	Sheyenne (38, 3779)							
		Barnes (9, 417)						
			00507B	3	33	140	58	1253
			1573	5	4	139	58	1253

Table 3. Continued.

State	River	County	Permit Number	Acres	Section(s)	Township North	Range East	Applicable Water Quality Control Point
			1976	172	27,34	139	58	1253
			1976A	102	28	139	58	1253
			2198	7	8,9	140	58	1253
			240	10	28,29	140	58	1253
			592	62	22	140	58	1253
			629	43	28	140	58	1253
			653A	13	16	140	58	1253
		Cass (7, 136)						
			1089	22	31	140	49	1068
			2358	7	7	138	49	1068
			3779	24	17	139	49	1068
			4189	36	18	140	49	1068
			4210	22	33	141	49	1068
			5115	21	29	139	49	1068
			515	4	20	139	49	1068
		Eddy (1, 75)						
			2206	75	30	150	63	1408
		Nelson (2, 206)						
			1889	31	27	150	61	1317
			4999	175	34	150	60	1317
		Ransom (19, 2945)						
			1227	49	2	134	56	1162
			1241	339	17,20	135	54	1162
			2011	138	30,31	135	56	1162
			2296	77	19	135	56	1162
			2411	366	16	135	54	1162
			2424C	93	21	134	54	1162
			2710	550	9	135	54	1162
			3605	305	17	135	53	1162
			3606	141	10	135	54	1162
			3614	129	35	134	55	1162
			3715	90	20	135	54	1162
			3756	59	32	135	54	1162
			397	1	1	134	56	1162
			4650	41	17	135	53	1162
			4747	115	10	135	54	1162
			4780	105	13	135	54	1162
			641	2	2	134	56	1162
			698	200	20	135	54	1162
			757	143	17	135	54	1162
Minnesota (17, 3195)								
	Red River (17, 3196)							
		Marshall (2, 532)						
			540072	225	32	155	50	296

Table 3. Continued.

State	River	County	Permit Number	Acres	Section(s)	Township North	Range East	Applicable Water Quality Control Point
			921218	307	7	154	50	296
		Polk (15, 2663)						
			734244	189	24	151	50	296
			811094	369	16,22	153	50	296
			881268	314	10	152	50	296
			901041	133	22	149	49	296
			901098	140	23,26	148	49	375
			901108	222	29	150	49	296
			901134	91	27	152	50	296
			901158	70	25	147	49	375
			901333	439	24	148	49	375
			911251	152	36	149	49	296
			911276	70	26	147	49	375
			921200	141	36	148	49	375
			931177	116	7	154	50	296
			941144	117	35	149	49	296
			951080	101	15	152	50	296

* Note acres tabulated may not exactly represent acreage in permit due to the practice of rotational irrigation and minor errors in digitizing locations when exact locations were indicated. Minnesota permit applications frequently indicated approximate areas to be irrigated. In these instances, the approximated area was digitized.

Table 4. Acreage breakdown for project area by Irrigibility Group and Subgroup. A detailed breakdown by soil and permit is in Appendix B1, Table B1. Irrigibility groups and recommended maximum EC and SAR values are from Compatibility of North Dakota Soils for Irrigation (Franzen et al., 1996). TDSmax value was calculated as (0.65)EC per recommendations in Richards et al., 1954; and Barr Engineering, 1999.

Irrigibility Group	Irrigibility Subgroup	Acres	Characteristics	ECMax umho/cm	TDSMax Mg/l	SARmax
?	?	10.2	Insufficient Information to determine subgroup	0	0	0
C	2B	356.0	Fine textured well and moderately drained with moderately or slow permeability and high available water capacity. Classified conditional because of salinity hazard and poor internal drainage	1000	650	6
C	2C	951.7	Fine textured soils with poor and very poor drainage and slow, very slow permeability and high available water holding capacity.	1000	650	6
C	3A	1172.1	Medium textured to moderately fine textured. Well drained to moderately well drained with moderately slow permeability and high available water holding capacity. Conditional due to the hazard of salt buildup.	1500	975	6
C	3B	5144.9	Medium, moderately fine and fine textured, moderately well drained to poorly drained soils with slow to moderately slow permeability and high water holding capacity. Conditional because of the need for supplemental surface and subsurface drainage.	1500	975	6
C	3D	519.4	Medium and moderately fine textured soils, well drained with soft bedrock at 20 to 40 inches, moderate and moderately slow permeability, and high water holding capacity. These soils are conditional due to slow internal drainage and the hazard of salinity	1800	1170	6
C	4B	1415.3	Medium textured, somewhat poorly drained and poorly drained with moderate permeability and high water holding capacity. Conditional because of the need for supplemental surface and subsurface drainage.	2250	1460	6
C	5A	71.3	Coarse and moderately coarse textured, well to moderately drained soils with glacial till or lake sediments at 20 to 40 inches, moderately slow permeability and moderate water holding capacity. Conditional due to restricted drainage because of subsoil stratification.	1800	1170	9

Table 4, Continued.

Irrigibility Group	Irrigibility Subgroup	Acres	Characteristics	ECMax umho/cm	TDSMax Mg/l	SARmax
C	6C	20.3	Medium textured, somewhat poorly drained and poorly drained soils with coarse sand and gravel at or just below the rooting zone, moderate to moderately rapid permeability and moderate to low water holding capacity. Conditional because of rapid water movement and need for supplemental drainage.	3000	1950	6
C	7B	116.8	Medium and moderately coarse textured, somewhat poorly drained and poorly drained soils with moderately rapid permeability and low to moderate water holding capacity. Conditional because of need for supplemental drainage.	3000	1950	12
C	8B	17.6	Coarse textured, somewhat poorly drained and poorly drained soils with rapid permeability and low water holding capacity. Conditional because of the requirement for supplemental drainage.	3000	1950	12
I	10	29.8	Medium to coarse textured, excessively and well drained soils with coarse sand and gravel or porcelainite (scoria) at less than 10 inches, rapid permeability and very low water holding capacity.	3000	1950	12
I	4A	2004.3	Medium and moderately fine textured, well and moderately well drained soils with moderate permeability and high water holding capacity.	2250	1460	6
I	6A	155.0	Medium textured, well and moderately well drained soils with coarse sand and gravel at 10 to 20 inches, moderate or moderately rapid permeability, low water holding capacity.	3000	1950	9
I	6B	232.0	Medium textured, well drained soils with coarse sand and gravel at 20 to 40 inches, moderate or moderately rapid permeability, and moderate or low water holding capacity.	3000	1950	9
I	7A	86.5	Moderately coarse textured, well and moderately well drained soils with moderately rapid permeability, moderate water holding capacity.	3000	1950	12
I	8A	416.9	Moderately coarse and coarse textured, somewhat excessively to moderately well drained soils. Rapid permeability and low water holding capacity. Some shallow gravel.	3000	1950	12
I	9A	3.5	Coarse textured soils with rapid permeability, low water holding capacity	3000	1950	12
I	9A	189.1	Coarse textured soils with rapid permeability, low water holding capacity.	3000	1950	12
N	1A	38.1	Non-irrigable because of slope	0	0	0
N	1B	36.5	Non-irrigable because of sodicity	0	0	0

Table 4, Continued.

Irrigibility Group	Irrigibility Subgroup	Acres	Characteristics	ECMax umho/cm	TDSMax Mg/l	SARmax
N	1C	150.5	Non-irrigable because of salinity	0	0	0
N	1D	57.1	Non-irrigible because of extremely slow permeability	0	0	0
N	1E	6.4	Non-irrigable because of restrictive subsoil layering	0	0	0
N	2A	28.3	Non-irrigable because of high salts in the subsoil	0	0	0
N	3C	11.4	Non-irrigable because of shallow depth to bedrock and lateral seepage hazard	0	0	0

Table 5. Acreage breakdown by hazard category for TDS irrigation water quality data, Wet7 climatic scenario, using *Baseflow-plus-Blended Water* data. Numbers represent the categorical acreage summation of percentage exceedances by irrigation subgroup TDSmax.

State	River	County	Permit Number	Non-Irrigible or No Group	Acreage Breakdown by Hazard Category (percentage of time TDS Maximums were exceeded during the project period, May 1, 2005 - September 30, 2050).															
				-Acres-	Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
Minnesota Counties																				
	Red River																			
		Marshall Total		7.0	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-
		Polk Total		98.4	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-
North Dakota Counties																				
	Red River																			
		Grand Forks Total		149.0	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-
		Pembina Total		-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-
		Traill Total		-	334.8	-	-	-	334.8	-	-	-	334.8	-	-	-	334.8	-	-	-
		Walsh Total		-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-
	Sheyenne River																			
		Barnes Total		17.7	399.5	-	-	-	47.0	-	352.5	-	47.0	-	-	352.5	3.3	396.2	-	-
		Cass Total		9.4	47.6	78.5	-	-	47.6	-	78.5	-	47.6	-	-	78.5	20.6	27.0	78.5	-
		Eddy Total		-	71.5	-	3.7	-	69.9	0.1	-	5.2	69.9	1.6	-	3.7	Upstream of Tolna Coulee			
		Nelson Total		45.8	155.6	4.7	-	-	145.8	10.8	-	3.7	145.8	9.8	-	4.7		155.6	4.7	-
		Ransom Total		11.3	2933.7	-	-	-	2870.1	-	63.6	-	2870.1	-	-	63.6	1073.7	1796.5	63.6	-
Summary Totals by River																				
	Red Total (MN)			105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
	Red Total (ND)			149.1	6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	
	Red Total			254.6	9207.4	-	-	-	9207.4	-	-	-	9207.4	-	-	-	9207.4	-	-	-
	Sheyenne Total (ND)			84.1	3608.0	83.2	3.7	-	3180.4	10.9	494.7	8.9	3180.4	11.4	-	503.0	1097.6	2375.3	146.8	-
Summary Totals Totals by State																				
	ND Total			233.2	9725.6	83.2	3.7	-	9298.0	10.9	494.7	8.9	9298.0	11.4	-	503.0	7215.2	2375.3	146.8	-
	MN Total			105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
Grand Total				338.6	12815.4	83.2	3.7	0.0	12387.8	10.9	494.7	8.9	12387.8	11.4	0.0	503.0	10305.0	2375.3	146.8	0.0
Project Totals								13240.9				13240.9				13240.9				13165.7

Table 6. Acreage breakdown by hazard category for TDS irrigation water quality data, Wet7 climatic scenario, using *Blended-Water-Only* data. Numbers represent the categorical acreage summation of percentage exceedances by Irrigation Subgroup TDSmax

State	River	County	Permit Number	Non-Irrigible or No Group	Acreage Breakdown by Hazard Category (percentage of time TDS Maximums were exceeded during the project period, May 1, 2005 - September 30, 2050).															
				-Acres-	Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
Minnesota Counties																				
	Red River																			
		Marshall Total		7.0	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-
		Polk Total		98.4	2565.2	-	-	-	2565.2	-	-	-	2514.5	50.7	-	-	2514.5	50.7	-	-
North Dakota Counties																				
	Red River																			
		Grand Forks Total		149.0	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-
		Pembina Total		-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-	247.2	3.0	-	-
		Traill Total		-	334.8				334.8	-	-	-	331.8	2.9	-	-	331.8	2.9	-	-
		Walsh Total		-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-	1178.7	149.7	-	-
	Sheyenne River																			
		Barnes Total		17.7	399.5	-	-	-	47.0	-	352.5	-	47.0	-	-	352.5	3.3	-	36.3	359.9
		Cass Total		9.4	47.6	78.5	-	-	47.6	-	78.5	-	47.6	-	-	78.5	-	20.6	27.0	78.5
		Eddy Total		-	71.5	-	3.7	-	70.0	-	-	5.2	69.9	0.1	1.6	3.7	Upstream of Tolna Coulee			
		Nelson Total		45.8	155.6	4.7			145.8	9.8	-	4.7	145.8	9.8	-	4.7		106.9	1.7	51.7
		Ransom Total		11.3	2933.7	-	-	-	2870.1	-	63.6	-	2870.1	-	-	63.6	1073.7	1031.6	764.9	63.6
Summary Totals Totals by River																				
	Red Total (MN)			105.5	3089.8	-	-	-	3089.8	-	-	-	3039.1	50.7	-	-	3039.1	50.7	-	-
	Red Total (ND)			149.1	6117.6	-	-	-	6117.6	-	-	-	6114.7	2.9	-	-	5961.9	155.7	-	-
	Red Total			254.6	9207.4	-	-	-	9207.4	-	-	-	9153.7	53.6	-	-	9001.0	206.4	-	-
	Sheyenne Total (ND)			84.1	3608.0	83.2	3.7	-	3180.5	9.8	494.7	9.9	3180.4	9.9	1.6	503.0	1076.9	1159.1	829.9	553.7
Summary Totals Totals by State																				
	ND Total			233.2	9725.6	83.2	3.7	-	9298.1	9.8	494.7	9.9	9295.1	12.8	1.6	503.0	7038.9	1314.7	829.9	553.7
	MN Total			105.5	3089.8	-	-	-	3089.8				3039.1	50.7	-	-	3039.1	50.7	-	-
Grand Total				338.5	12815.4	83.2	3.7	0.0	12387.9	9.8	494.7	9.9	12334.1	63.6	1.6	503.0	10077.9	1365.5	829.9	553.7
Project Totals								13240.8				13240.8				13240.8				13165.6

Table 7. Acreage breakdown by hazard category for SAR irrigation water quality data, WET7 climatic scenario, using *Baseflow-plus-Blended-Water* data. Numbers represent the categorical acreage summation of percentage exceedances by Irrigation Subgroup SARmax.

State	River	County	Permit Number	Non-Irrigible or No Group	Acreage Breakdown by Hazard Category (percentage of time SAR Maximums were exceeded during the project period, May 1, 2005 - September 30, 2050).															
				-Acres-	Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
Minnesota Counties																				
	Red River																			
		Marshall Total		7.0	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-
		Polk Total		98.4	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-
North Dakota Counties																				
	Red River																			
		Grand Forks Total		149.0	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-
		Pembina Total		-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-
		Traill Total		-	334.8	-	-	-	334.8	-	-	-	334.8	-	-	-	334.8	-	-	-
		Walsh Total		-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-
	Sheyenne River																			
		Barnes Total		17.7	399.5	-	-	-	399.5	-	-	-	399.5	-	-	-	2.9	396.7	-	-
		Cass Total		9.4	126.2	-	-	-	126.2	-	-	-	126.2	-	-	-	-	126.2	-	-
		Eddy Total		-	75.2	-	-	-	75.2	-	-	-	75.2	-	-	-	Upstream of Tolna Coulee			
		Nelson Total		45.8	160.3	-	-	-	160.3	-	-	-	160.3	-	-	-	56.4	104.0	-	-
		Ransom Total		11.3	2933.7	-	-	-	2933.7	-	-	-	2933.7	-	-	-	1182.0	1751.7	-	-
Summary Totals Totals by River																				
	Red Total (MN)			105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
	Red Total (ND)			149.1	6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-
	Red Total			254.6	9207.4	-	-	-	9207.4	-	-	-	9207.4	-	-	-	9207.4	-	-	-
	Sheyenne Total (ND)			84.1	3694.9	-	-	-	3694.9	-	-	-	3694.9	-	-	-	1182.0	1751.7	-	-
Summary Totals Totals by State																				
	ND Total			233.2	9812.5	-	-	-	9812.5	-	-	-	9812.5	-	-	-	6994.8	2742.5	-	-
	MN Total			105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
Grand Total				338.5	12902.3	0.0	0.0	0.0	12902.3	0.0	0.0	0.0	12902.3	0.0	0.0	0.0	10448.6	2378.5	0.0	0.0
Project Totals								13240.8				13240.8				13240.8				13165.6

Table 8. Acreage breakdown by hazard category for SAR irrigation water quality data, Wet7 climatic scenario, using *Blended-Water-Only* data. Numbers represent the categorical acreage summation of percentage exceedances by Irrigation Subgroup SARmax.

State	River	County	Permit Number	Non-Irrigible or No Group	Acreage Breakdown by Hazard Category (percentage of time SAR Maximums were exceeded during the project period, May 1, 2005 - September 30, 2050).															
				-Acres-	Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High	Non/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
Minnesota Counties																				
	Red River																			
		Marshall Total		7.0	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-
		Polk Total		98.4	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-
North Dakota Counties																				
	Red River																			
		Grand Forks Total		149.0	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-
		Pembina Total		-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-
		Traill Total		-	334.8				334.8	-	-	-	334.8	-	-	-	334.8	-	-	-
		Walsh Total		-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-
	Sheyenne River																			
		Barnes Total		17.7	399.5	-	-	-	399.5	-	-	-	399.5	-	-	-	2.9	-	-	396.7
		Cass Total		9.4	126.2		-	-	126.2	-	-	-	126.2	-	-	-		126.2	-	-
		Eddy Total		-	75.2	-	-	-	75.2	-	-	-	75.2	-	-	-	Upstream of Tolna Coulee			
		Nelson Total		45.8	160.3	-	-	-	160.3	-	-	-	160.3	-		-	56.4	-	51.8	52.1
		Ransom Total		11.3	2933.7	-	-	-	2933.7	-	-	-	2933.7	-	-	-	1125.5	-	1808.2	-
Summary Totals Totals by River																				
	Red Total (MN)			105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
	Red Total (ND)			149.1	6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-
	Red Total			254.6	9207.4	-	-	-	9207.4	-	-	-	9207.4				9207.4	-	-	-
	Sheyenne Total (ND)			84.1	3694.9	-	-	-	3694.9	-	-	-	3694.9	-	-	-	1184.7	126.2	1860.1	448.8
Summary Totals Totals by State																				
	ND Total			233.2	9812.5	-	-	-	9812.5	-	-	-	9812.5	-	-	-	7327.7	126.2	1840.7	448.8
	MN Total			105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
Grand Total				338.5	12902.3	0.0	0.0	0.0	12902.3	0.0	0.0	0.0	12902.3	0.0	0.0	0.0	10392.1	126.2	1860.1	448.8
Project Totals								13240.8				13240.8				13240.8				13165.6

Appendix A

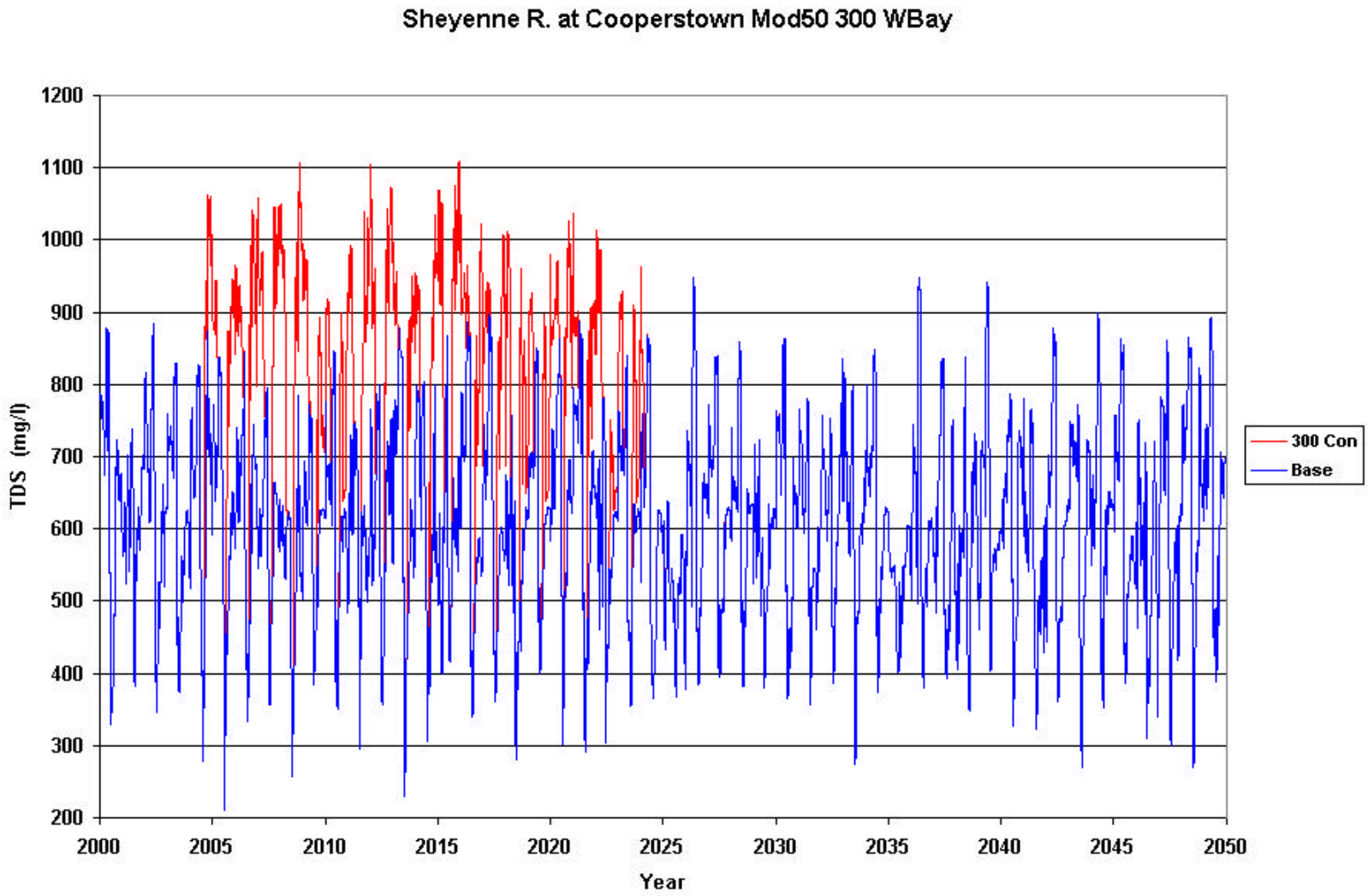


Figure A1-1. TDS As a function of time for the Cooperstown Moderate 50 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation ceases by year 2027 because Devils Lake has dropped below the 1435 elevation. Note overall differences in peak TDS values between Base and Alternative traces is approximately 200 mg/l.

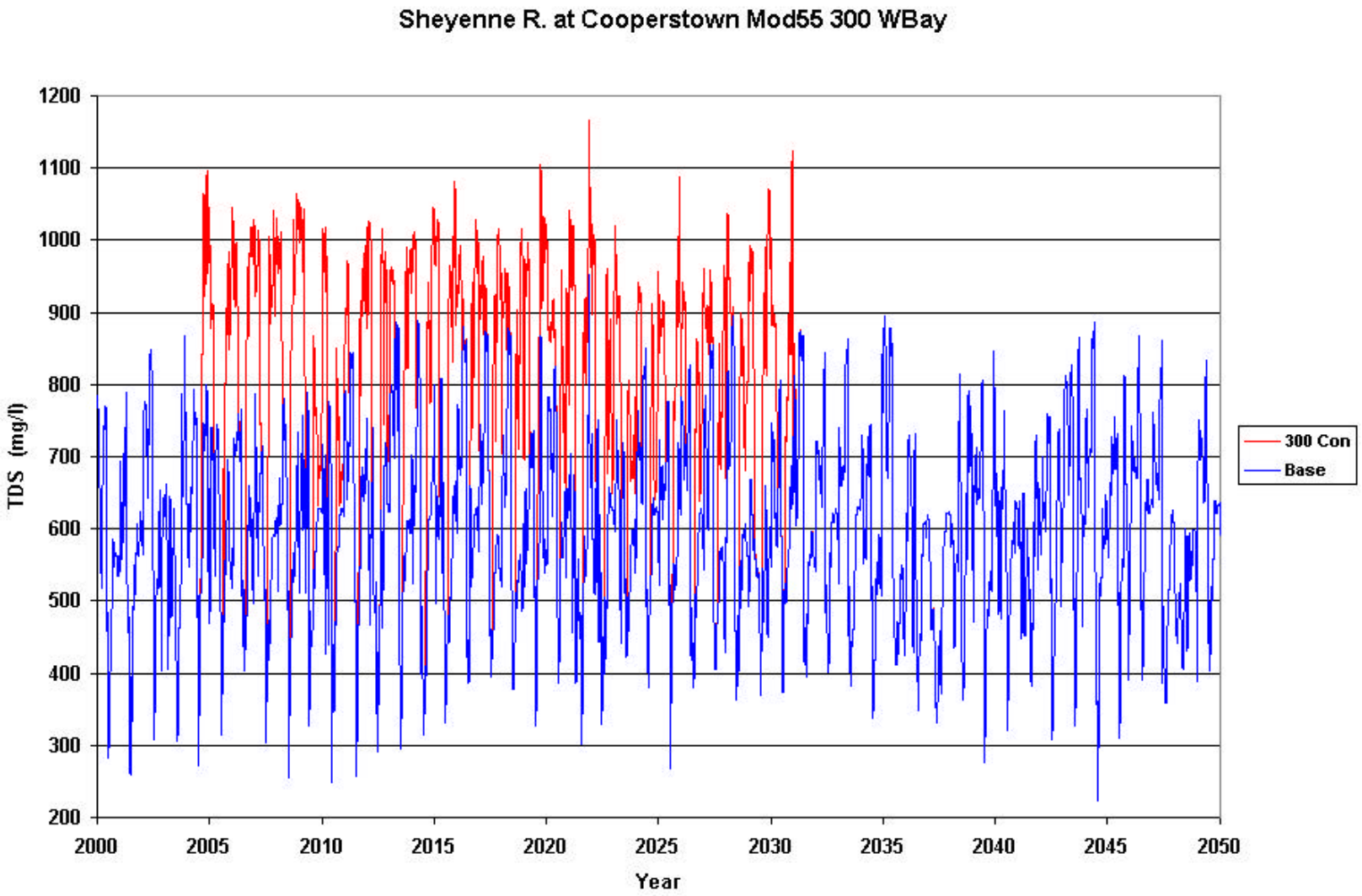


Figure A1-2. TDS As a function of time for the Cooperstown Moderate 55 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation ceases in year 2032 because Devils Lake has dropped below the 1435 elevation. Note overall differences in peak TDS values between Base and Alternative traces is approximately 200 mg/l.

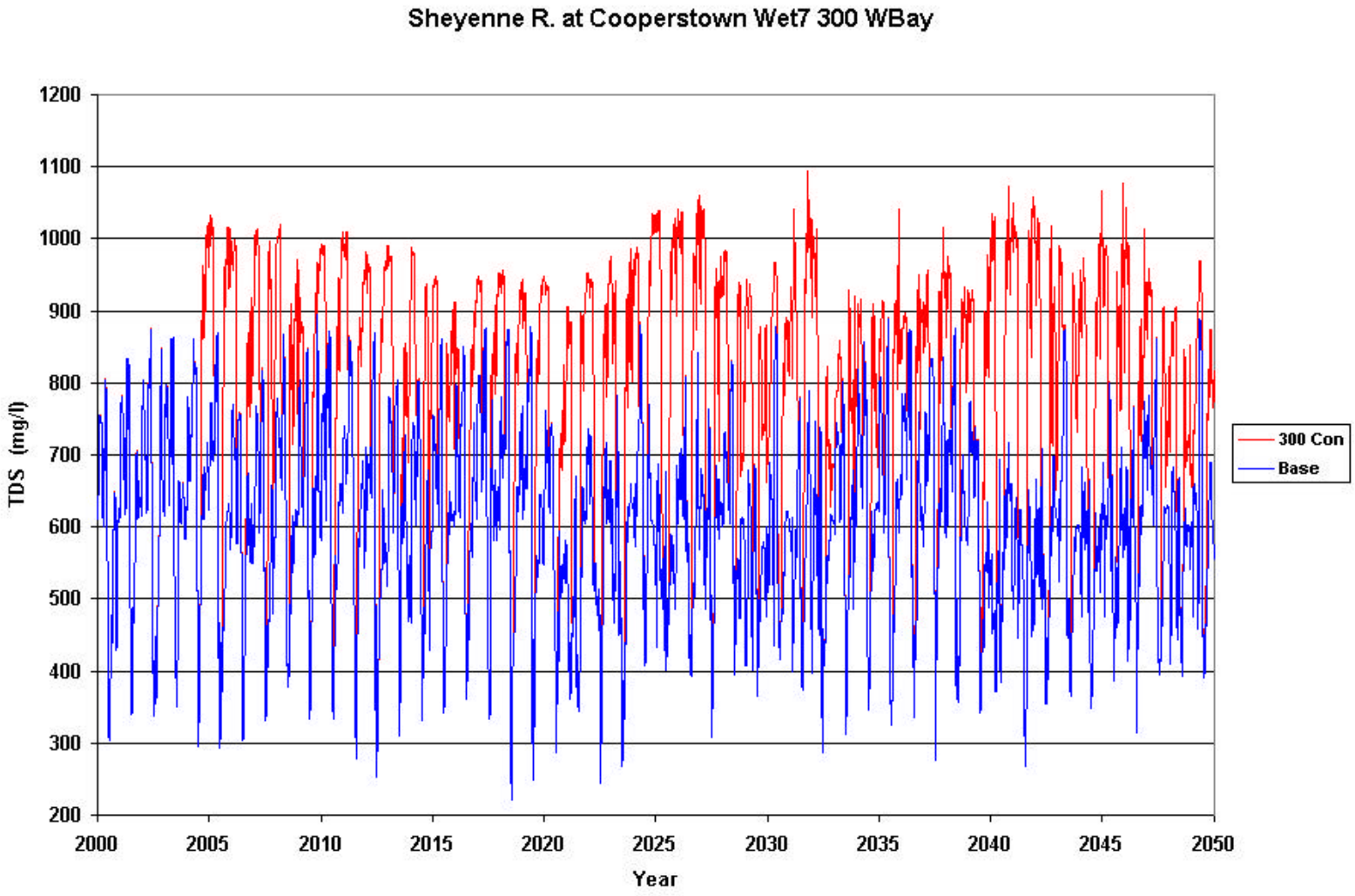


Figure A1-3. TDS As a function of time for the Cooperstown Wet7 300 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation continues through the planning period because Devils Lake does not drop below the 1435 elevation. Note overall differences in peak TDS values between Base and Alternative traces is approximately 200 mg/l.

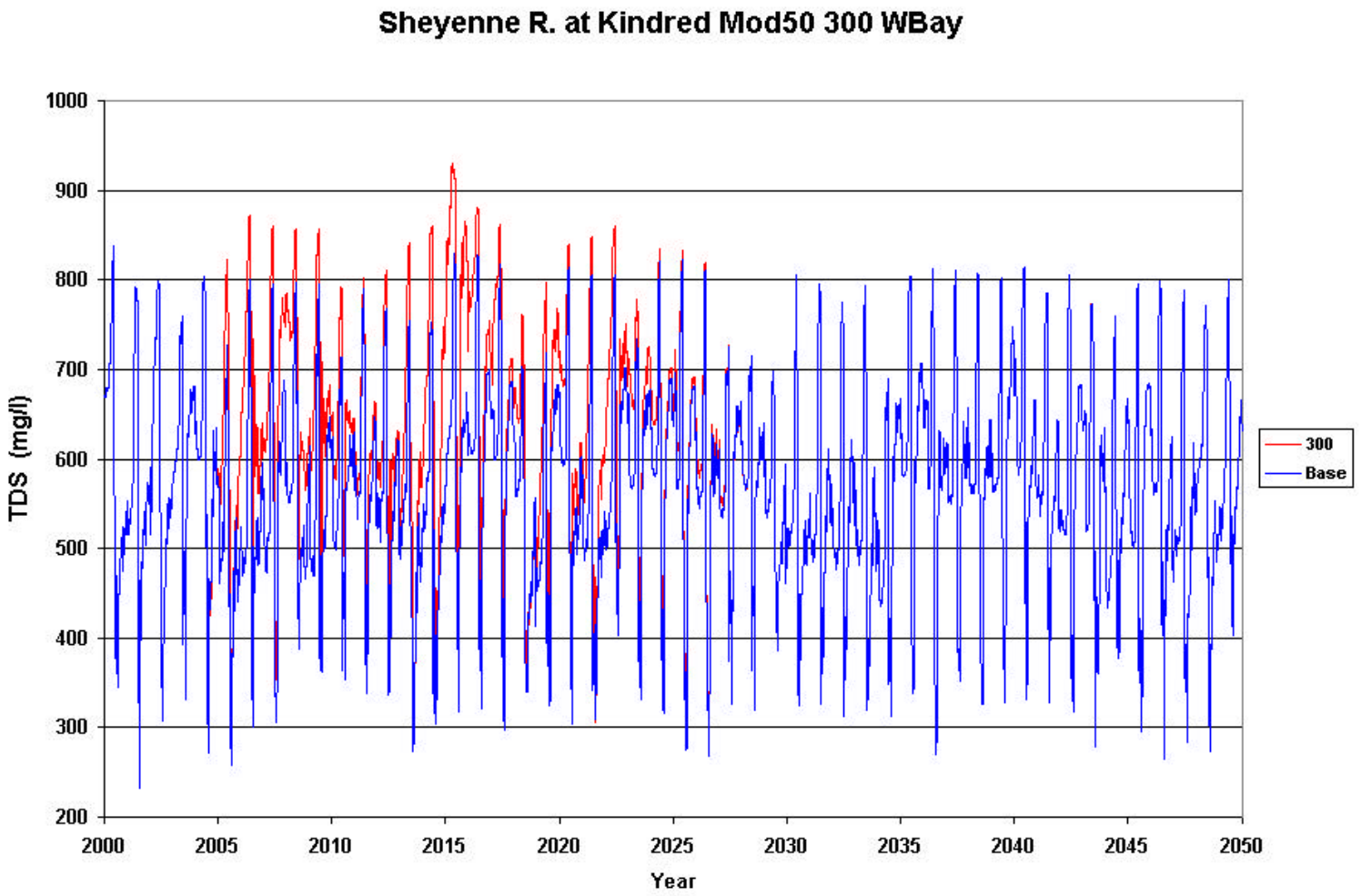


Figure A1-4. TDS As a function of time for the Kindred Moderate 50 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation ceases by year 2027 because Devils Lake has dropped below the 1435 elevation. Note maximum differences in peak TDS values between Base and Alternative traces is approximately 100 mg/l.

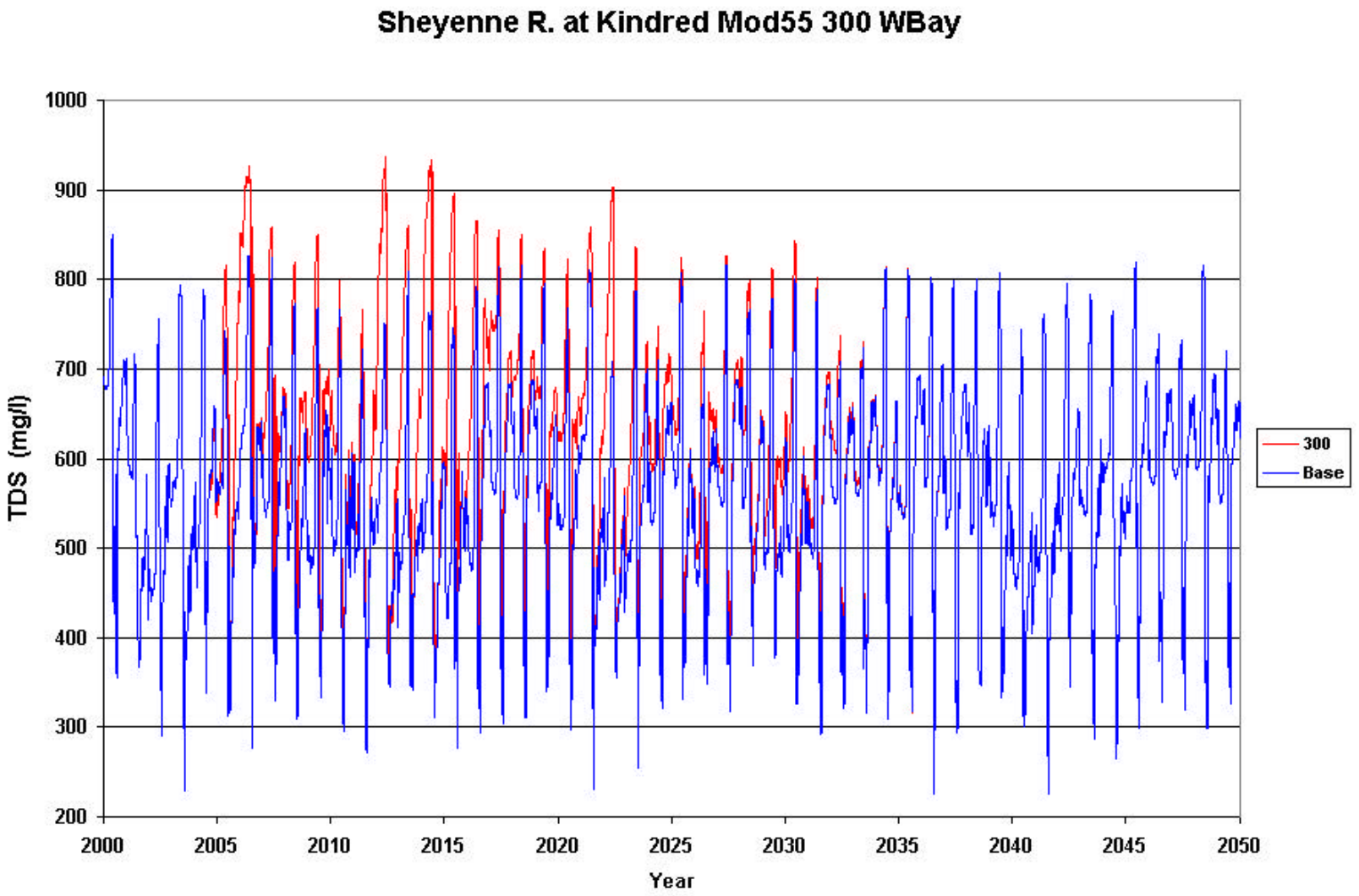


Figure A1-5. TDS As a function of time for the Cooperstown Mod55 300 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation ceases during year 2035 because the predicted Devils Lake level drops below the 1435 elevation. Note maximum differences in peak TDS values between Base and Alternative traces is approximately 200 mg/l.

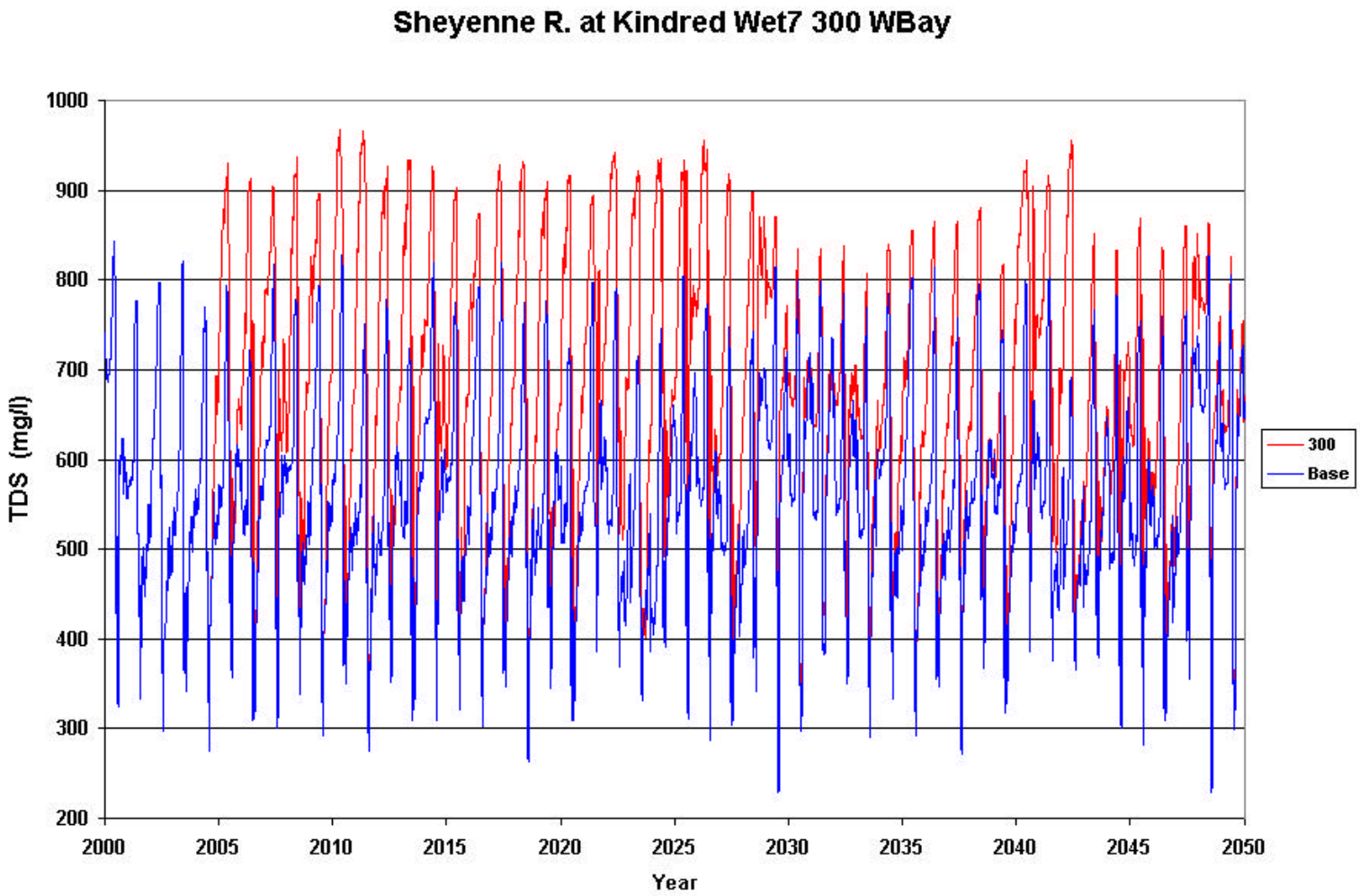


Figure A1-6. TDS As a function of time for the Kindred Wet7 climatic scenario, Base and 300 cfs Constrained Alternative Traces shown. Outlet operation begins May 1, 2005. Outlet operation continues throughout the planning period because Devils Lake does not drop below the 1435 elevation. Note overall differences in peak TDS values between Base and Alternative traces is approximately 200 mg/l.

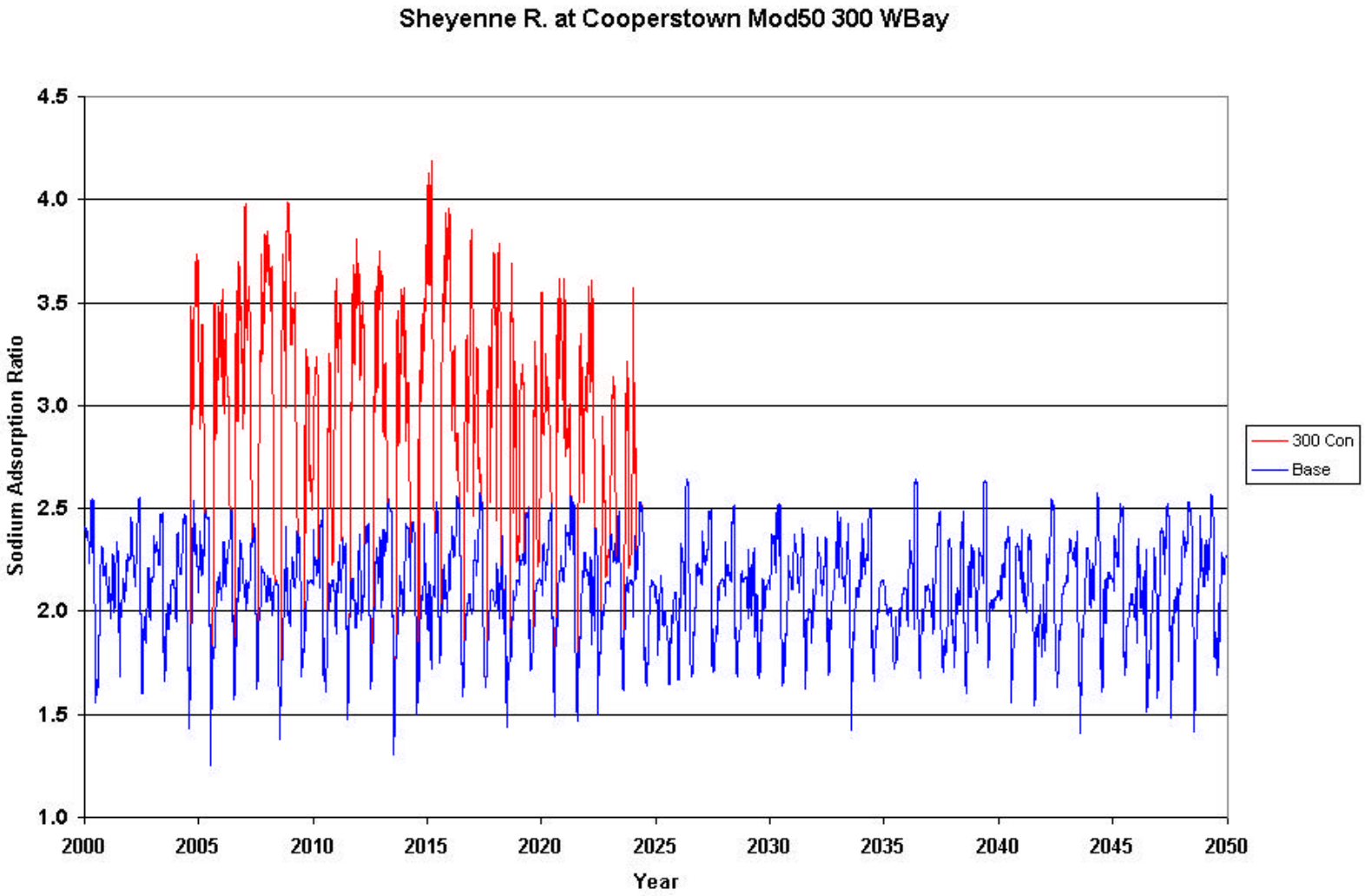


Figure A1-7. SAR As a function of time for the Cooperstown Mod55 300 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation ceases around year 2027 because the elevation of Devils Lake drops below the 1435 elevation. Note differences in peak SAR values between Base and Alternative traces is approximately 1.5.

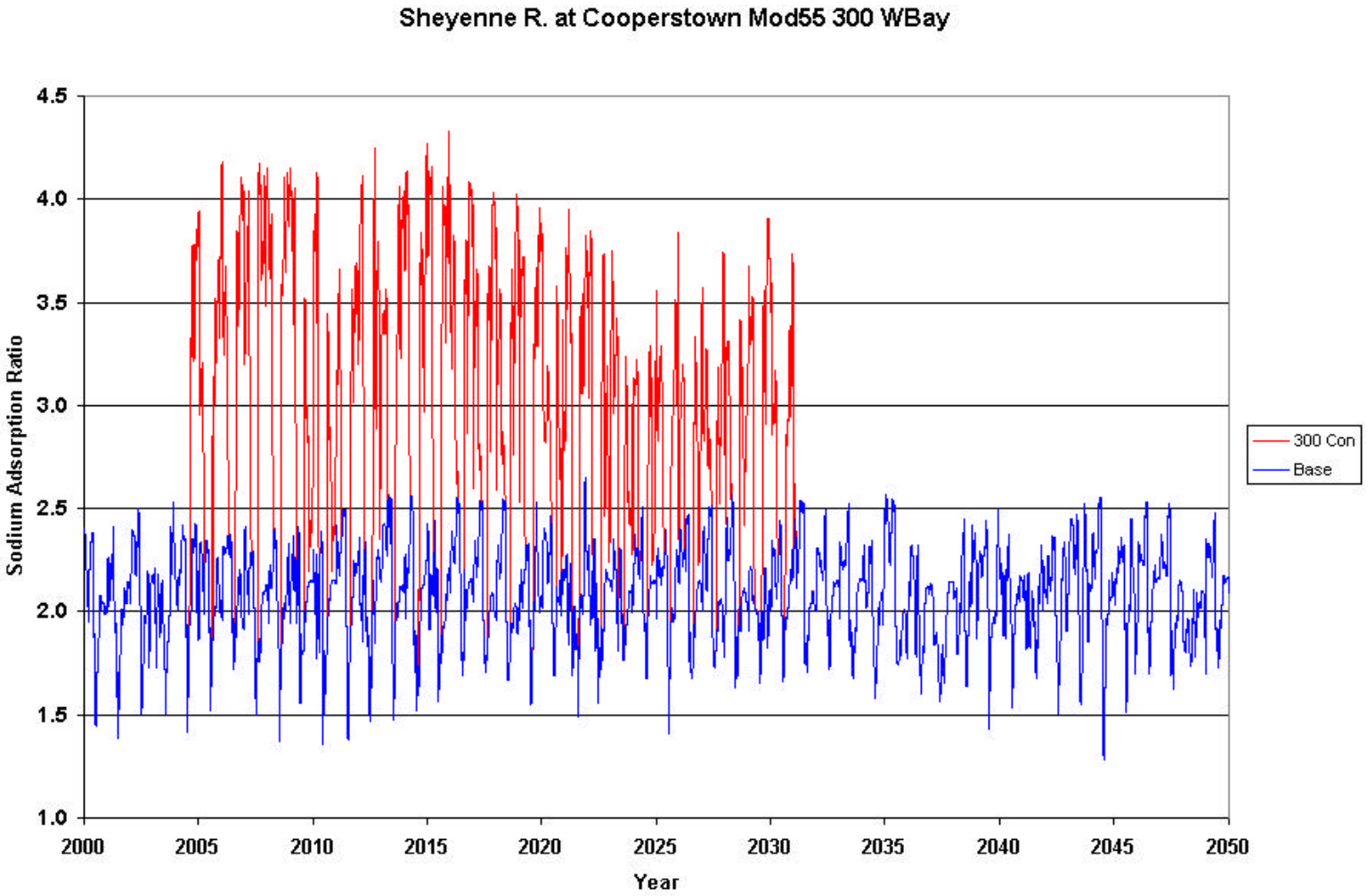


Figure A1-8. SAR As a function of time for the Cooperstown Mod55 300 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation ceases around year 2032 because the elevation of Devils Lake drops below the 1435 elevation. Note differences in peak SAR values between Base and Alternative traces is approximately 1.5.

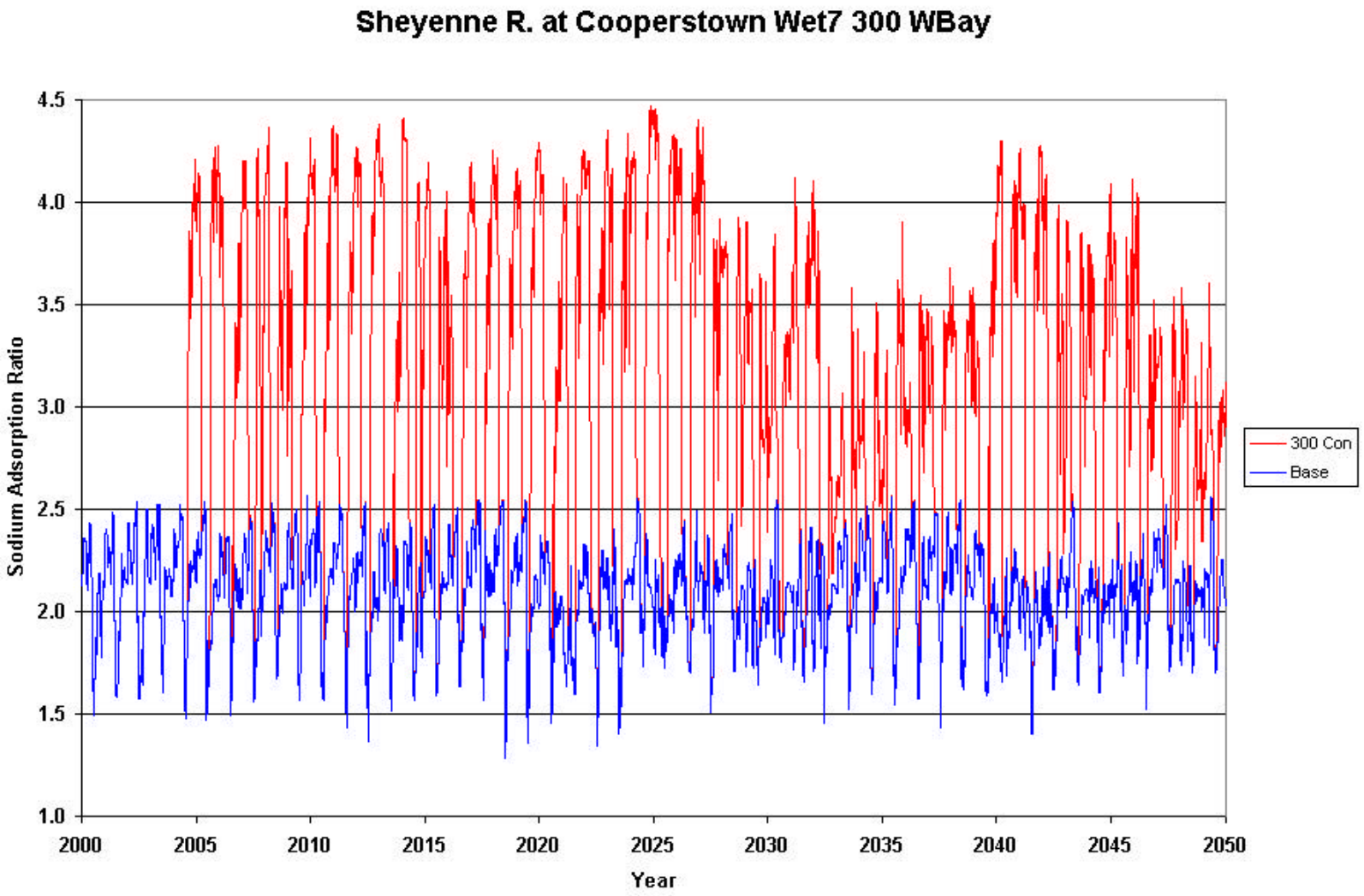


Figure A1-9. SAR As a function of time for the Cooperstown Wet7 300 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation continues throughout the planning period because Devils Lake does not drop below the 1435 elevation. Note differences in peak SAR values between Base and Alternative traces is approximately 1.5 to 2.0.

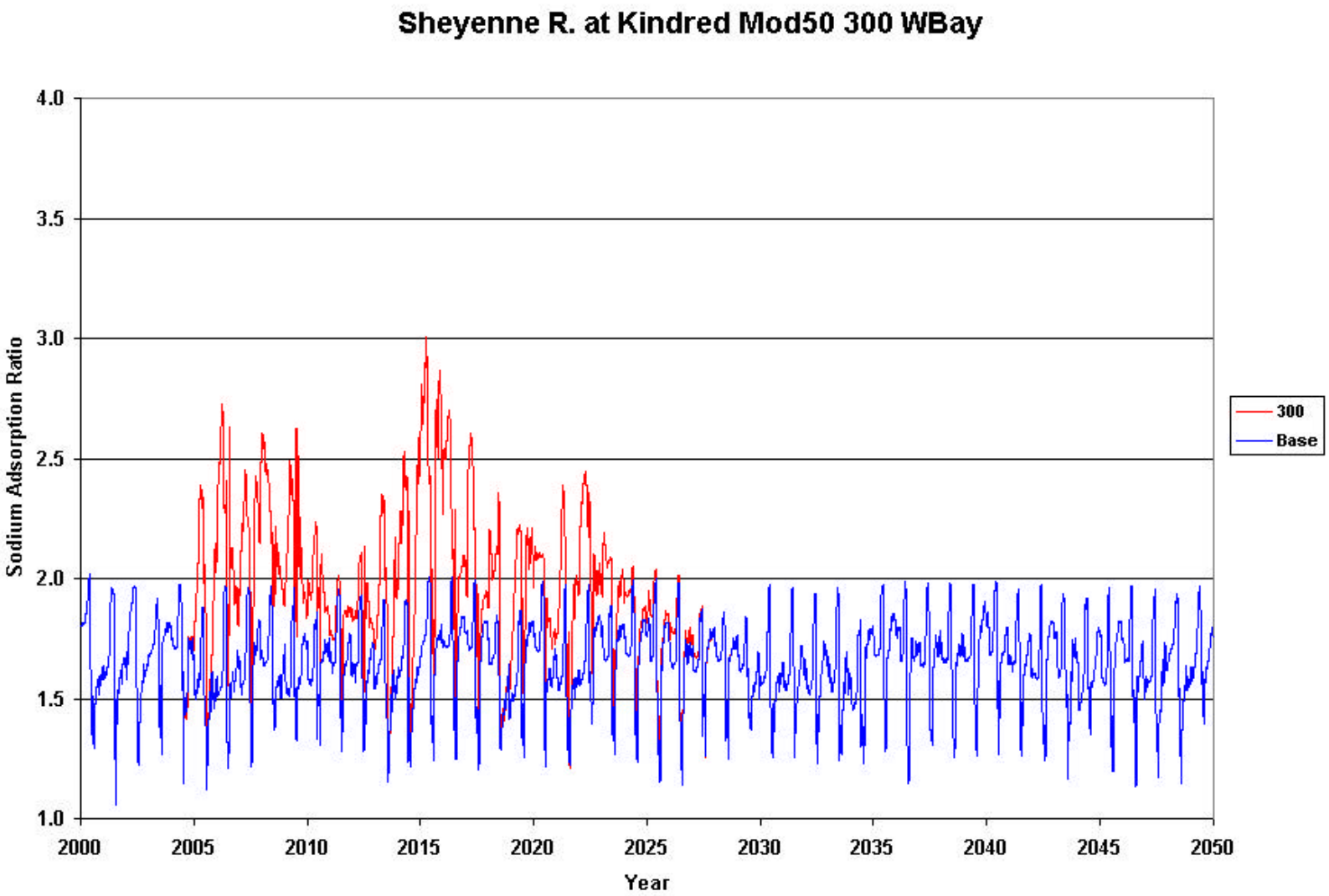


Figure A1-10. SAR As a function of time for the Kindred Mod50 300 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation ceases around year 2027 because the elevation of Devils Lake drops below the 1435 elevation. Note differences in peak SAR values between Base and Alternative traces is approximately 1.0.

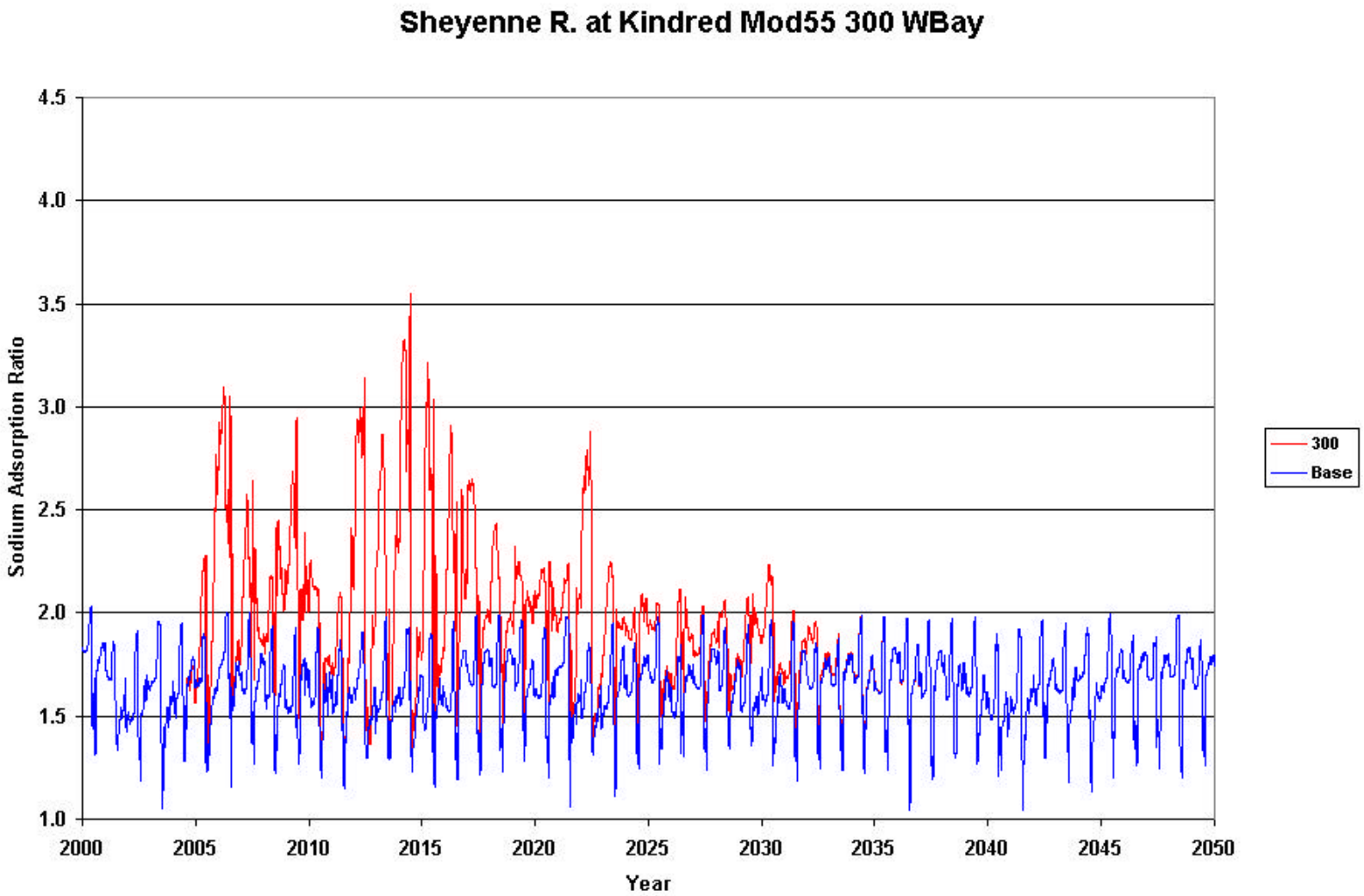


Figure A1-11. SAR As a function of time for the Kindred Mod55 300 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation ceases around year 2032 because the elevation of Devils Lake drops below the 1435 elevation. Note differences in peak SAR values between Base and Alternative traces is approximately 1.0 – 1.5.

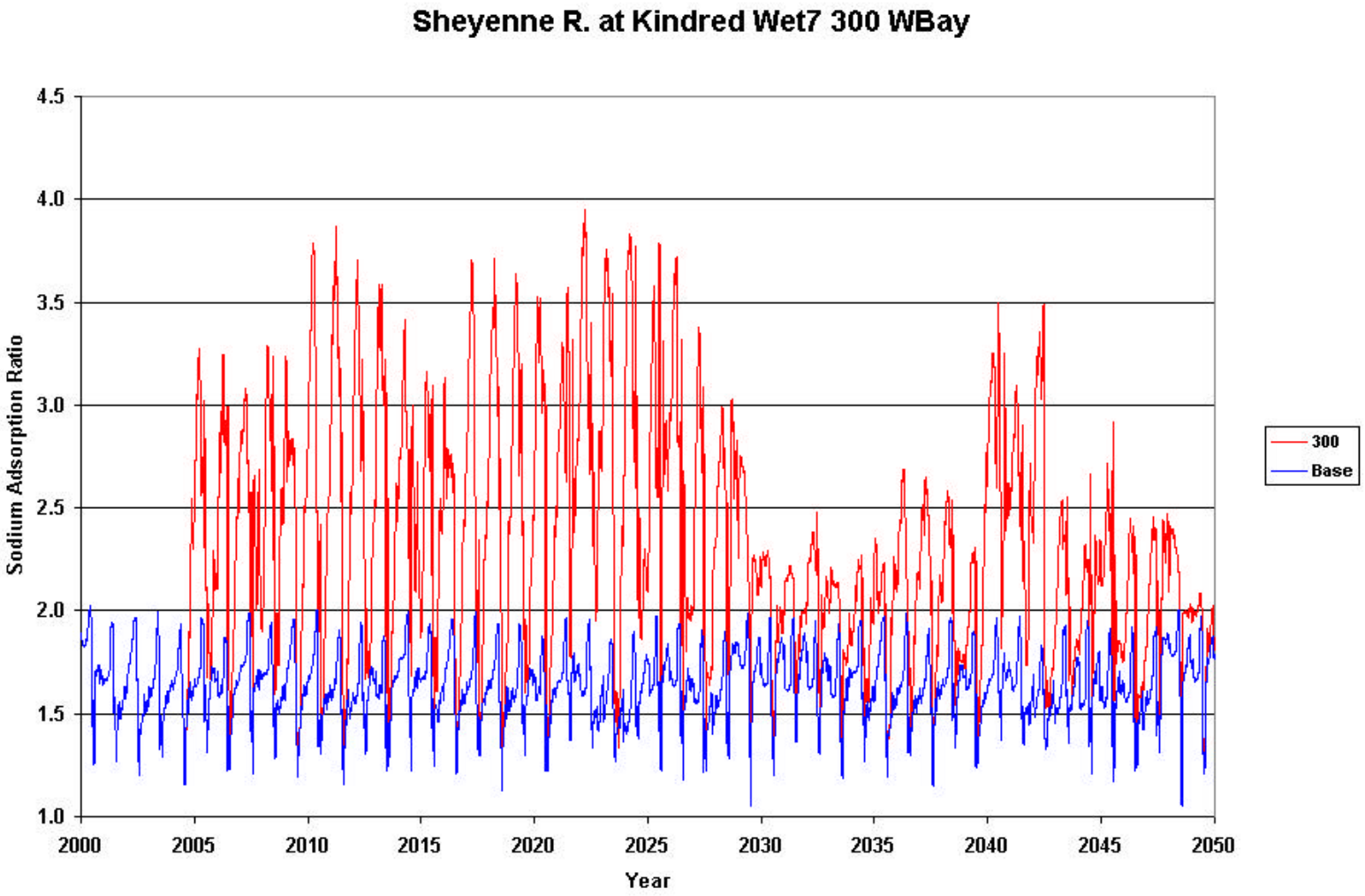


Figure A1-12. SAR As a function of time for the Kindred Wet7 300 trace, Base and 300 cfs Constrained Alternative traces shown. Outlet operation begins May 1, 2005. Outlet operation continues through the planning period because the elevation of Devils Lake never drops below the 1435 elevation. Note differences in peak SAR values between Base and Alternative traces is approximately 1.5 –2.0.

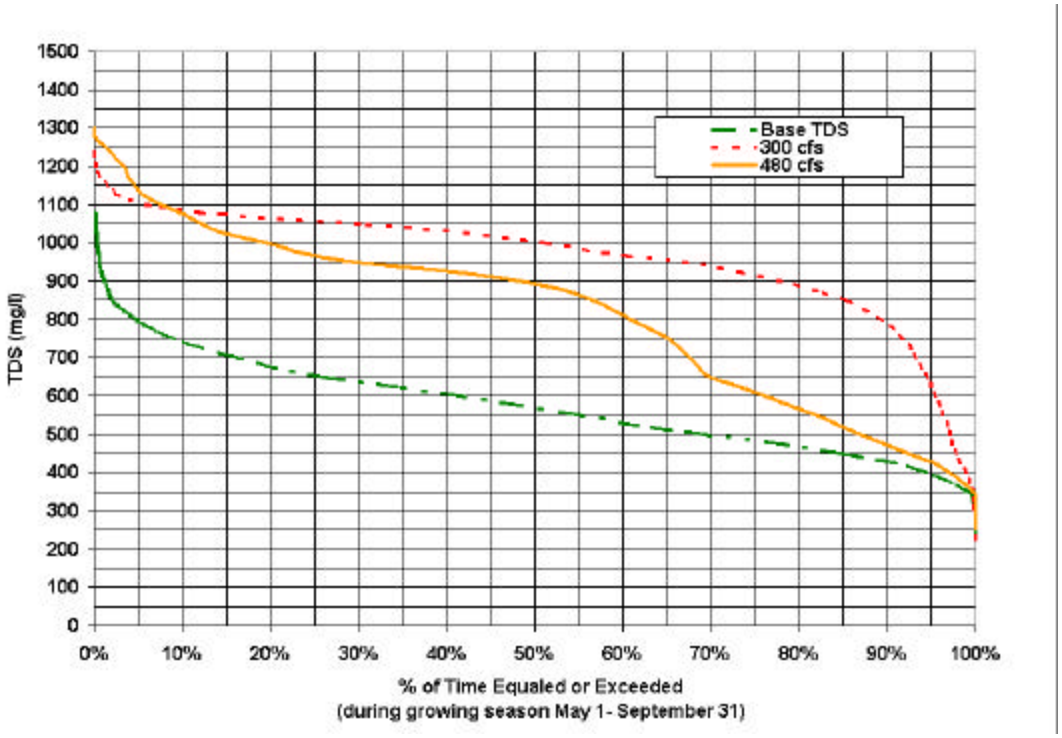


Figure A2-1. TDS percent exceedance graph for the Warwick control point (CP 1408).

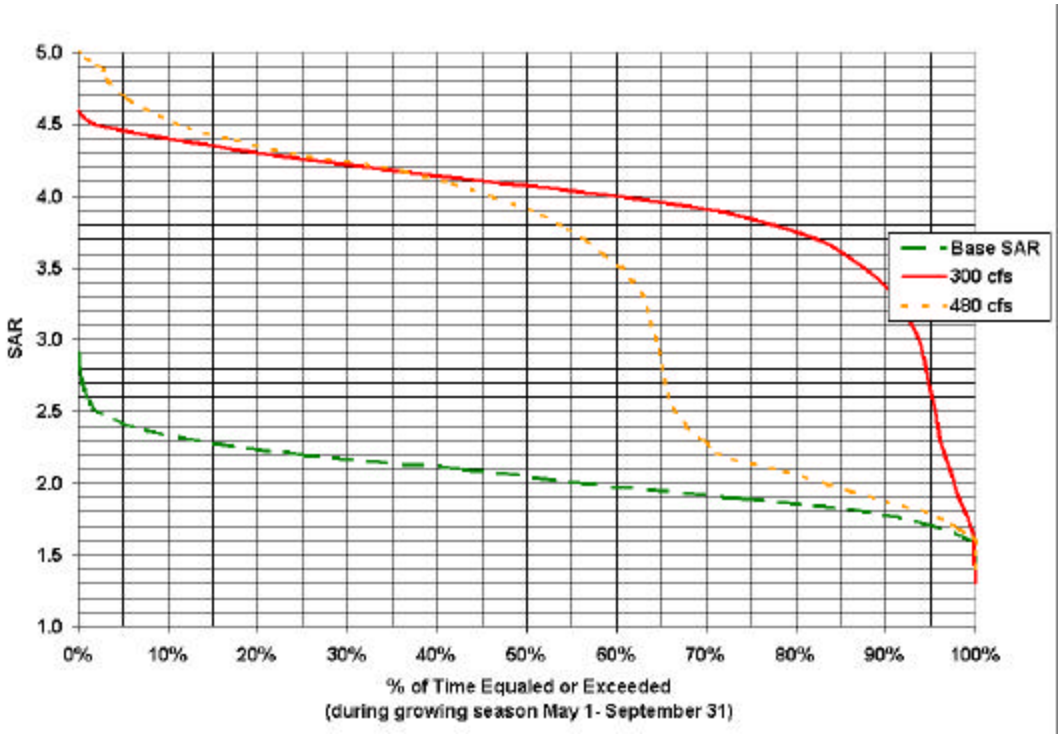


Figure A2-2. SAR percent exceedance graph for the Warwick control point (CP 1408).

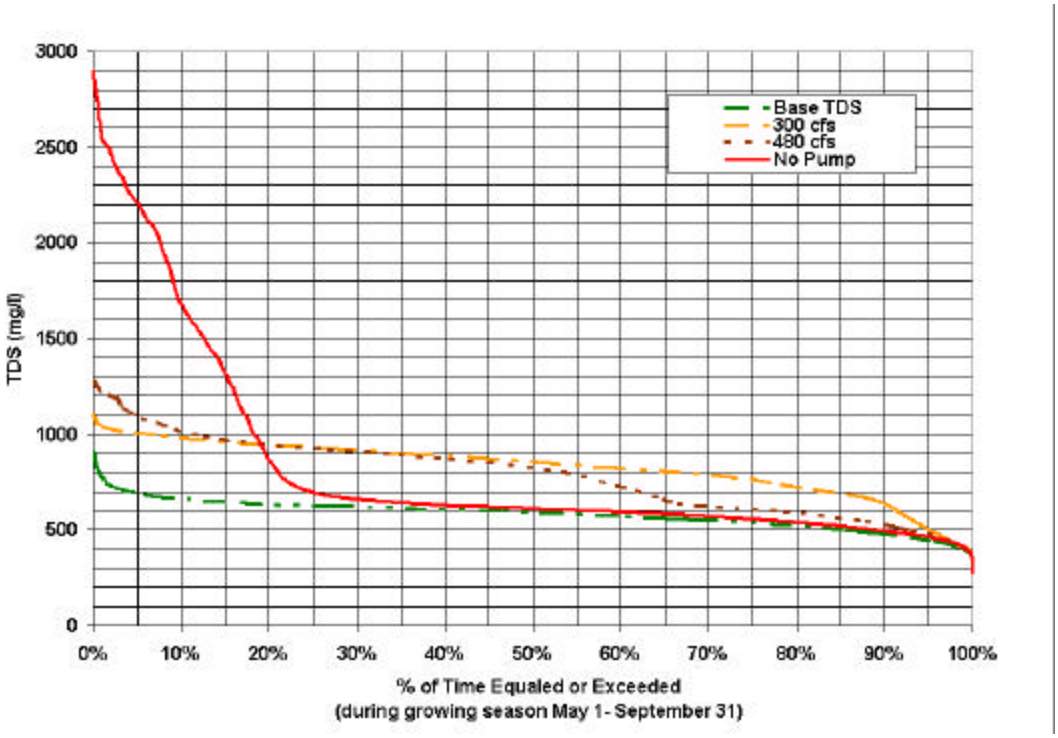


Figure A2-3. TDS percent exceedance graph for the Cooperstown control point (CP 1317).

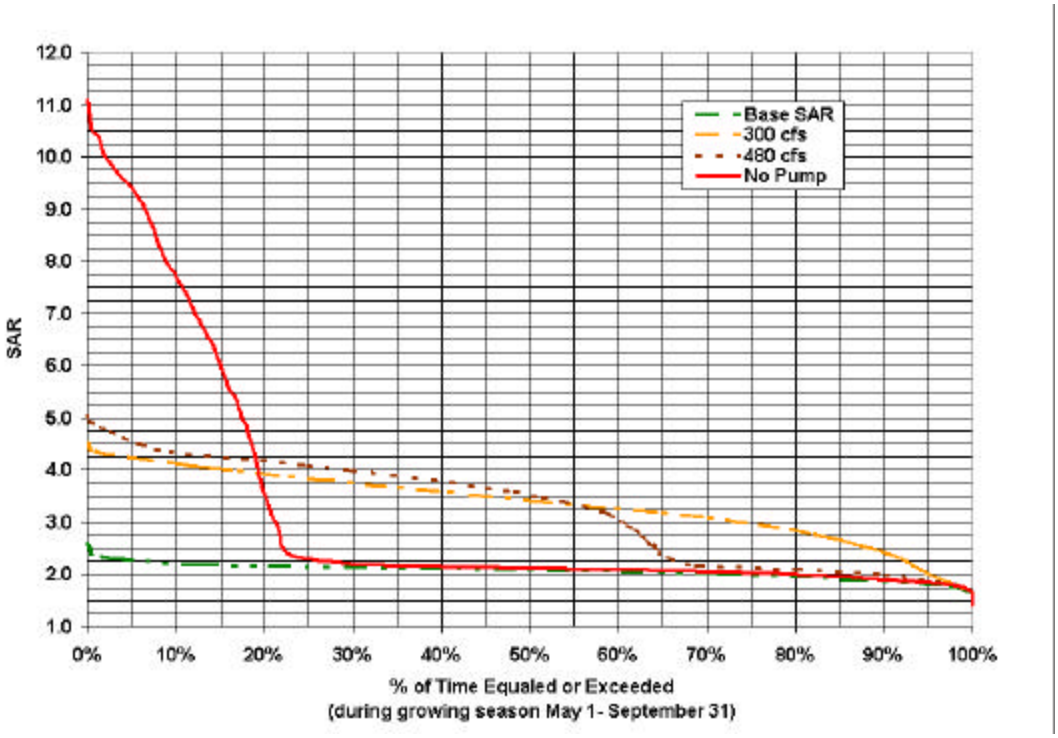


Figure A2-4. SAR percent exceedance graph for the Cooperstown control point (CP 1317).

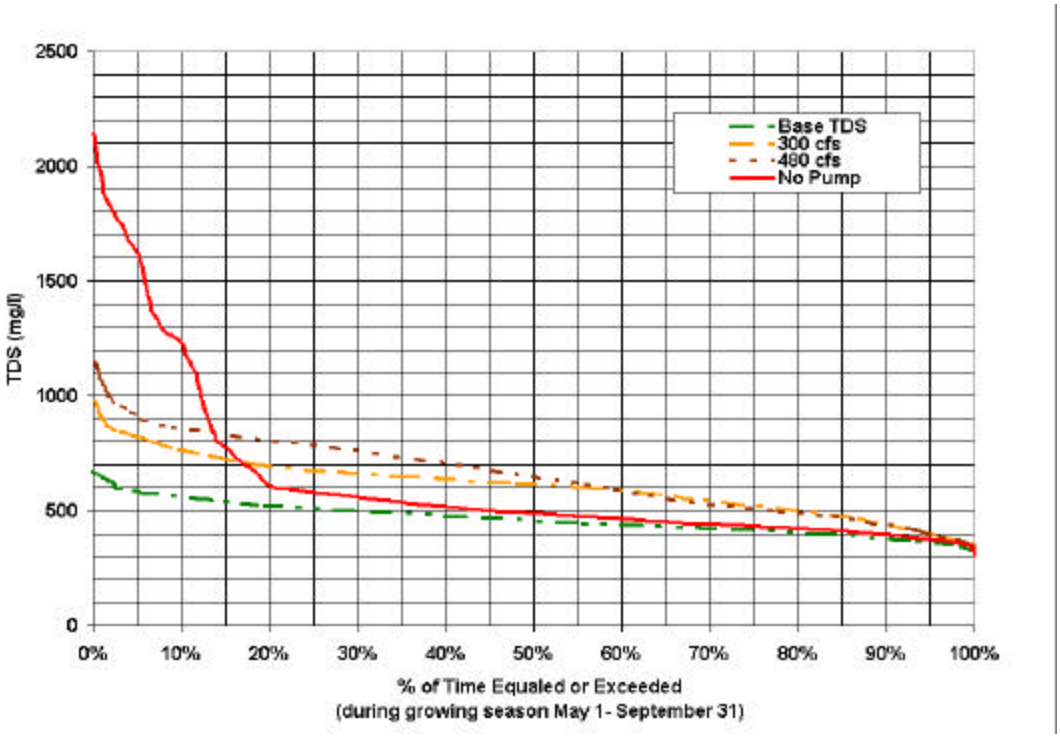


Figure A2-5. TDS percent exceedance graph for the Valley City control point (CP 1253).

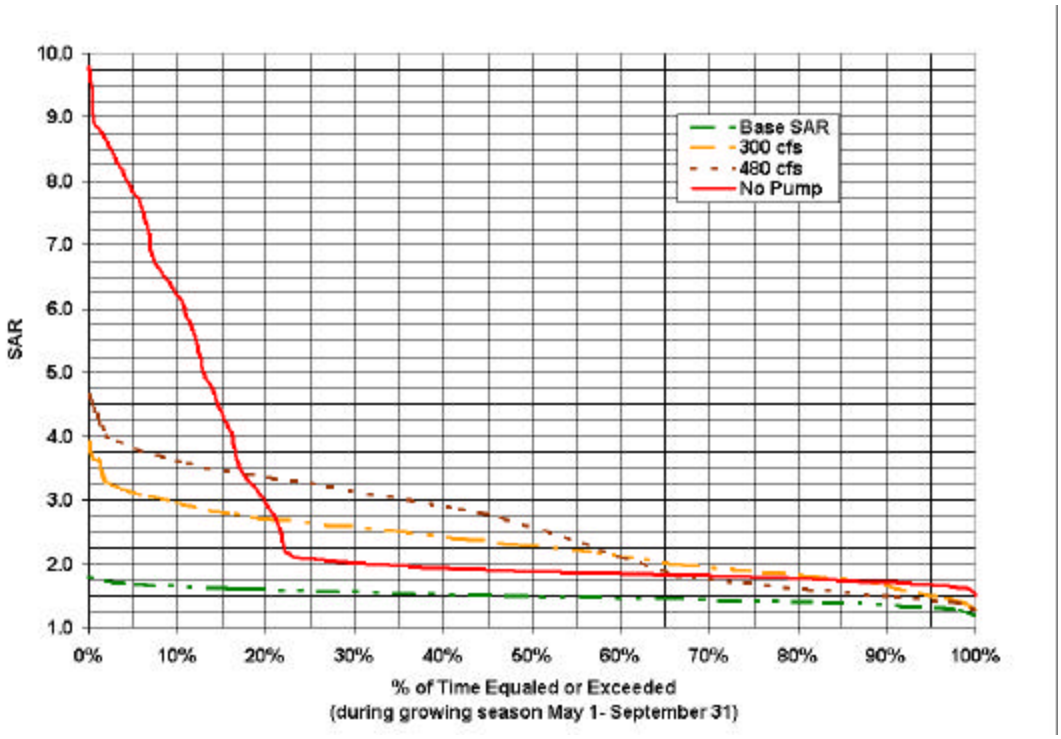


Figure A2-6. SAR percent exceedance graph for the Valley City control point (CP 1408).

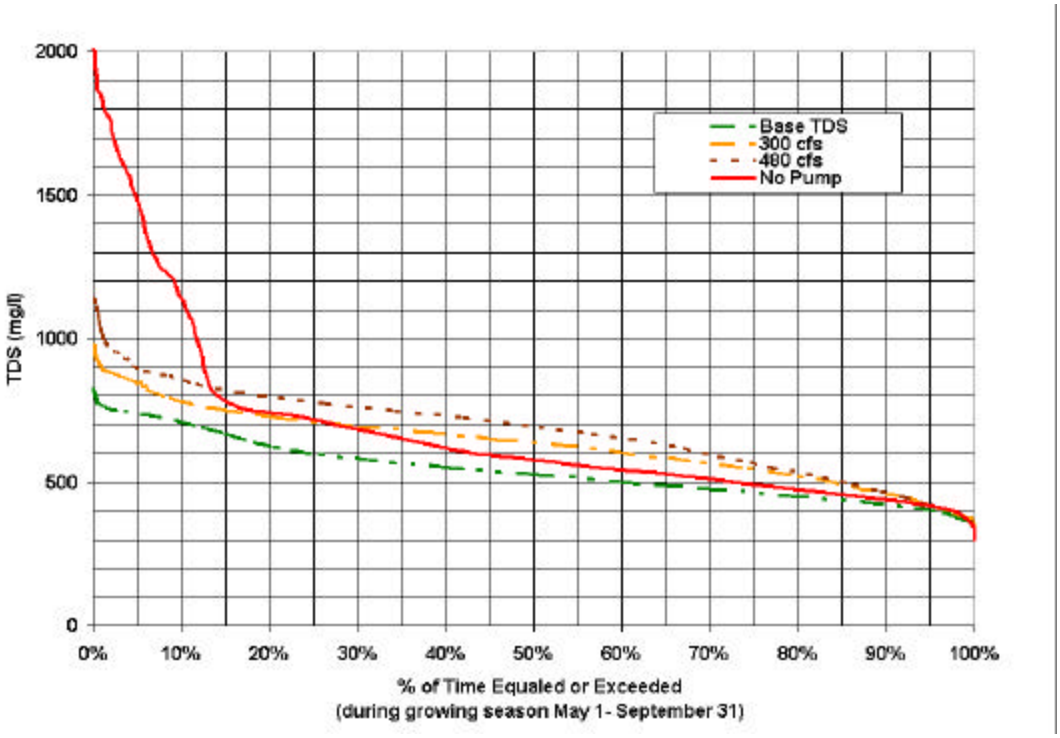


Figure A2-7. TDS percent exceedance graph for the Lisbon control point (CP 1162).

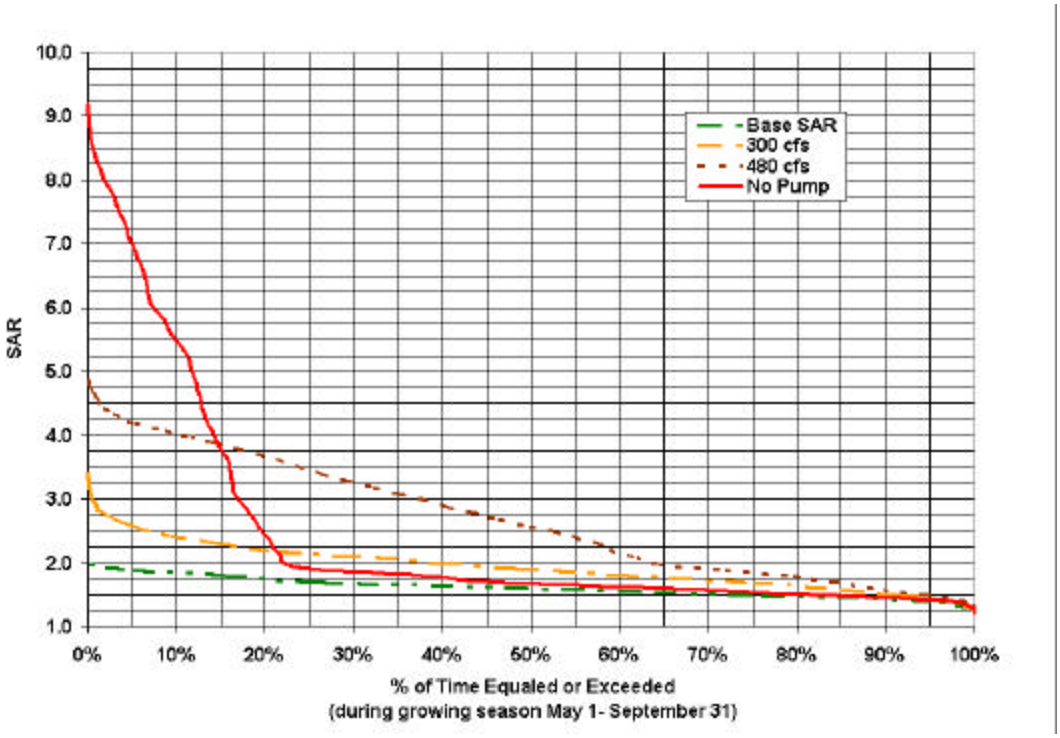


Figure A2-8. SAR percent exceedance graph for the Lisbon control point (CP 1162).

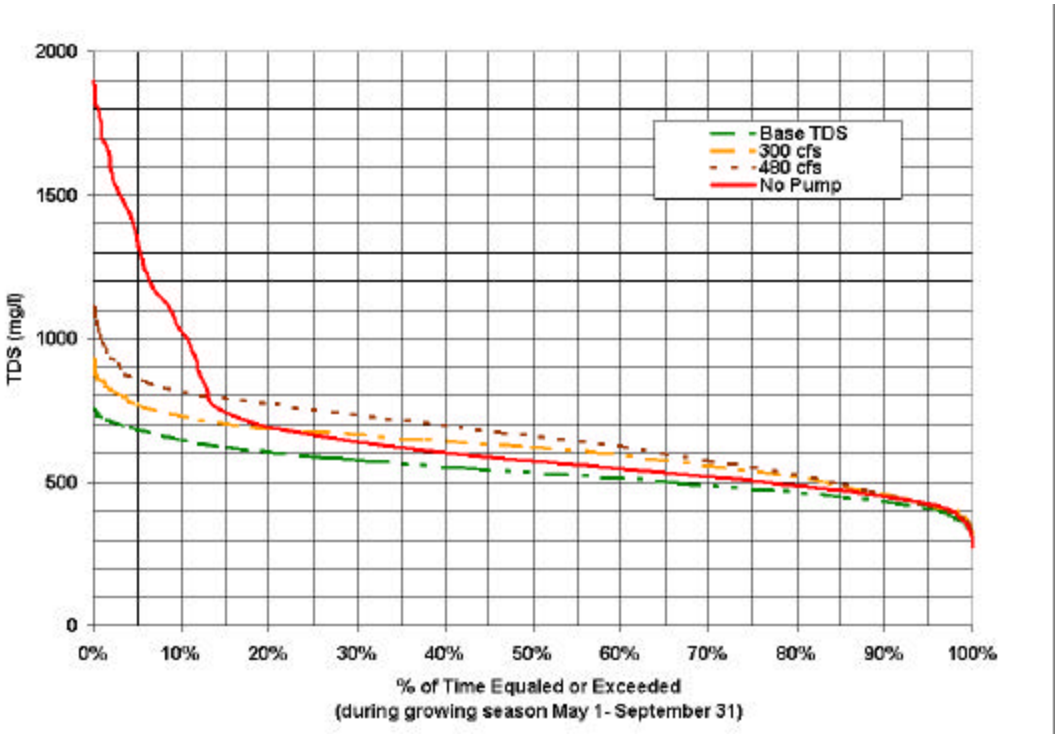


Figure A2-9. TDS percent exceedance graph for the Kindred control point (CP 1068).

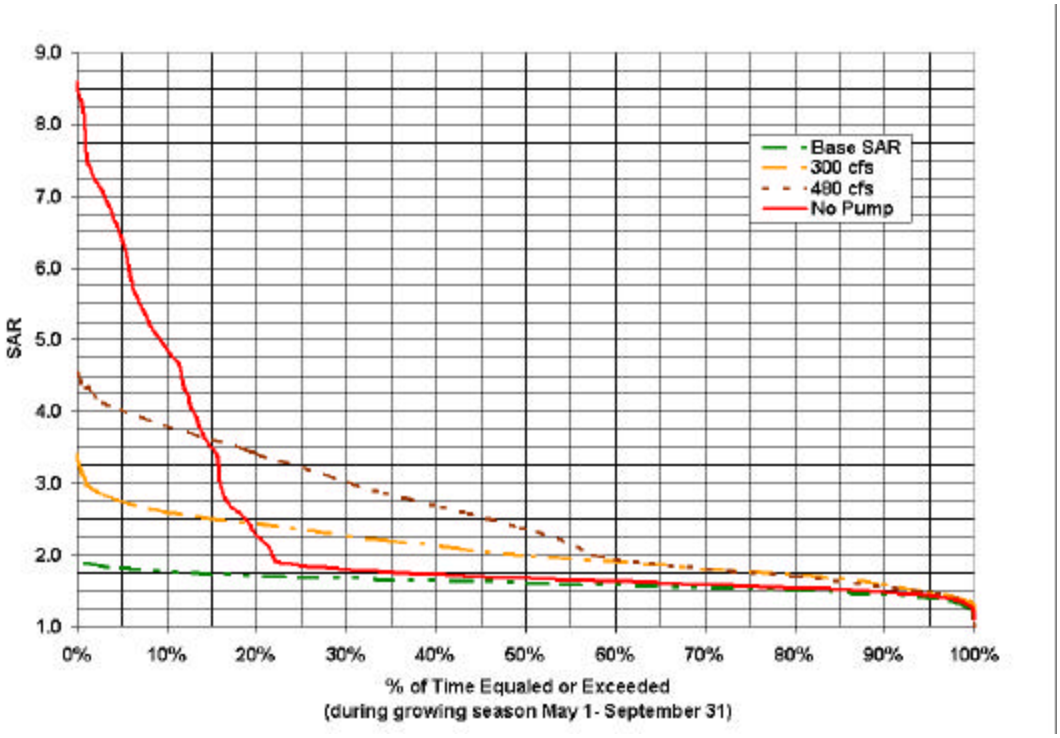


Figure A2-10. SAR percent exceedance graph for the Kindred control point (CP 1068).

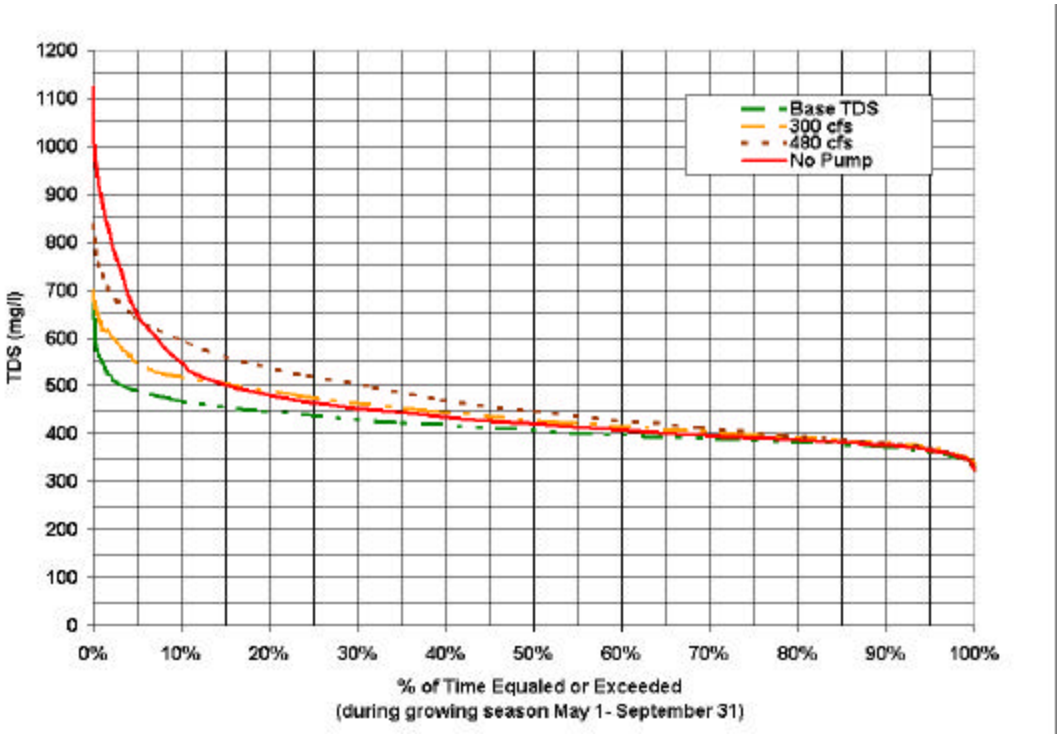


Figure A2-11. TDS percent exceedance graph for the Halstad control point (CP 375).

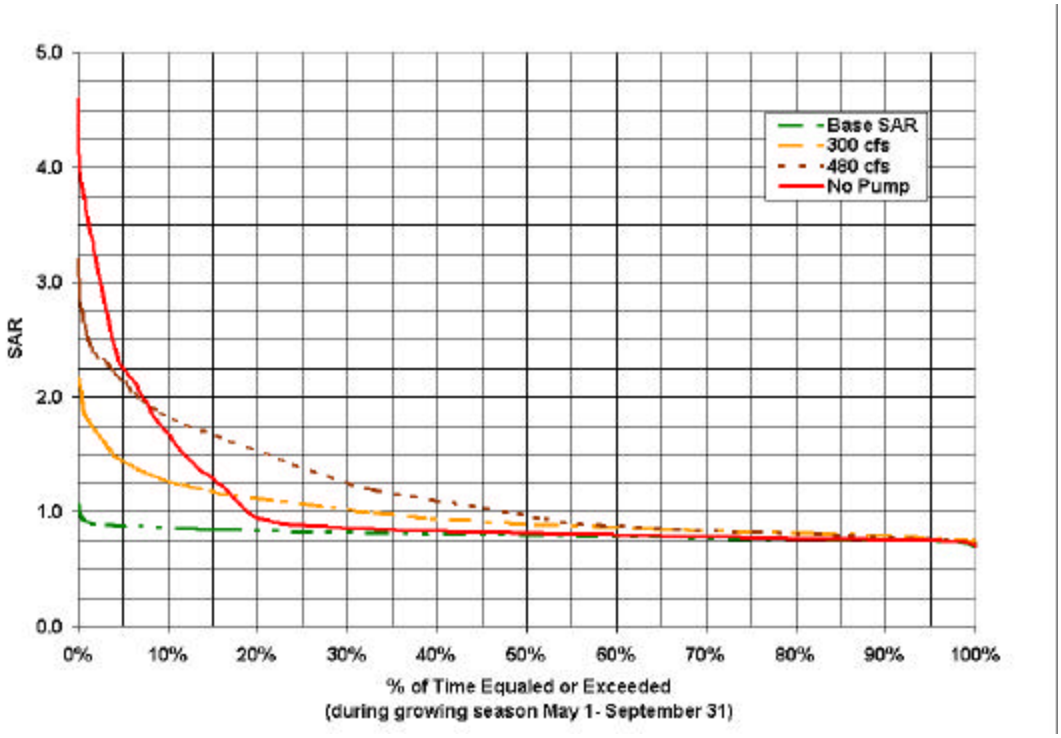


Figure A2-12. SAR percent exceedance graph for the Halstad control point (CP 375).

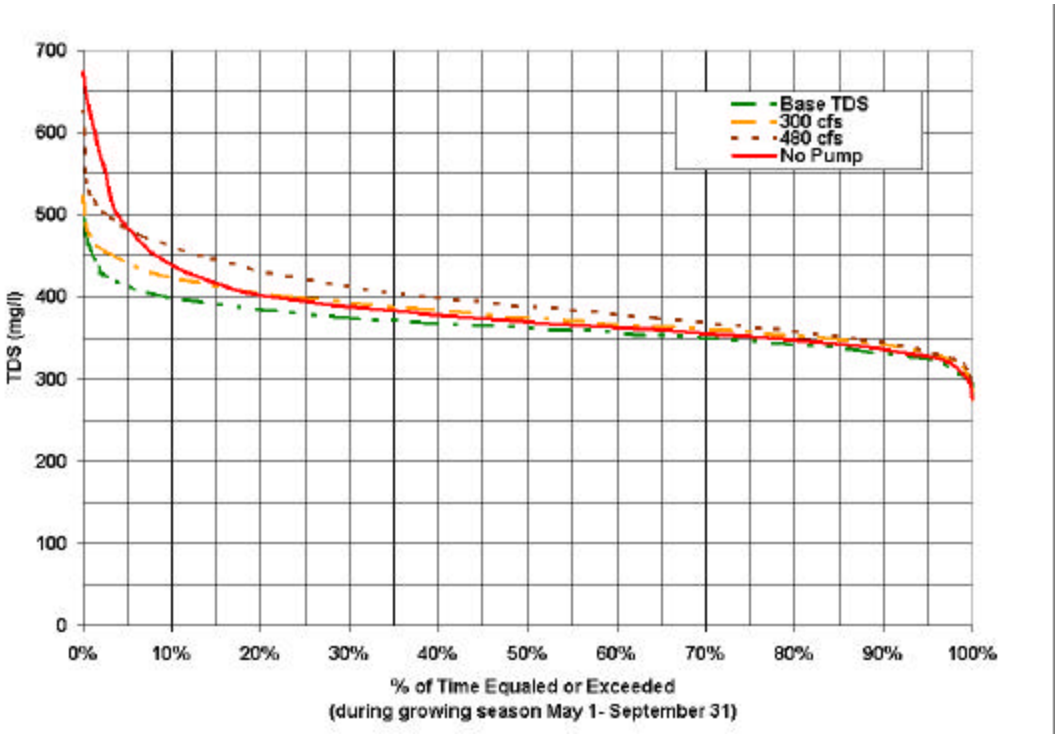


Figure A2-13. TDS percent exceedance graph for the Grand Forks control point (CP 296).

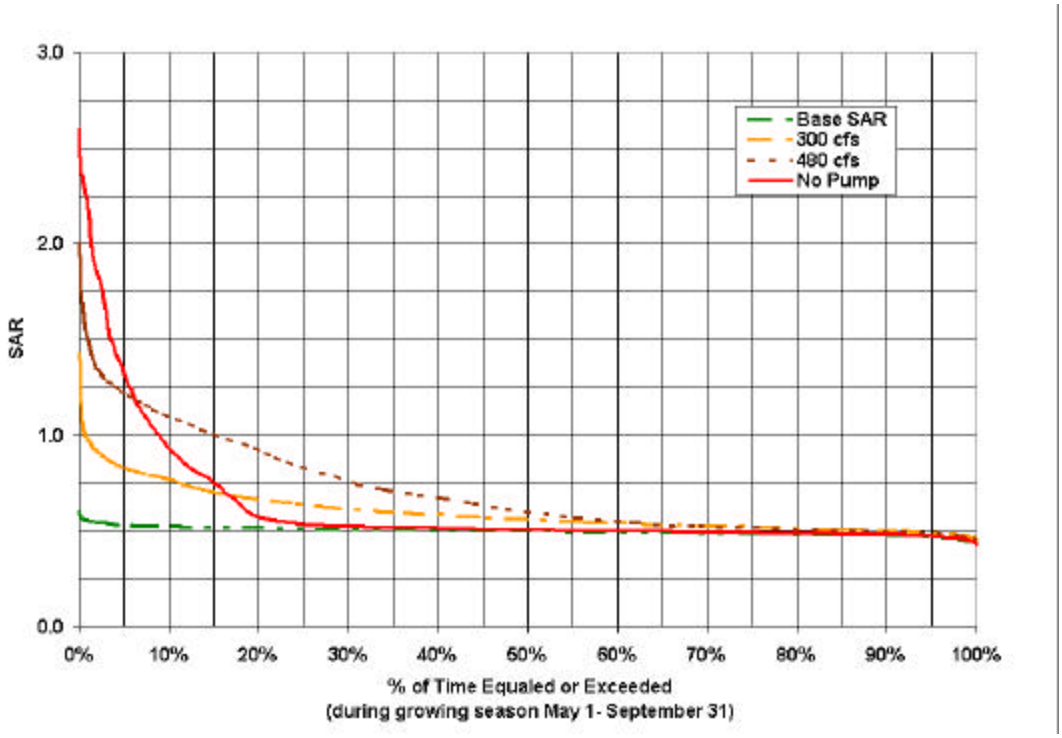


Figure A2-14. SAR percent exceedance graph for the Grand Forks control point (CP 296).

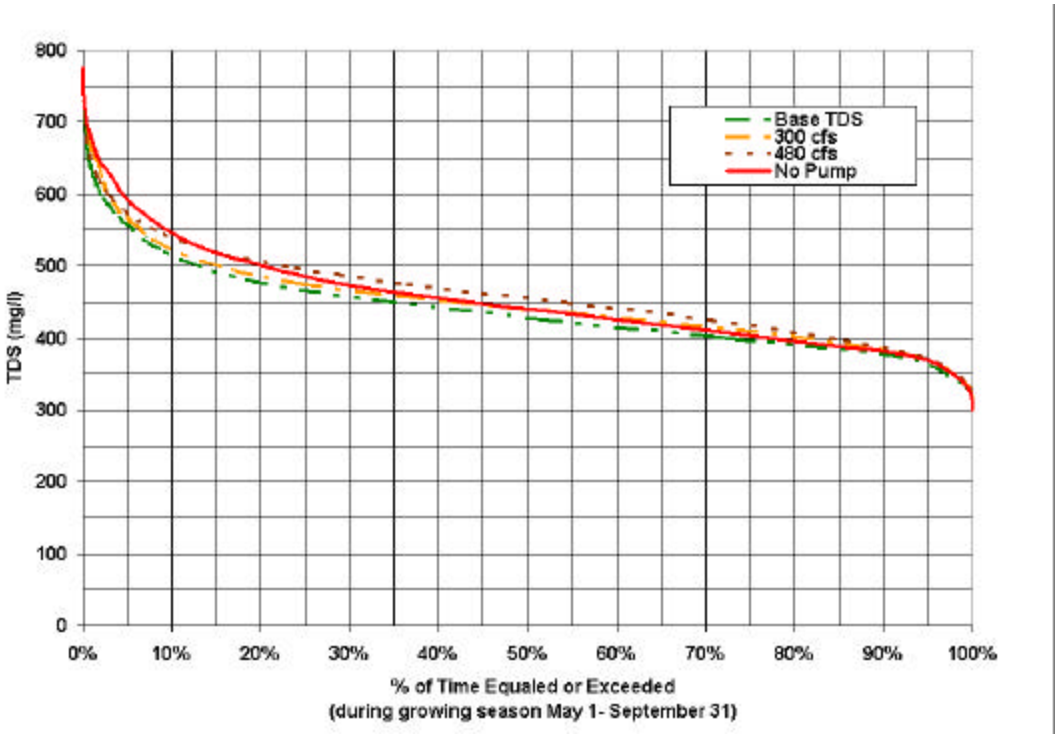


Figure A2-15. TDS percent exceedance graph for the Emerson control point (CP 99).

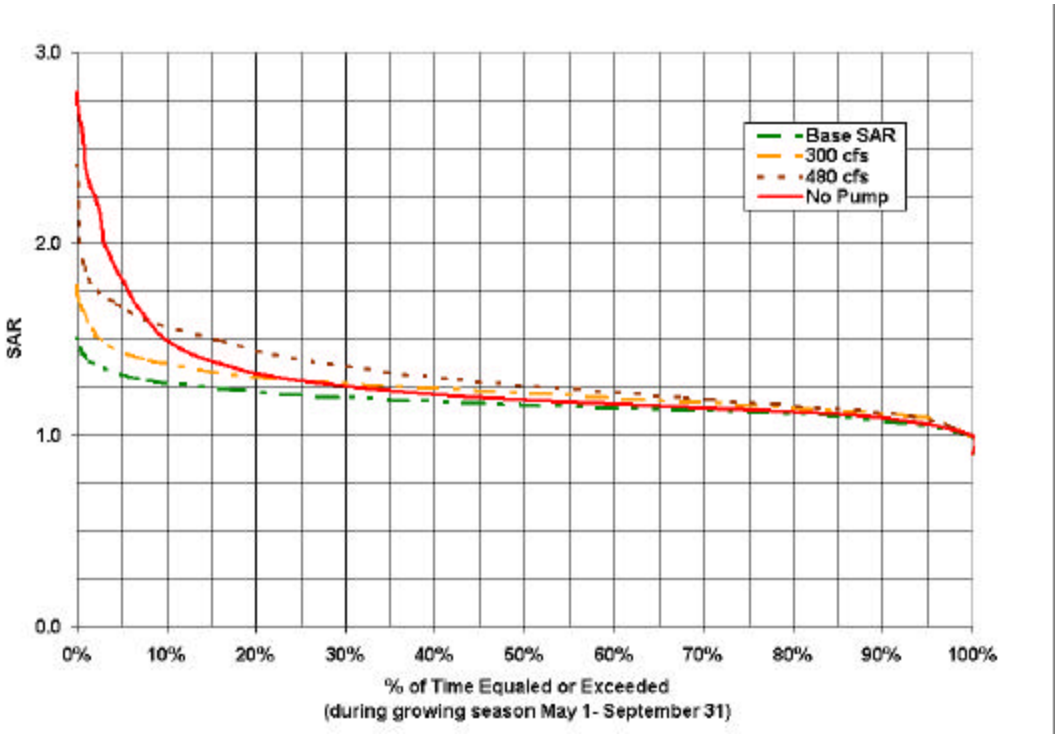
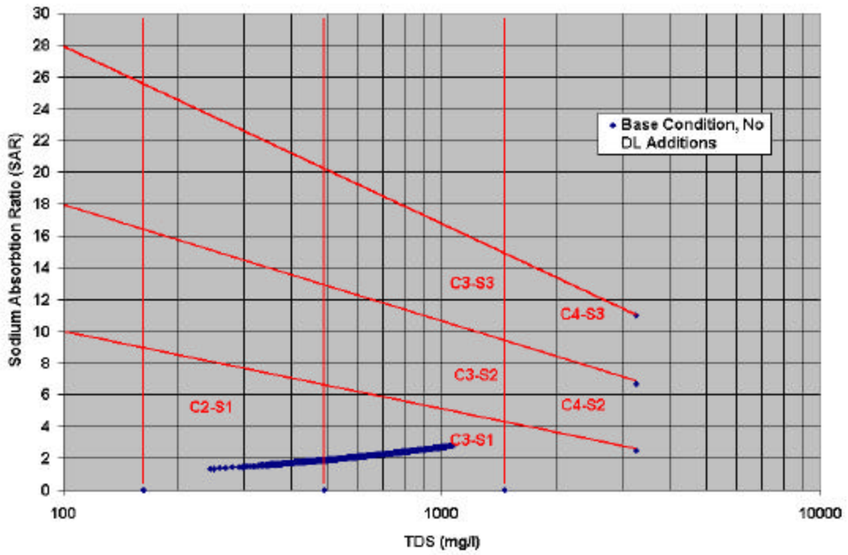
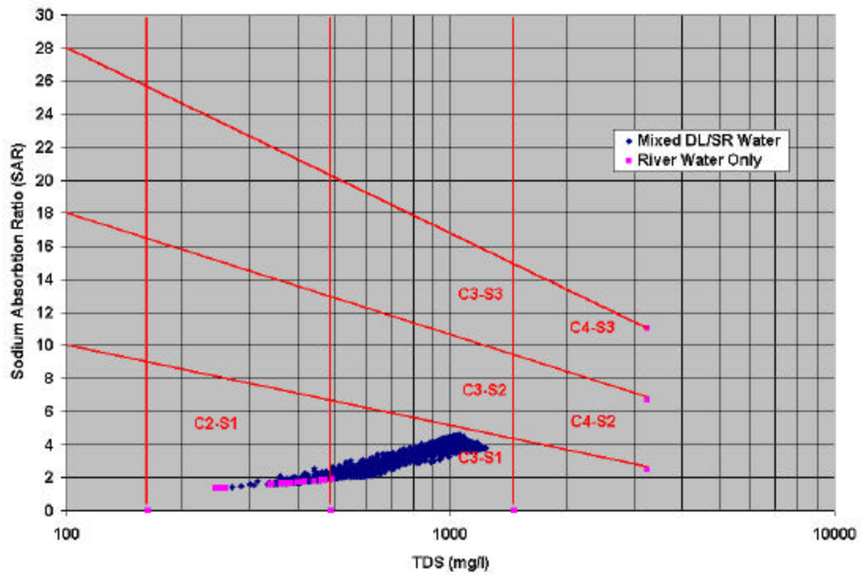


Figure A2-16. SAR percent exceedance graph for the Emerson control point (CP 99).

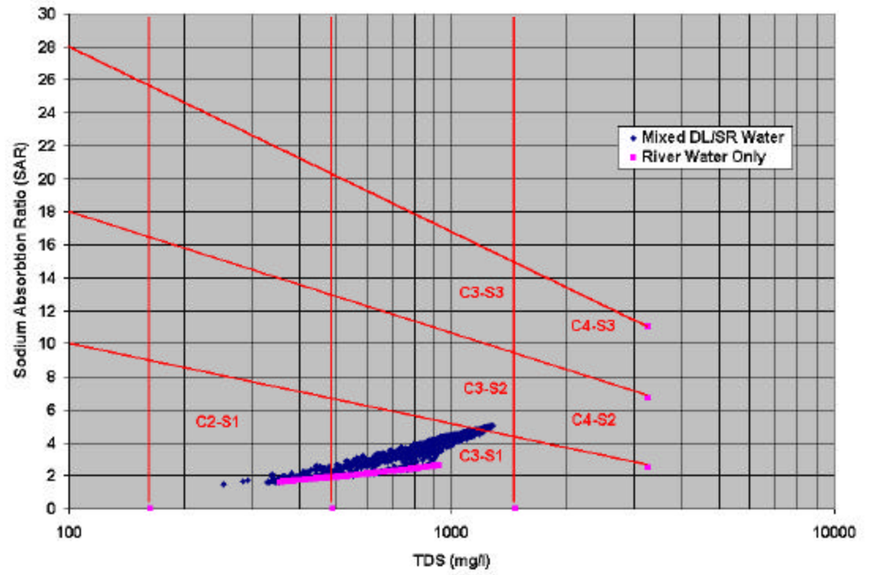


(A) Base Condition



(B) 300 cfs Constrained Alternative

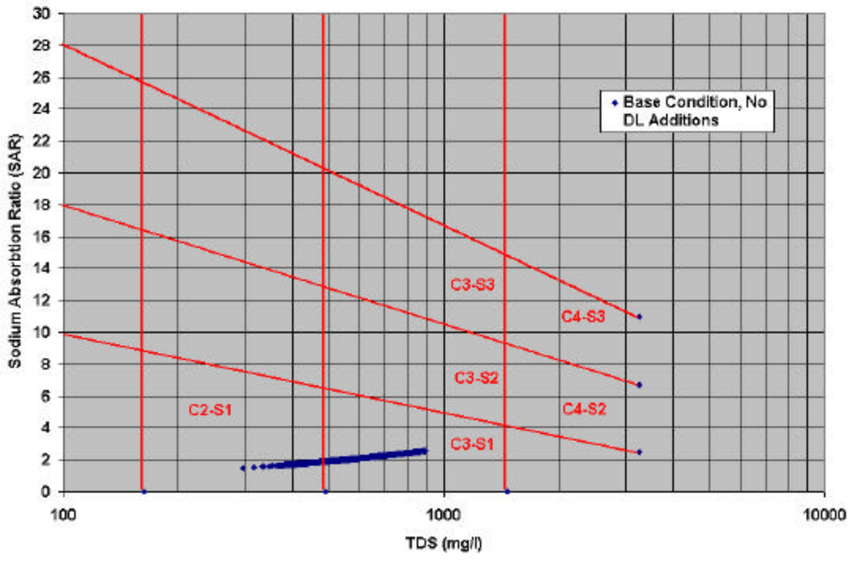
Figure A3-1. NSSL classifications of Sheyenne River Water, Wet7 climatic scenario, all alternatives, Warwick Control Point



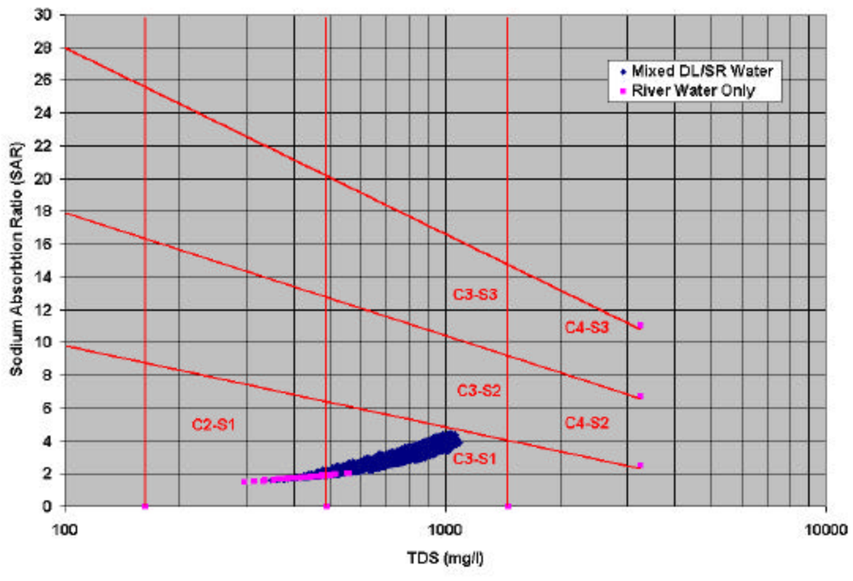
(C) 480 cfs Unconstrained Alternative

(Upstream of Natural Outlet)

(D) No Pump, Natural Spill Alternative

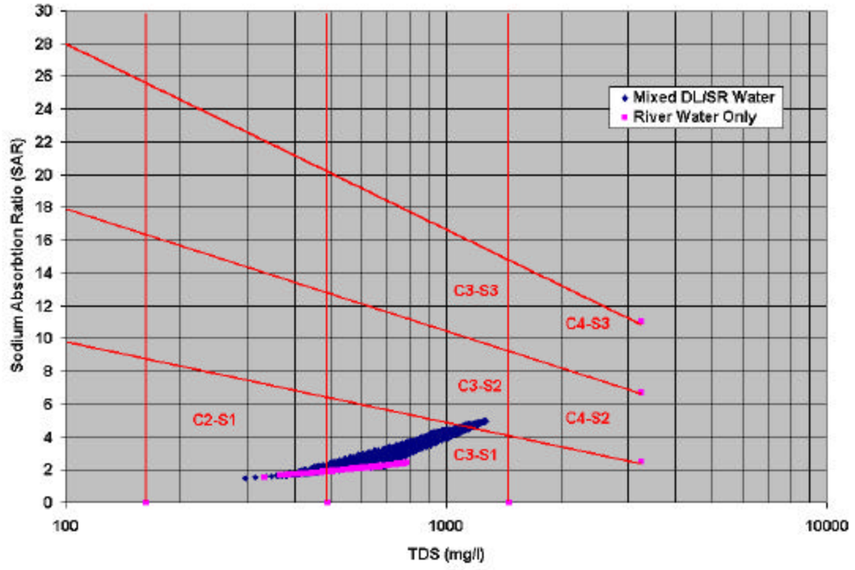


(A) Base Condition

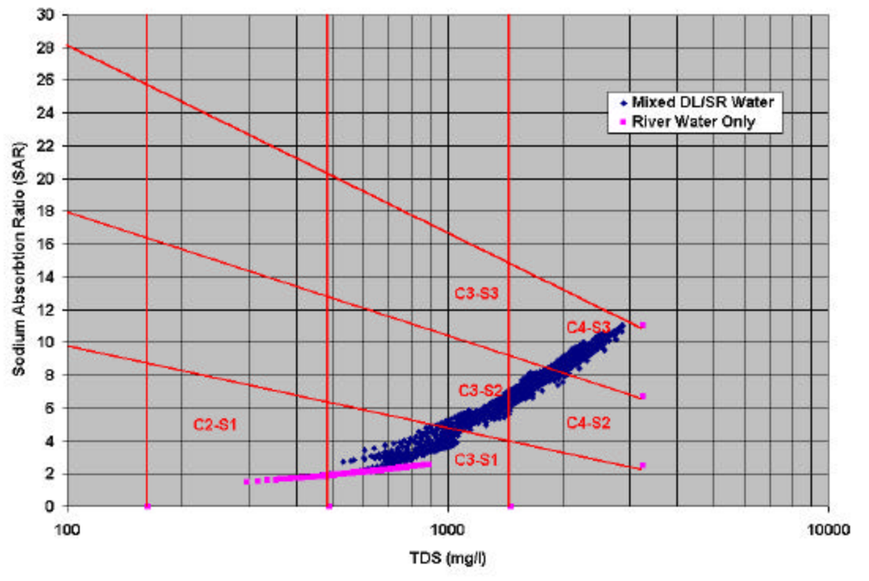


(B) 300 cfs Constrained Alternative

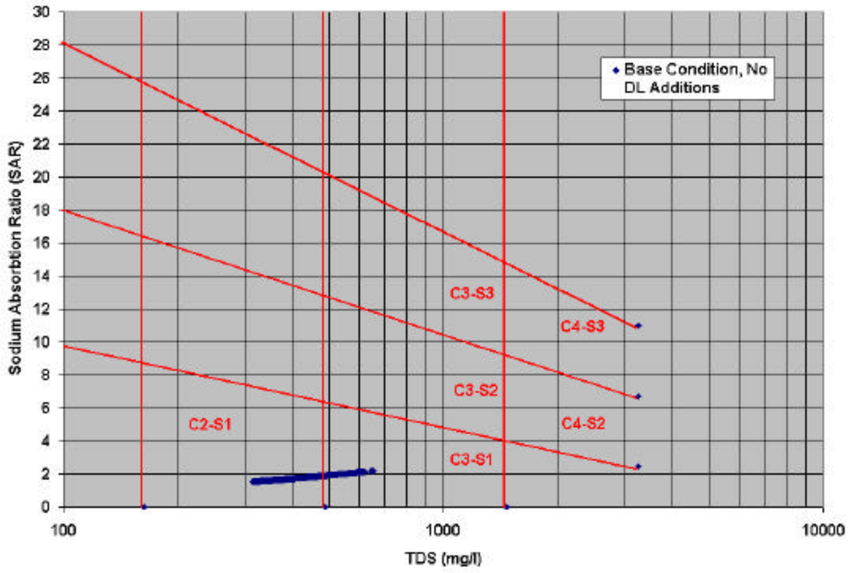
Figure A3-2. NSSL classifications of Sheyenne River Water, Wet7 climatic scenario, all alternatives, Cooperstown Control Point



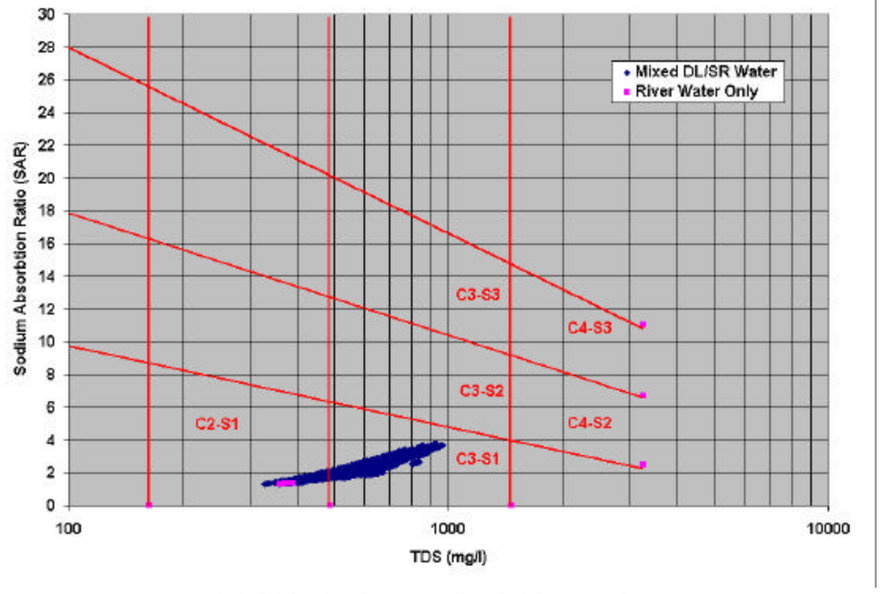
(C) 480 cfs Unconstrained Alternative



(D) No Pump, Natural Spill Alternative

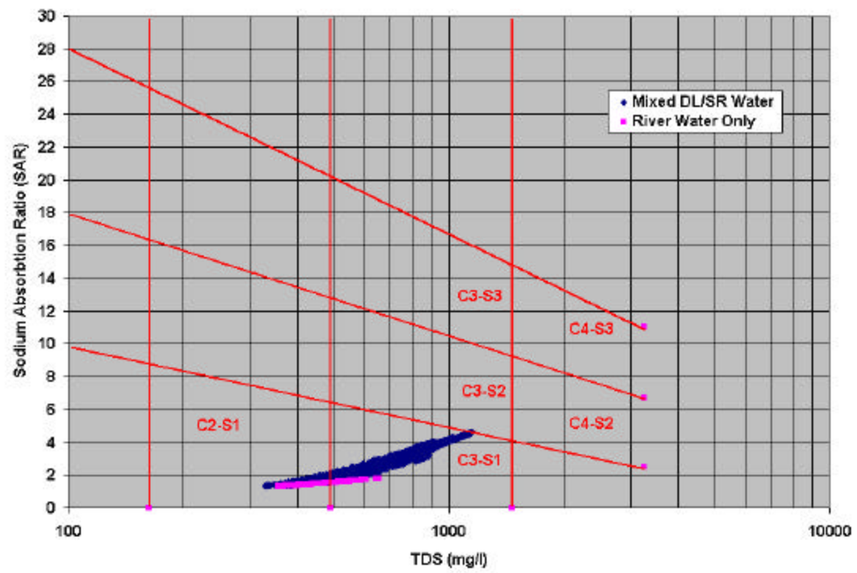


(A) Base Condition

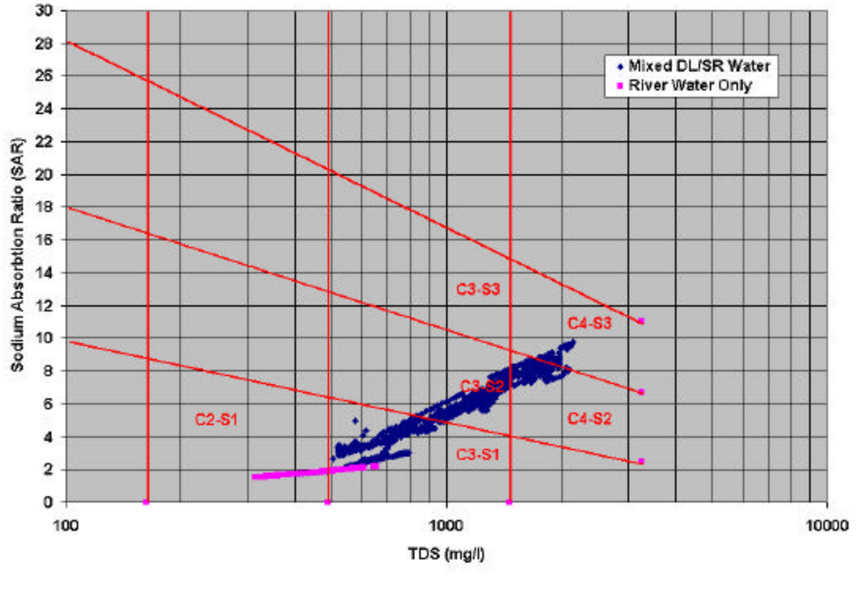


(B) 300 cfs Constrained Alternative

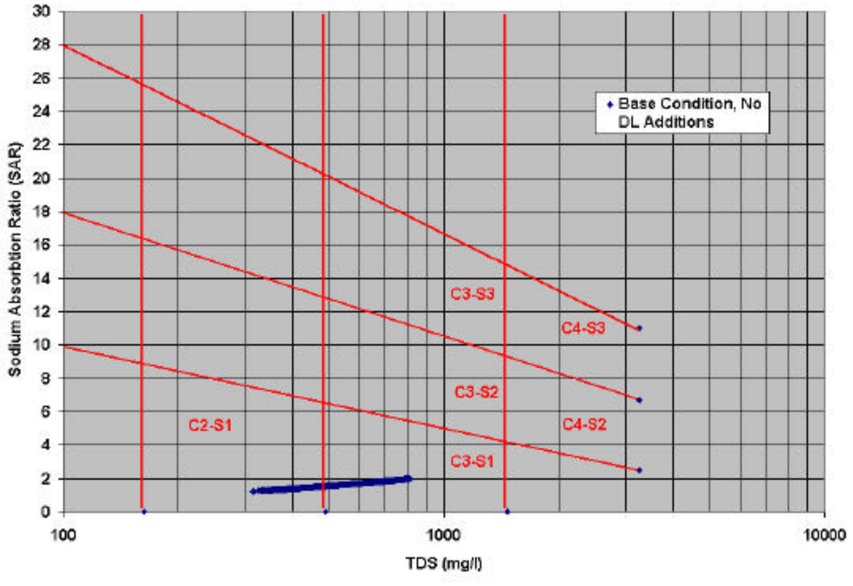
Figure A3-3. NSSL classifications of Sheyenne River Water, Wet7 climatic scenario, all alternatives, Valley City Control Point



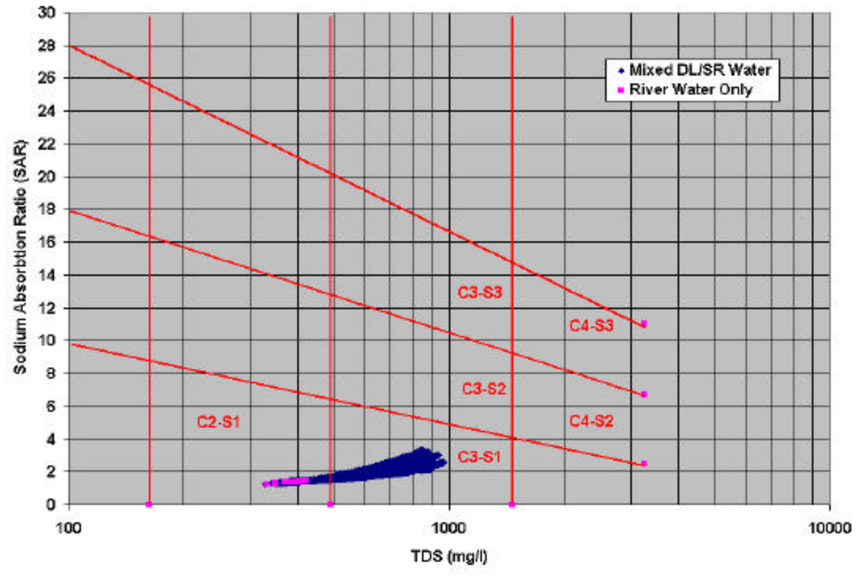
(C) 480 cfs Unconstrained Alternative



(D) No Pump, Natural Spill Alternative

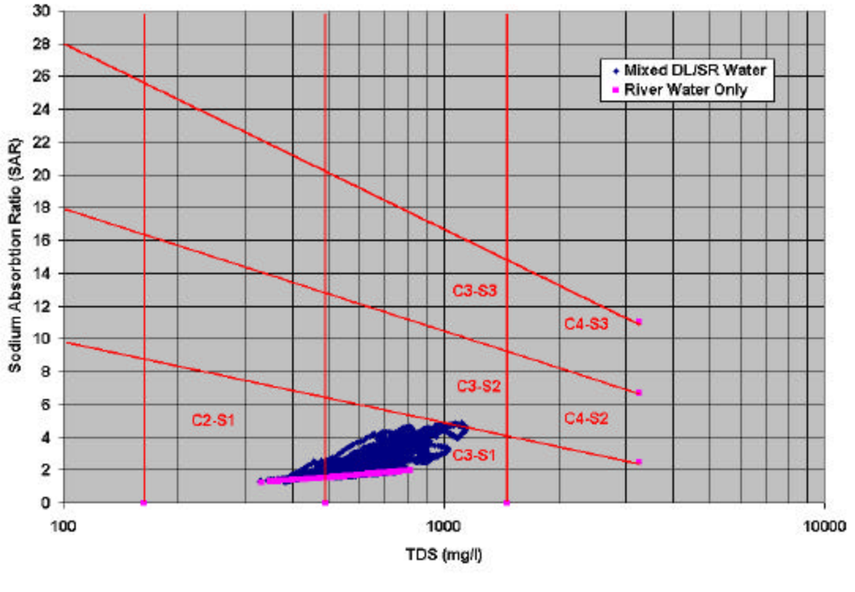


(A) Base Condition

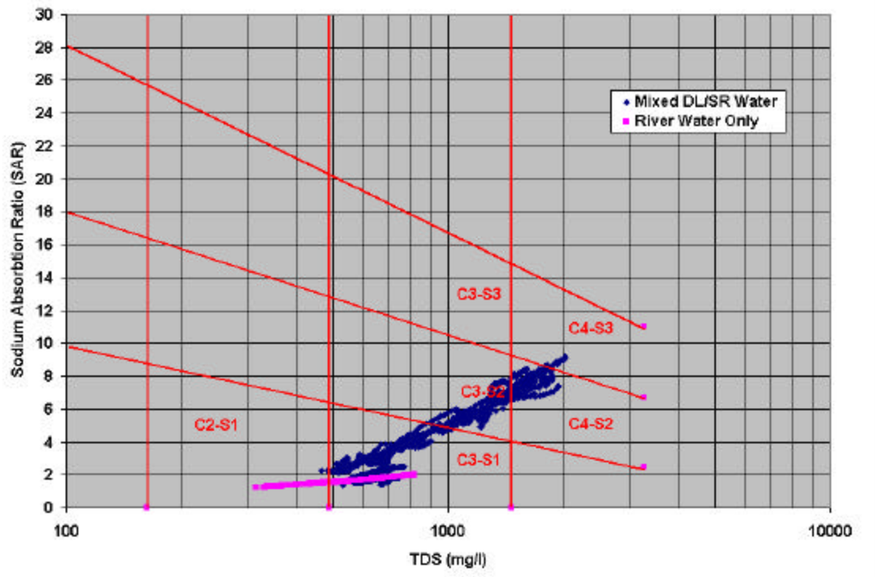


(B) 300 cfs Constrained Alternative

Figure A3-4. NSSL classifications of Sheyenne River Water, Wet7 climatic scenario, all alternatives, Lisbon Control Point



(C) 480 cfs Unconstrained Alternative



(D) No Pump, Natural Spill Alternative

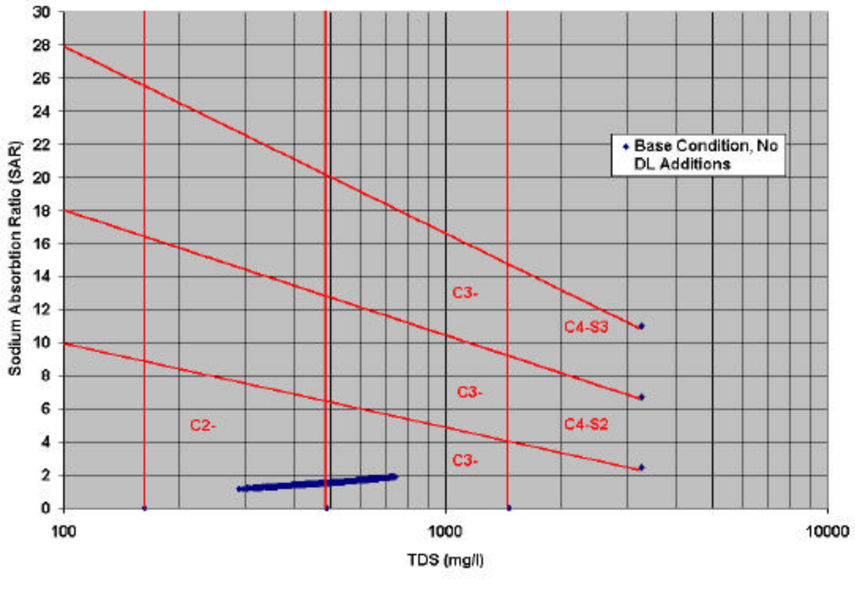
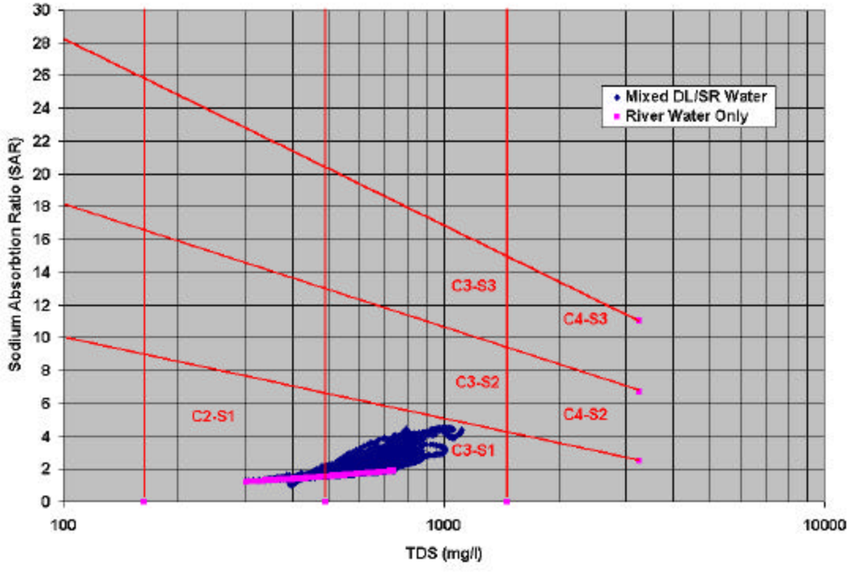
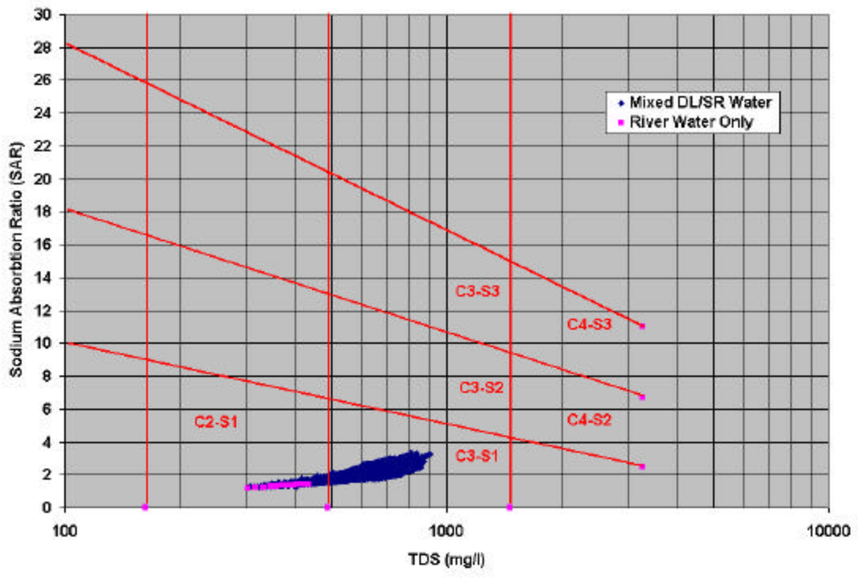


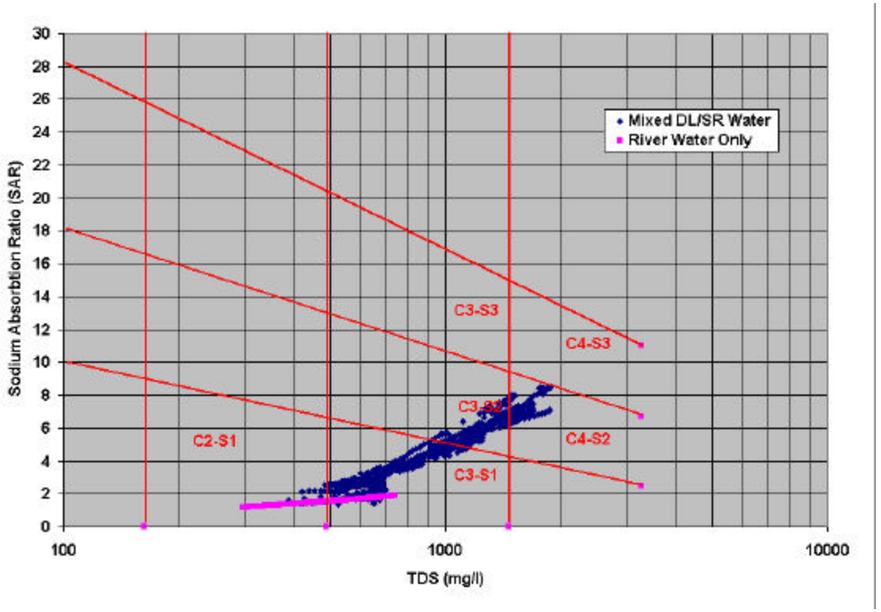
Figure A3-5. NSSL classifications of Sheyenne River Water, Wet7 climatic scenario, all alternatives, Kindred Control Point



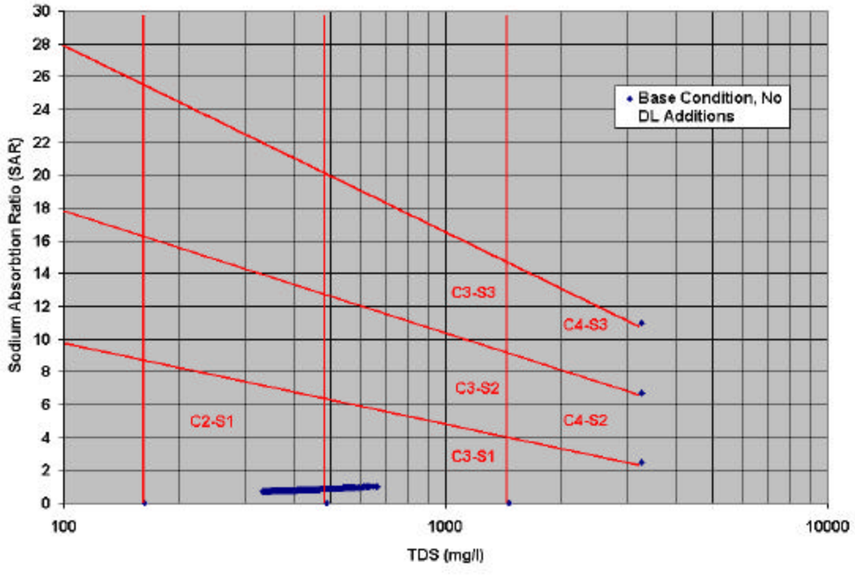
(C) 480 cfs Unconstrained Alternative



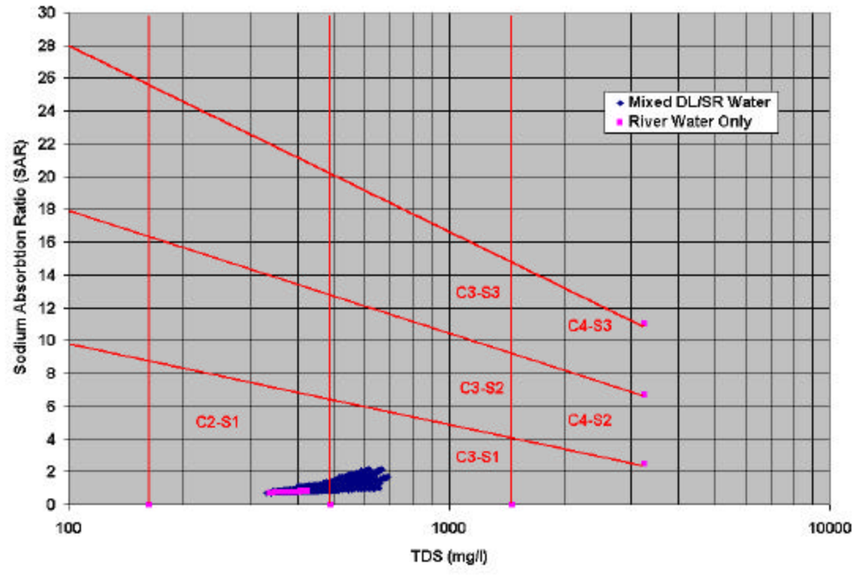
(B) 300 cfs Constrained Alternative



(D) No Pump, Natural Spill Alternative

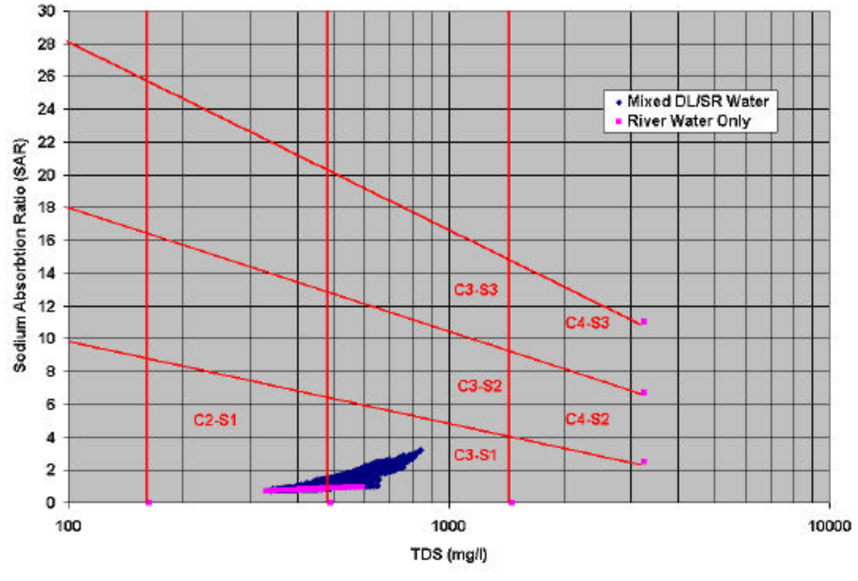


(A) Base Condition

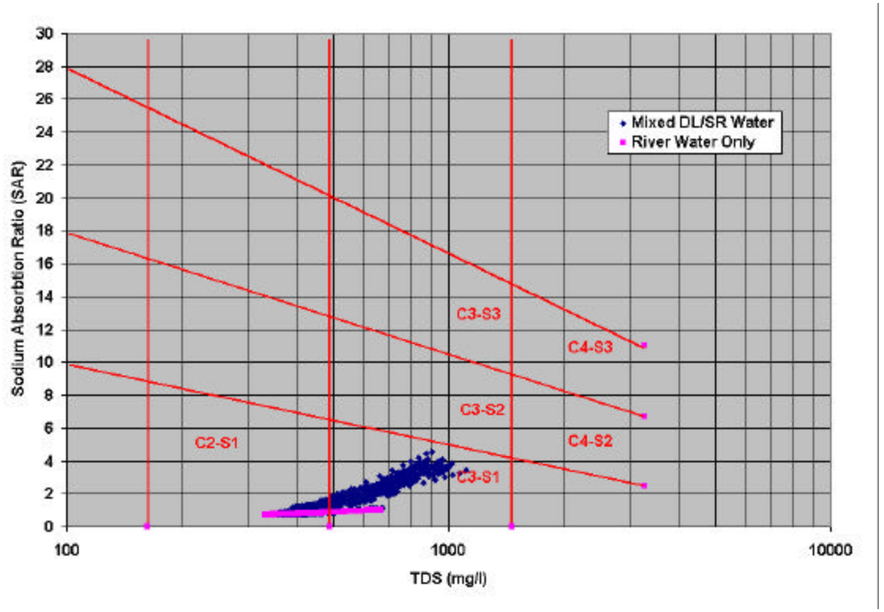


(B) 300 cfs Constrained Alternative

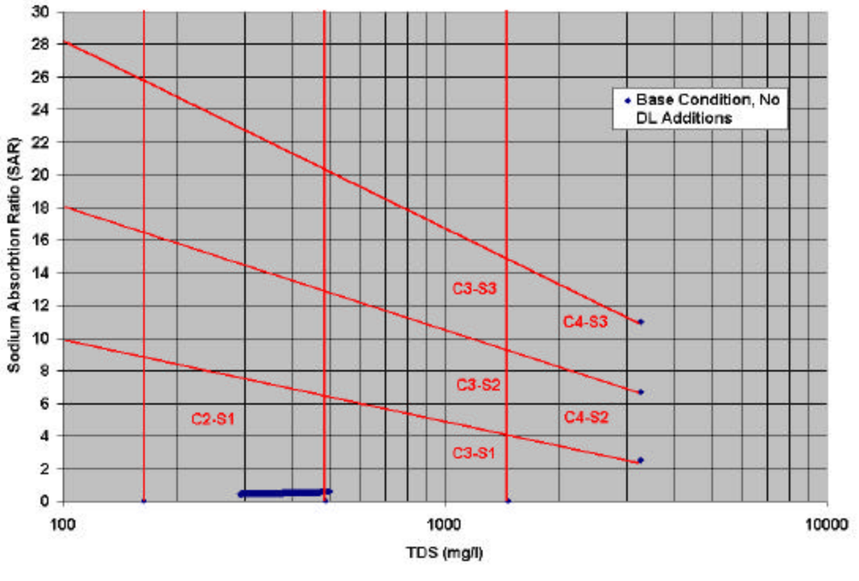
Figure A3-6. NSSL classifications of Sheyenne River Water, Wet7 climatic scenario, all alternatives, Halstad Control Point



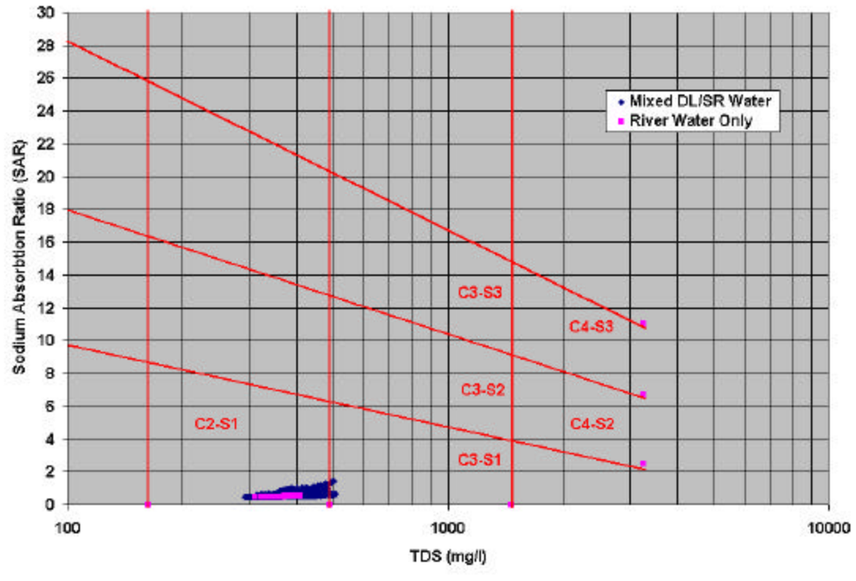
(C) 480 cfs Unconstrained Alternative



(D) No Pump, Natural Spill Alternative

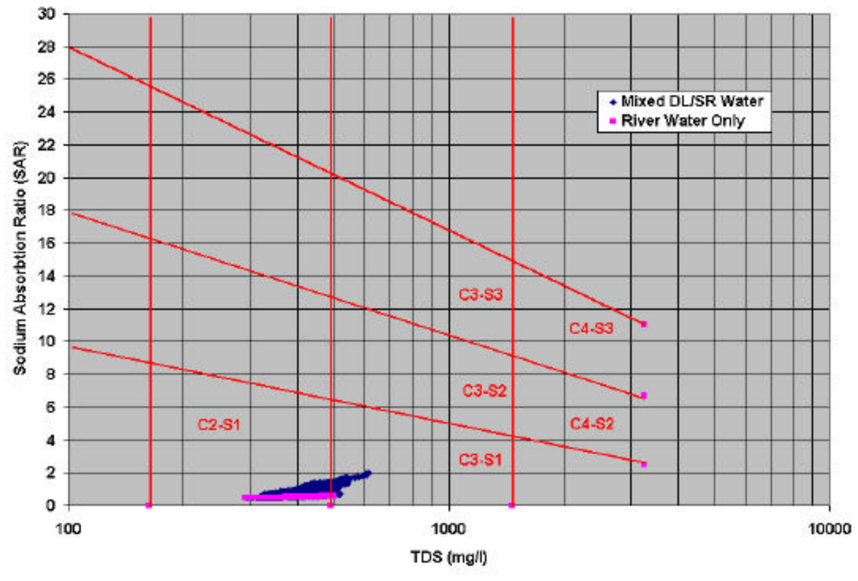


(A) Base Condition

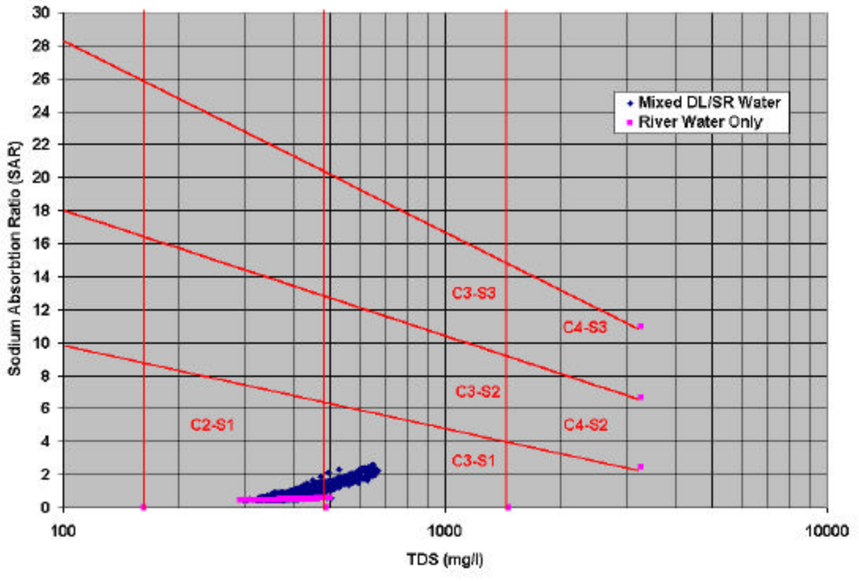


(B) 300 cfs Constrained Alternative

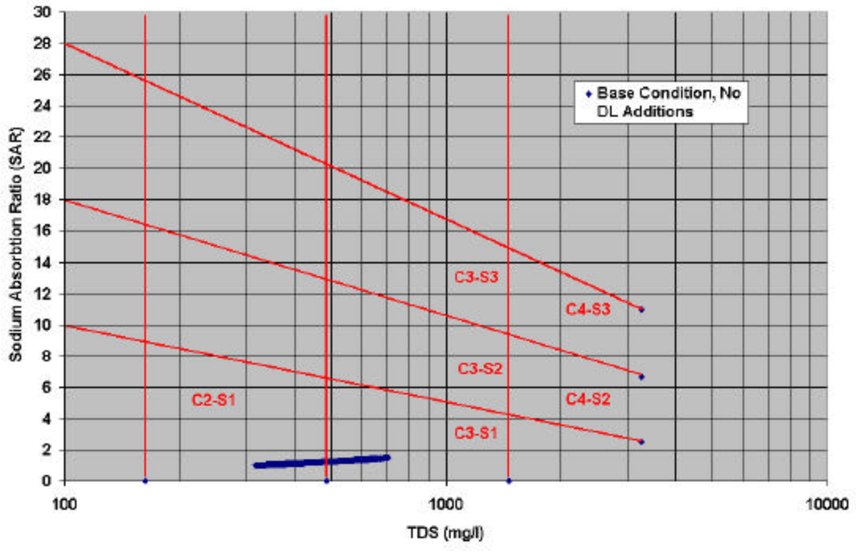
Figure A3-7. NSSL classifications of Sheyenne River Water, Wet7 climatic scenario, all alternatives, Grand Forks Control Point



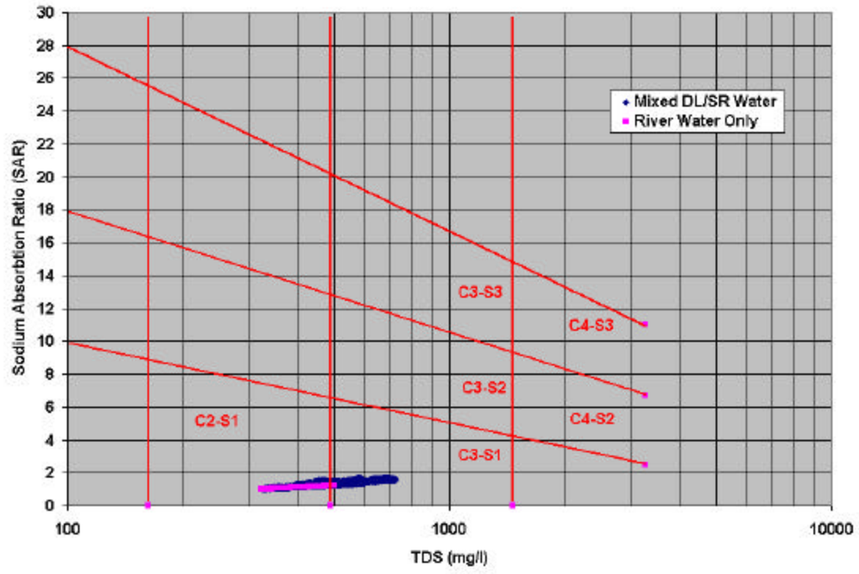
(C) 480 cfs Unconstrained Alternative



(D) No Pump, Natural Spill Alternative

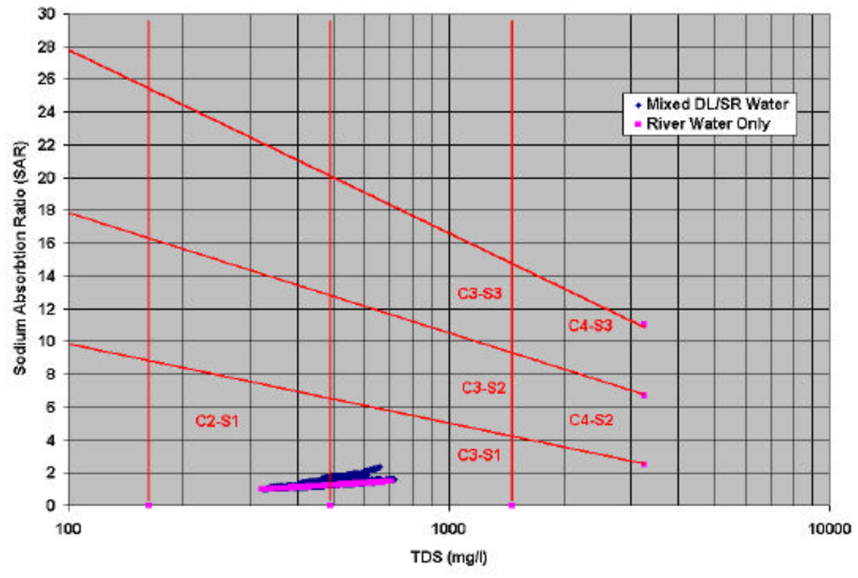


(A) Base Condition

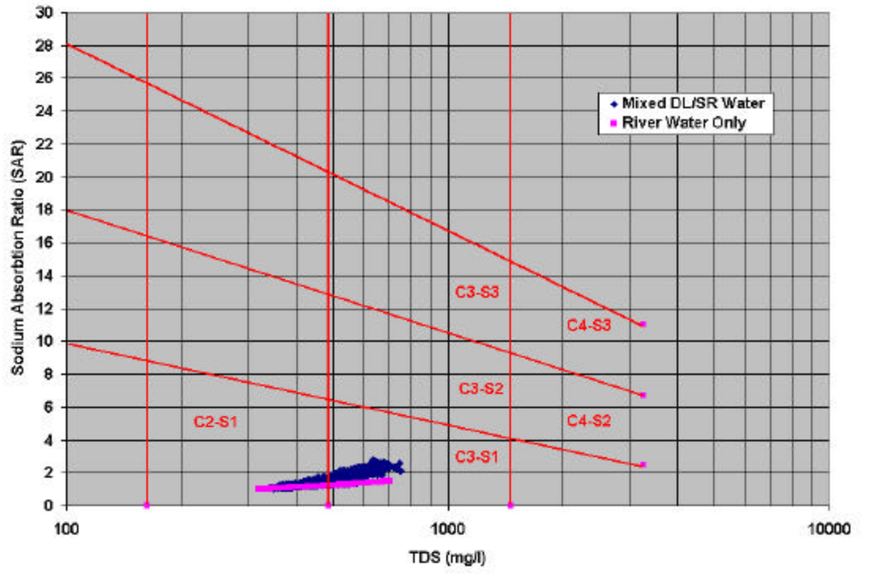


(B) 300 cfs Constrained Alternative

Figure A3-8. NSSL classifications of Sheyenne River Water, Wet7 climatic scenario, all alternatives, Emerson Control Point



(C) Natural Spill Alternative



(D) No Pump, Natural Spill Alternative

Appendix B

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
00507B	ND	Sheyenne	Barnes	1253	**36**	Fargo	90	2.8	C	2C	1000	650	6
00507B	ND	Sheyenne	Barnes	1253	**36**	Dovray	5	0.2	C	2C	1000	650	6
00507B	ND	Sheyenne	Barnes	1253	**36**	Lismore	3	0.1	C	3D	1800	1170	6
00507B	ND	Sheyenne	Barnes	1253	**36**	Ryan	2	0.1	N	1B			
01305P	ND	Red	Grand Forks	296	**126**	Bearden	85	29.5	C	3B	1500	975	6
01305P	ND	Red	Grand Forks	296	**126**	Ojata	4	1.4	N	1C			
01305P	ND	Red	Grand Forks	296	**126**	Perella	4	1.4	C	3B	1500	975	6
01305P	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	1.0	N	1C			
01305P	ND	Red	Grand Forks	296	**126**	Colvin	2	0.7	C	3B	1500	975	6
01305P	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	0.7	N	1C			
01305P	ND	Red	Grand Forks	296	**43b**	Cashel	85	39.9	C	3B	1500	975	6
01305P	ND	Red	Grand Forks	296	**43b**	Ladelle	5	2.3	I	4A	2250	1460	6
01305P	ND	Red	Grand Forks	296	**43b**	Wahpeton	4	1.9	C	3B	1500	975	6
01305P	ND	Red	Grand Forks	296	**43b**	Bearden	3	1.4	C	3B	1500	975	6
01305P	ND	Red	Grand Forks	296	**43b**	Dovray Channeled	3	1.4	C	2C	1000	650	6
01305P	ND	Red	Grand Forks	296	**79c**	Zell	50	7.3	N/I	1A/4A	2250	1460	6
01305P	ND	Red	Grand Forks	296	**79c**	Ladelle	35	5.1	I	4A	2250	1460	6
01305P	ND	Red	Grand Forks	296	**79c**	Bearden	5	0.7	C	3B	1500	975	6
01305P	ND	Red	Grand Forks	296	**79c**	Lamoure	5	0.7	C	3B	1500	975	6
01305P	ND	Red	Grand Forks	296	**79c**	Rauville	3	0.4	C	3B	1500	975	6
01305P	ND	Red	Grand Forks	296	**79c**	Ojata	2	0.3	N	1C			
1046	ND	Red	Grand Forks	296	**41**	Bearden	50	9.9	C	3B	1500	975	6
1046	ND	Red	Grand Forks	296	**41**	Perella	35	6.9	C	3B	1500	975	6
1046	ND	Red	Grand Forks	296	**41**	Bearden Saline	6	1.2	N	1C			
1046	ND	Red	Grand Forks	296	**41**	Overly	5	1.0	C	3A	1500	975	6
1046	ND	Red	Grand Forks	296	**41**	Wahpeton	4	0.8	C	3B	1500	975	6
1046	ND	Red	Grand Forks	296	**43b**	Cashel	85	173.3	C	3B	1500	975	6
1046	ND	Red	Grand Forks	296	**43b**	Ladelle	5	10.2	I	4A	2250	1460	6
1046	ND	Red	Grand Forks	296	**43b**	Wahpeton	4	8.2	C	3B	1500	975	6
1046	ND	Red	Grand Forks	296	**43b**	Bearden	3	6.1	C	3B	1500	975	6
1046	ND	Red	Grand Forks	296	**43b**	Dovray Channeled	3	6.1	C	2C	1000	650	6
1046	ND	Red	Grand Forks	296	**43e**	Cashel	85	23.1	C	3B	1500	975	6
1046	ND	Red	Grand Forks	296	**43e**	Wahpeton	6	1.6	C	3B	1500	975	6
1046	ND	Red	Grand Forks	296	**43e**	Dovray Channeled	5	1.4	C	2C	1000	650	6
1046	ND	Red	Grand Forks	296	**43e**	Ladelle	4	1.1	I	4A	2250	1460	6
1046	ND	Red	Grand Forks	296	**45**	Wahpeton	85	36.5	C	3B	1500	975	6
1046	ND	Red	Grand Forks	296	**45**	Laprairie	6	2.6	I	4A	2250	1460	6
1046	ND	Red	Grand Forks	296	**45**	Cashel	5	2.1	C	3B	1500	975	6
1046	ND	Red	Grand Forks	296	**45**	Perella	4	1.7	C	3B	1500	975	6
1048	ND	Red	Grand Forks	296	**43b**	Cashel	85	27.8	C	3B	1500	975	6
1048	ND	Red	Grand Forks	296	**43b**	Ladelle	5	1.6	I	4A	2250	1460	6
1048	ND	Red	Grand Forks	296	**43b**	Wahpeton	4	1.3	C	3B	1500	975	6
1048	ND	Red	Grand Forks	296	**43b**	Bearden	3	1.0	C	3B	1500	975	6
1048	ND	Red	Grand Forks	296	**43b**	Dovray Channeled	3	1.0	C	2C	1000	650	6
1048	ND	Red	Grand Forks	296	**43e**	Cashel	85	6.0	C	3B	1500	975	6
1048	ND	Red	Grand Forks	296	**43e**	Wahpeton	6	0.4	C	3B	1500	975	6
1048	ND	Red	Grand Forks	296	**43e**	Dovray Channeled	5	0.4	C	2C	1000	650	6
1048	ND	Red	Grand Forks	296	**43e**	Ladelle	4	0.3	I	4A	2250	1460	6
1048	ND	Red	Grand Forks	296	**45**	Wahpeton	85	40.4	C	3B	1500	975	6
1048	ND	Red	Grand Forks	296	**45**	Laprairie	6	2.9	I	4A	2250	1460	6
1048	ND	Red	Grand Forks	296	**45**	Cashel	5	2.4	C	3B	1500	975	6
1048	ND	Red	Grand Forks	296	**45**	Perella	4	1.9	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**126**	Bearden	85	52.2	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**126**	Ojata	4	2.5	N	1C			
1081	ND	Red	Grand Forks	296	**126**	Perella	4	2.5	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	1.8	N	1C			
1081	ND	Red	Grand Forks	296	**126**	Colvin	2	1.2	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	1.2	N	1C			
1081	ND	Red	Grand Forks	296	**25**	Overly	85	20.9	C	3A	1500	975	6
1081	ND	Red	Grand Forks	296	**25**	Perella	6	1.5	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**25**	Bearden	5	1.2	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**25**	Colvin	4	1.0	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**26**	Bearden	65	0.2	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**26**	Overly	25	0.1	C	3A	1500	975	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
1081	ND	Red	Grand Forks	296	**26**	Colvin	5	0.0	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**26**	Perella	5	0.0	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**43b**	Cashel	85	5.4	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**43b**	Ladelle	5	0.3	I	4A	2250	1460	6
1081	ND	Red	Grand Forks	296	**43b**	Wahpeton	4	0.3	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**43b**	Bearden	3	0.2	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**43b**	Dovray Channeled	3	0.2	C	2C	1000	650	6
1081	ND	Red	Grand Forks	296	**43e**	Cashel	85	0.2	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**43e**	Wahpeton	6	0.0	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**43e**	Dovray Channeled	5	0.0	C	2C	1000	650	6
1081	ND	Red	Grand Forks	296	**43e**	Ladelle	4	0.0	I	4A	2250	1460	6
1081	ND	Red	Grand Forks	296	**46**	Ladelle	85	4.7	I	4A	2250	1460	6
1081	ND	Red	Grand Forks	296	**46**	Ludden	6	0.3	C	2C	1000	650	6
1081	ND	Red	Grand Forks	296	**46**	Rauville	5	0.3	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**46**	Lamoure Channeled	4	0.2	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**79c**	Zell	50	36.5	N/I	1A/4A	2250	1460	6
1081	ND	Red	Grand Forks	296	**79c**	Ladelle	35	25.5	I	4A	2250	1460	6
1081	ND	Red	Grand Forks	296	**79c**	Bearden	5	3.6	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**79c**	Lamoure	5	3.6	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**79c**	Rauville	3	2.2	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**79c**	Ojata	2	1.5	N	1C			
1081	ND	Red	Grand Forks	296	**79d**	Zell	55	11.6	N/I	1A/4A	2250	1460	6
1081	ND	Red	Grand Forks	296	**79d**	Ladelle	30	6.4	I	4A	2250	1460	6
1081	ND	Red	Grand Forks	296	**79d**	Lamoure	6	1.3	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**79d**	Bearden	4	0.8	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**79d**	Rauville	3	0.6	C	3B	1500	975	6
1081	ND	Red	Grand Forks	296	**79d**	Ojata	2	0.4	N	1C			
1089	ND	Sheyenne	Cass	1068	**24**	Cashel	75	0.1	C	3B	1500	975	6
1089	ND	Sheyenne	Cass	1068	**24**	Fargo	10	0.0	C	2C	1000	650	6
1089	ND	Sheyenne	Cass	1068	**24**	Wahpeton	8	0.0	C	3B	1500	975	6
1089	ND	Sheyenne	Cass	1068	**24**	Fairdale	5	0.0	I	4A	2250	1460	6
1089	ND	Sheyenne	Cass	1068	**24**	Hegne	2	0.0	C	2C	1000	650	6
1089	ND	Sheyenne	Cass	1068	**36**	Fargo	73	12.2	C	2C	1000	650	6
1089	ND	Sheyenne	Cass	1068	**36**	Hegne	12	2.0	C	2C	1000	650	6
1089	ND	Sheyenne	Cass	1068	**36**	Dovray	5	0.8	C	2C	1000	650	6
1089	ND	Sheyenne	Cass	1068	**36**	Enloe	4	0.7	C	2C	1000	650	6
1089	ND	Sheyenne	Cass	1068	**36**	Cashel	2	0.3	C	3B	1500	975	6
1089	ND	Sheyenne	Cass	1068	**36**	Ryan	2	0.3	N	1B			
1089	ND	Sheyenne	Cass	1068	**36**	Wahpeton	2	0.3	C	3B	1500	975	6
1089	ND	Sheyenne	Cass	1068	**57**	Fairdale	80	4.3	I	4A	2250	1460	6
1089	ND	Sheyenne	Cass	1068	**57**	Cashel	10	0.5	C	3B	1500	975	6
1089	ND	Sheyenne	Cass	1068	**57**	Ladelle	5	0.3	I	4A	2250	1460	6
1089	ND	Sheyenne	Cass	1068	**57**	Fargo	3	0.2	C	2C	1000	650	6
1089	ND	Sheyenne	Cass	1068	**57**	Hegne	2	0.1	C	2C	1000	650	6
1227	ND	Sheyenne	Ransom	1162	**2209**	Buse	40	1.2	N/C	1A/3D	1800	1170	6
1227	ND	Sheyenne	Ransom	1162	**2209**	Barnes	36	1.1	C	3D	1800	1170	6
1227	ND	Sheyenne	Ransom	1162	**2209**	Svea	12	0.4	C	3D	1800	1170	6
1227	ND	Sheyenne	Ransom	1162	**2209**	Forman	5	0.1	C	3D	1800	1170	6
1227	ND	Sheyenne	Ransom	1162	**2209**	Sioux	5	0.1	N/I	1A/10	3000	1950	12
1227	ND	Sheyenne	Ransom	1162	**2209**	Maddock	2	0.1	I	8A	3000	1950	12
1227	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	36.9	I	4A	2250	1460	6
1227	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	5.9	I	4A	2250	1460	6
1227	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	1.4	I	4A	2250	1460	6
1227	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	1.4	I	4A	2250	1460	6
1227	ND	Sheyenne	Ransom	1162	**493**	Darnen	80	0.3	I	4A	2250	1460	6
1227	ND	Sheyenne	Ransom	1162	**493**	Svea	15	0.1	C	3D	1800	1170	6
1227	ND	Sheyenne	Ransom	1162	**493**	Barnes	3	0.0	C	3D	1800	1170	6
1227	ND	Sheyenne	Ransom	1162	**493**	Sioux	2	0.0	N/I	1A/10	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**1043**	La Prairie	80	6.6	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**1043**	Fairdale	12	1.0	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**1043**	Fordville	4	0.3	I	6B	3000	1950	9
1241	ND	Sheyenne	Ransom	1162	**1043**	Laprairie Channeled	3	0.2	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**1043**	Rauville	1	0.1	C	3B	1500	975	6
1241	ND	Sheyenne	Ransom	1162	**1403**	Overly	70	68.6	C	3A	1500	975	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
1241	ND	Sheyenne	Ransom	1162	**1403**	Great Bend	19	18.6	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**1403**	Gardena	5	4.9	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**1403**	Bearden	3	2.9	C	3B	1500	975	6
1241	ND	Sheyenne	Ransom	1162	**1403**	Perella	2	2.0	C	3B	1500	975	6
1241	ND	Sheyenne	Ransom	1162	**1403**	Tonka	1	1.0	C	2C	1000	650	6
1241	ND	Sheyenne	Ransom	1162	**1834**	Tonka	84	2.0	C	2C	1000	650	6
1241	ND	Sheyenne	Ransom	1162	**1834**	Hamerly	12	0.3	C	3B	1500	975	6
1241	ND	Sheyenne	Ransom	1162	**1834**	Vallers	4	0.1	C	3B	1500	975	6
1241	ND	Sheyenne	Ransom	1162	**1842**	Towner	61	5.3	C	5A	1800	1170	9
1241	ND	Sheyenne	Ransom	1162	**1842**	Lohnes	15	1.3	I	9A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**1842**	Maddock	10	0.9	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**1842**	Arvilla	5	0.4	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**1842**	Fordville	5	0.4	I	6B	3000	1950	9
1241	ND	Sheyenne	Ransom	1162	**1842**	Hamar	2	0.2	C	2B	1000	650	6
1241	ND	Sheyenne	Ransom	1162	**1842**	Hecla	2	0.2	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**1859**	Ulen	70	7.0	C	8B	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**1859**	Rosewood	14	1.4	C	8B	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**1859**	Hamar Fsl	5	0.5	C	2B	1000	650	6
1241	ND	Sheyenne	Ransom	1162	**1859**	Wyndmere	4	0.4	C	7B	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**1859**	Divide	3	0.3	C	6C	3000	1950	6
1241	ND	Sheyenne	Ransom	1162	**1859**	Aylmer	2	0.2	I	9A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**1859**	Hecla	2	0.2	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**2091**	Zell	70	8.5	N/I	1A/4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**2091**	Buse	10	1.2	N/C	1A/3D	1800	1170	6
1241	ND	Sheyenne	Ransom	1162	**2091**	Eckman	7	0.9	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**2091**	Gardena	7	0.9	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**2091**	Langhei	3	0.4	N/C	1A/3D	1800	1170	6
1241	ND	Sheyenne	Ransom	1162	**2091**	Sioux	3	0.4	N/I	1A/10	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**2213**	Eckman	50	2.4	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**2213**	Zell	35	1.7	N/I	1A/4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**2213**	Gardena	8	0.4	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**2213**	Buse	5	0.2	N/C	1A/3D	1800	1170	6
1241	ND	Sheyenne	Ransom	1162	**2213**	Renshaw	2	0.1	I	6A	3000	1950	9
1241	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	3.3	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	0.5	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	0.1	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	0.1	I	4A	2250	1460	6
1241	ND	Sheyenne	Ransom	1162	**2221**	Lohnes	92	66.5	I	9A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**2221**	Maddock	4	2.9	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**2221**	Claire	2	1.4	I	9A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**2221**	Hecla	2	1.4	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**726**	Fordville	65	37.5	I	6B	3000	1950	9
1241	ND	Sheyenne	Ransom	1162	**726**	Renshaw	25	14.4	I	6A	3000	1950	9
1241	ND	Sheyenne	Ransom	1162	**726**	Svea	4	2.3	C	3D	1800	1170	6
1241	ND	Sheyenne	Ransom	1162	**726**	Divide	3	1.7	C	6C	3000	1950	6
1241	ND	Sheyenne	Ransom	1162	**726**	Arvilla	2	1.2	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**726**	Sioux	1	0.6	N/I	1A/10	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**76**	Arvilla	79	8.5	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**76**	Brantford	10	1.1	I	6A	3000	1950	9
1241	ND	Sheyenne	Ransom	1162	**76**	Fordville	3	0.3	I	6B	3000	1950	9
1241	ND	Sheyenne	Ransom	1162	**76**	Divide	2	0.2	C	6C	3000	1950	6
1241	ND	Sheyenne	Ransom	1162	**76**	Embden	2	0.2	I	7A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**76**	Hecla	2	0.2	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**76**	Sioux	2	0.2	N/I	1A/10	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**939**	Hecla	62	30.7	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**939**	Hamar	24	11.9	C	2B	1000	650	6
1241	ND	Sheyenne	Ransom	1162	**939**	Ulen	4	2.0	C	8B	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**939**	Aylmer	3	1.5	I	9A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**939**	Maddock	3	1.5	I	8A	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**939**	Hamar Lfs Pd	2	1.0	C	2B	1000	650	6
1241	ND	Sheyenne	Ransom	1162	**939**	Rosewood	1	0.5	C	8B	3000	1950	12
1241	ND	Sheyenne	Ransom	1162	**939**	Wyndmere	1	0.5	C	7B	3000	1950	12
1573	ND	Sheyenne	Barnes	1253	**56**	Ladelle	75	0.1	I	4A	2250	1460	6
1573	ND	Sheyenne	Barnes	1253	**56**	Fairdale	18	0.0	I	4A	2250	1460	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
1573	ND	Sheyenne	Barnes	1253	**56**	Sinai	5	0.0	C	2B	1000	650	6
1573	ND	Sheyenne	Barnes	1253	**56**	Lamoure	2	0.0	C	3B	1500	975	6
1573	ND	Sheyenne	Barnes	1253	**82**	Sinai	80	3.0	C	2B	1000	650	6
1573	ND	Sheyenne	Barnes	1253	**82**	Nutley	18	0.7	C	2B	1000	650	6
1573	ND	Sheyenne	Barnes	1253	**82**	Ladelle	2	0.1	I	4A	2250	1460	6
1573	ND	Sheyenne	Barnes	1253	**82b**	Sinai	80	0.6	C	2B	1000	650	6
1573	ND	Sheyenne	Barnes	1253	**82b**	Edgeley	10	0.1	N	3C			
1573	ND	Sheyenne	Barnes	1253	**82b**	Nutley	10	0.1	C	2B	1000	650	6
1573	ND	Sheyenne	Barnes	1253	**83f**	Kloten	55	0.3	N	1e			
1573	ND	Sheyenne	Barnes	1253	**83f**	Buse	30	0.1	N/C	1A/3D	1800	1170	6
1573	ND	Sheyenne	Barnes	1253	**83f**	Edgeley	7	0.0	N	3C			
1573	ND	Sheyenne	Barnes	1253	**83f**	Barnes	2	0.0	C	3D	1800	1170	6
1573	ND	Sheyenne	Barnes	1253	**83f**	Nutley	2	0.0	C	2B	1000	650	6
1573	ND	Sheyenne	Barnes	1253	**83f**	Sioux	2	0.0	N/I	1A/10	3000	1950	12
1573	ND	Sheyenne	Barnes	1253	**83f**	Lamoure	1	0.0	C	3B	1500	975	6
1573	ND	Sheyenne	Barnes	1253	**83f**	Sinai	1	0.0	C	2B	1000	650	6
1889	ND	Sheyenne	Nelson	1317	**Hka**	Hecla	80	11.2	I	8A	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Hka**	Wyndmere	6	0.8	C	7B	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Hka**	Hamar Sl Pd	5	0.7	C	2B	1000	650	6
1889	ND	Sheyenne	Nelson	1317	**Hka**	Claire	4	0.6	I	9A	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Hka**	Lohnes	3	0.4	I	9A	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Hka**	Maddock	2	0.3	I	8A	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Ln**	La Prairie	85	4.8	I	4A	2250	1460	6
1889	ND	Sheyenne	Nelson	1317	**Ln**	Lamoure	7	0.4	C	3B	1500	975	6
1889	ND	Sheyenne	Nelson	1317	**Ln**	Ladelle	5	0.3	I	4A	2250	1460	6
1889	ND	Sheyenne	Nelson	1317	**Ln**	Walsh	3	0.2	C	3D	1800	1170	6
1889	ND	Sheyenne	Nelson	1317	**Tf**	Tiffany	84	6.1	C	7B	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Tf**	Wyndmere	4	0.3	C	7B	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Tf**	Fossum	3	0.2	C	3D	1800	1170	6
1889	ND	Sheyenne	Nelson	1317	**Tf**	Venlo	3	0.2	C	8B	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Tf**	Arveson	2	0.1	C	7B	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Tf**	Embden	2	0.1	I	7A	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Tf**	Hamar	2	0.1	C	2B	1000	650	6
1889	ND	Sheyenne	Nelson	1317	**Wo**	Wyndmere	77	3.2	C	7B	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Wo**	Fossum	8	0.3	C	3D	1800	1170	6
1889	ND	Sheyenne	Nelson	1317	**Wo**	Hamar	4	0.2	C	2B	1000	650	6
1889	ND	Sheyenne	Nelson	1317	**Wo**	Clontarf	3	0.1	I	8A	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Wo**	Hecla	3	0.1	I	8A	3000	1950	12
1889	ND	Sheyenne	Nelson	1317	**Wo**	Stirum	3	0.1	N	1B			
1889	ND	Sheyenne	Nelson	1317	**Wo**	Lohnes	2	0.1	I	9A	3000	1950	12
1976	ND	Sheyenne	Barnes	1253	**54**	Lamoure	80	0.7	C	3B	1500	975	6
1976	ND	Sheyenne	Barnes	1253	**54**	Colvin Channeled	9	0.1	C	3B	1500	975	6
1976	ND	Sheyenne	Barnes	1253	**54**	Marysland	6	0.1	C	6C	3000	1950	6
1976	ND	Sheyenne	Barnes	1253	**54**	Rauville	3	0.0	C	3B	1500	975	6
1976	ND	Sheyenne	Barnes	1253	**54**	Colvin Saline	2	0.0	N	1C			
1976	ND	Sheyenne	Barnes	1253	**56**	Ladelle	75	14.1	I	4A	2250	1460	6
1976	ND	Sheyenne	Barnes	1253	**56**	Fairdale	18	3.4	I	4A	2250	1460	6
1976	ND	Sheyenne	Barnes	1253	**56**	Sinai	5	0.9	C	2B	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**56**	Lamoure	2	0.4	C	3B	1500	975	6
1976	ND	Sheyenne	Barnes	1253	**68e**	Sioux	65	1.8	N/I	1A/10	3000	1950	12
1976	ND	Sheyenne	Barnes	1253	**68e**	Renshaw	30	0.8	I	6A	3000	1950	9
1976	ND	Sheyenne	Barnes	1253	**68e**	Barnes	2	0.1	C	3D	1800	1170	6
1976	ND	Sheyenne	Barnes	1253	**68e**	Gardena	2	0.1	I	4A	2250	1460	6
1976	ND	Sheyenne	Barnes	1253	**68e**	Fordville	1	0.0	I	6B	3000	1950	9
1976	ND	Sheyenne	Barnes	1253	**82**	Sinai	80	67.2	C	2B	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**82**	Nutley	18	15.1	C	2B	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**82**	Ladelle	2	1.7	I	4A	2250	1460	6
1976	ND	Sheyenne	Barnes	1253	**82b**	Sinai	80	2.3	C	2B	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**82b**	Edgeley	10	0.3	N	3C			
1976	ND	Sheyenne	Barnes	1253	**82b**	Nutley	10	0.3	C	2B	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**83f**	Kloten	55	0.4	N	1e			
1976	ND	Sheyenne	Barnes	1253	**83f**	Buse	30	0.2	N/C	1A/3D	1800	1170	6
1976	ND	Sheyenne	Barnes	1253	**83f**	Edgeley	7	0.0	N	3C			
1976	ND	Sheyenne	Barnes	1253	**83f**	Barnes	2	0.0	C	3D	1800	1170	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
1976	ND	Sheyenne	Barnes	1253	**83f**	Nutley	2	0.0	C	2B	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**83f**	Sioux	2	0.0	N/I	1A/10	3000	1950	12
1976	ND	Sheyenne	Barnes	1253	**83f**	Lamoure	1	0.0	C	3B	1500	975	6
1976	ND	Sheyenne	Barnes	1253	**83f**	Sinai	1	0.0	C	2B	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**9**	Nutley	95	41.8	C	2B	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**9**	Fargo	5	2.2	C	2C	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**9b**	Nutley	95	12.9	C	2B	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**9b**	Edgeley Var.	3	0.4	N	3C			
1976	ND	Sheyenne	Barnes	1253	**9b**	Fargo	2	0.3	C	2C	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**9d**	Nutley	85	3.6	C	2B	1000	650	6
1976	ND	Sheyenne	Barnes	1253	**9d**	Edgeley Var.	11	0.5	N	3C			
1976	ND	Sheyenne	Barnes	1253	**9d**	Buse	2	0.1	N/C	1A/3D	1800	1170	6
1976	ND	Sheyenne	Barnes	1253	**9d**	Kloten	2	0.1	N	1e			
1976A	ND	Sheyenne	Barnes	1253	**54**	Lamoure	80	5.0	C	3B	1500	975	6
1976A	ND	Sheyenne	Barnes	1253	**54**	Colvin Channeled	9	0.6	C	3B	1500	975	6
1976A	ND	Sheyenne	Barnes	1253	**54**	Marysland	6	0.4	C	6C	3000	1950	6
1976A	ND	Sheyenne	Barnes	1253	**54**	Rauville	3	0.2	C	3B	1500	975	6
1976A	ND	Sheyenne	Barnes	1253	**54**	Colvin Saline	2	0.1	N	1C			
1976A	ND	Sheyenne	Barnes	1253	**82**	Sinai	80	16.5	C	2B	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**82**	Nutley	18	3.7	C	2B	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**82**	Ladelle	2	0.4	I	4A	2250	1460	6
1976A	ND	Sheyenne	Barnes	1253	**82b**	Sinai	80	17.2	C	2B	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**82b**	Edgeley	10	2.2	N	3C			
1976A	ND	Sheyenne	Barnes	1253	**82b**	Nutley	10	2.2	C	2B	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**83f**	Kloten	55	0.9	N	1e			
1976A	ND	Sheyenne	Barnes	1253	**83f**	Buse	30	0.5	N/C	1A/3D	1800	1170	6
1976A	ND	Sheyenne	Barnes	1253	**83f**	Edgeley	7	0.1	N	3C			
1976A	ND	Sheyenne	Barnes	1253	**83f**	Barnes	2	0.0	C	3D	1800	1170	6
1976A	ND	Sheyenne	Barnes	1253	**83f**	Nutley	2	0.0	C	2B	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**83f**	Sioux	2	0.0	N/I	1A/10	3000	1950	12
1976A	ND	Sheyenne	Barnes	1253	**83f**	Lamoure	1	0.0	C	3B	1500	975	6
1976A	ND	Sheyenne	Barnes	1253	**83f**	Sinai	1	0.0	C	2B	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**9**	Nutley	95	3.6	C	2B	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**9**	Fargo	5	0.2	C	2C	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**9b**	Nutley	95	33.2	C	2B	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**9b**	Edgeley Var.	3	1.0	N	3C			
1976A	ND	Sheyenne	Barnes	1253	**9b**	Fargo	2	0.7	C	2C	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**9d**	Nutley	85	11.0	C	2B	1000	650	6
1976A	ND	Sheyenne	Barnes	1253	**9d**	Edgeley Var.	11	1.4	N	3C			
1976A	ND	Sheyenne	Barnes	1253	**9d**	Buse	2	0.3	N/C	1A/3D	1800	1170	6
1976A	ND	Sheyenne	Barnes	1253	**9d**	Kloten	2	0.3	N	1e			
2011	ND	Sheyenne	Ransom	1162	**1055**	Ladelle	91	10.2	I	4A	2250	1460	6
2011	ND	Sheyenne	Ransom	1162	**1055**	Lamoure	4	0.5	C	3B	1500	975	6
2011	ND	Sheyenne	Ransom	1162	**1055**	Ladelle Channeled	2	0.2	I	4A	2250	1460	6
2011	ND	Sheyenne	Ransom	1162	**1055**	Laprairie	2	0.2	I	4A	2250	1460	6
2011	ND	Sheyenne	Ransom	1162	**1055**	Rauville	1	0.1	C	3B	1500	975	6
2011	ND	Sheyenne	Ransom	1162	**156**	Barnes	56	11.9	C	3D	1800	1170	6
2011	ND	Sheyenne	Ransom	1162	**156**	Svea	28	5.9	C	3D	1800	1170	6
2011	ND	Sheyenne	Ransom	1162	**156**	Buse	7	1.5	N/C	1A/3D	1800	1170	6
2011	ND	Sheyenne	Ransom	1162	**156**	Tonka	4	0.8	C	2C	1000	650	6
2011	ND	Sheyenne	Ransom	1162	**156**	Parnell	3	0.6	C	2C	1000	650	6
2011	ND	Sheyenne	Ransom	1162	**156**	Hamerly	1	0.2	C	3B	1500	975	6
2011	ND	Sheyenne	Ransom	1162	**156**	Vallers	1	0.2	C	3B	1500	975	6
2011	ND	Sheyenne	Ransom	1162	**2209**	Buse	40	0.0	N/C	1A/3D	1800	1170	6
2011	ND	Sheyenne	Ransom	1162	**2209**	Barnes	36	0.0	C	3D	1800	1170	6
2011	ND	Sheyenne	Ransom	1162	**2209**	Svea	12	0.0	C	3D	1800	1170	6
2011	ND	Sheyenne	Ransom	1162	**2209**	Forman	5	0.0	C	3D	1800	1170	6
2011	ND	Sheyenne	Ransom	1162	**2209**	Sioux	5	0.0	N/I	1A/10	3000	1950	12
2011	ND	Sheyenne	Ransom	1162	**2209**	Maddock	2	0.0	I	8A	3000	1950	12
2011	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	72.5	I	4A	2250	1460	6
2011	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	11.6	I	4A	2250	1460	6
2011	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	2.7	I	4A	2250	1460	6
2011	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	2.7	I	4A	2250	1460	6
2011	ND	Sheyenne	Ransom	1162	**2223**	Renshaw	52	1.6	I	6A	3000	1950	9

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Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
2011	ND	Sheyenne	Ransom	1162	**2223**	Sioux	22	0.7	N/I	1A/10	3000	1950	12
2011	ND	Sheyenne	Ransom	1162	**2223**	Fordville	17	0.5	I	6B	3000	1950	9
2011	ND	Sheyenne	Ransom	1162	**2223**	Arvilla	6	0.2	I	8A	3000	1950	12
2011	ND	Sheyenne	Ransom	1162	**2223**	Divide	3	0.1	C	6C	3000	1950	6
2011	ND	Sheyenne	Ransom	1162	**314**	Buse	53	6.9	N/C	1A/3D	1800	1170	6
2011	ND	Sheyenne	Ransom	1162	**314**	Barnes	31	4.0	C	3D	1800	1170	6
2011	ND	Sheyenne	Ransom	1162	**314**	Svea	11	1.4	C	3D	1800	1170	6
2011	ND	Sheyenne	Ransom	1162	**314**	Darnen	4	0.5	I	4A	2250	1460	6
2011	ND	Sheyenne	Ransom	1162	**314**	Tonka	1	0.1	C	2C	1000	650	6
2198	ND	Sheyenne	Barnes	1253	**56**	Ladelle	75	5.1	I	4A	2250	1460	6
2198	ND	Sheyenne	Barnes	1253	**56**	Fairdale	18	1.2	I	4A	2250	1460	6
2198	ND	Sheyenne	Barnes	1253	**56**	Sinai	5	0.3	C	2B	1000	650	6
2198	ND	Sheyenne	Barnes	1253	**56**	Lamoure	2	0.1	C	3B	1500	975	6
2198	ND	Sheyenne	Barnes	1253	**82**	Sinai	80	0.1	C	2B	1000	650	6
2198	ND	Sheyenne	Barnes	1253	**82**	Nutley	18	0.0	C	2B	1000	650	6
2198	ND	Sheyenne	Barnes	1253	**82**	Ladelle	2	0.0	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Blb**	Binford	82	10.7	I	8A	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Blb**	Binford >40% Gr. Substra.	5	0.7	I	8A	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Blb**	Coe	3	0.4	N/I	1A/10	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Blb**	Gardena	3	0.4	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Blb**	Tolna	3	0.4	C	7B	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Blb**	Tonka	2	0.3	C	2C	1000	650	6
2206	ND	Sheyenne	Eddy	1408	**Blb**	Vang	2	0.3	I	6B	3000	1950	9
2206	ND	Sheyenne	Eddy	1408	**Bn**	Borup	85	0.9	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Bn**	Divide	5	0.1	C	6C	3000	1950	6
2206	ND	Sheyenne	Eddy	1408	**Bn**	Glyndon	4	0.0	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Bn**	Borup Vpd	2	0.0	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Bn**	Marysland	2	0.0	C	6C	3000	1950	6
2206	ND	Sheyenne	Eddy	1408	**Bn**	Totten	2	0.0	N	1B			
2206	ND	Sheyenne	Eddy	1408	**Cvd**	Coe	84	1.2	N/I	1A/10	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Cvd**	Vang	4	0.1	I	6B	3000	1950	9
2206	ND	Sheyenne	Eddy	1408	**Cvd**	Brantford	3	0.0	I	6A	3000	1950	9
2206	ND	Sheyenne	Eddy	1408	**Cvd**	Tonka	3	0.0	C	2C	1000	650	6
2206	ND	Sheyenne	Eddy	1408	**Cvd**	Binford	2	0.0	I	8A	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Cvd**	Gardena	2	0.0	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Cvd**	Tolna	2	0.0	C	7B	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Emc**	Egeland	50	2.1	I	7A	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Emc**	Embden	30	1.3	I	7A	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Emc**	Hamar	5	0.2	C	2B	1000	650	6
2206	ND	Sheyenne	Eddy	1408	**Emc**	Tiffany	4	0.2	C	7B	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Emc**	Emrick	3	0.1	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Emc**	Esmond	3	0.1	N/I	1A/4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Emc**	Heimdal	3	0.1	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Emc**	Swenoda	2	0.1	C	5A	1800	1170	9
2206	ND	Sheyenne	Eddy	1408	**Evd**	Coe	25	2.6	N/I	1A/10	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Evd**	Embden	25	2.6	I	7A	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Evd**	Esmond	25	2.6	N/I	1A/4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Evd**	Emrick	7	0.7	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Evd**	Heimdal	5	0.5	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Evd**	Binford	4	0.4	I	8A	3000	1950	12
2206	ND	Sheyenne	Eddy	1408	**Evd**	Brantford	4	0.4	I	6A	3000	1950	9
2206	ND	Sheyenne	Eddy	1408	**Evd**	Vang	3	0.3	I	6B	3000	1950	9
2206	ND	Sheyenne	Eddy	1408	**Evd**	Tonka	2	0.2	C	2C	1000	650	6
2206	ND	Sheyenne	Eddy	1408	**Fra**	Fram	85	7.8	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Fra**	Emrick	5	0.5	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Fra**	Heimdal	3	0.3	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Fra**	Wyard	3	0.3	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Fra**	Tonka	2	0.2	C	2C	1000	650	6
2206	ND	Sheyenne	Eddy	1408	**Fra**	Vallers	2	0.2	C	3B	1500	975	6
2206	ND	Sheyenne	Eddy	1408	**Hsb**	Heimdal	42	10.1	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Hsb**	Emrick	33	7.9	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Hsb**	Fram	5	1.2	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Hsb**	Parnell	5	1.2	C	2C	1000	650	6
2206	ND	Sheyenne	Eddy	1408	**Hsb**	Tonka	4	1.0	C	2C	1000	650	6

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Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
2206	ND	Sheyenne	Eddy	1408	**Hsb**	Vallers	4	1.0	C	3B	1500	975	6
2206	ND	Sheyenne	Eddy	1408	**Hsb**	Wyard	4	1.0	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Hsb**	Esmond	3	0.7	N/I	1A/4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Htd**	Heimdal	40	2.6	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Htd**	Emrick	25	1.6	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Htd**	Esmond	20	1.3	N/I	1A/4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Htd**	Vallers	4	0.3	C	3B	1500	975	6
2206	ND	Sheyenne	Eddy	1408	**Htd**	Fram	3	0.2	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Htd**	Parnell	3	0.2	C	2C	1000	650	6
2206	ND	Sheyenne	Eddy	1408	**Htd**	Wyard	3	0.2	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Htd**	Tonka	2	0.1	C	2C	1000	650	6
2206	ND	Sheyenne	Eddy	1408	**Hte**	Heimdal	40	2.1	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Hte**	Esmond	25	1.3	N/I	1A/4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Hte**	Emrick	20	1.1	I	4A	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Hte**	Fram	4	0.2	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Hte**	Parnell	3	0.2	C	2C	1000	650	6
2206	ND	Sheyenne	Eddy	1408	**Hte**	Vallers	3	0.2	C	3B	1500	975	6
2206	ND	Sheyenne	Eddy	1408	**Hte**	Wyard	3	0.2	C	4B	2250	1460	6
2206	ND	Sheyenne	Eddy	1408	**Hte**	Tonka	2	0.1	C	2C	1000	650	6
2296	ND	Sheyenne	Ransom	1162	**1055**	Ladelle	91	9.5	I	4A	2250	1460	6
2296	ND	Sheyenne	Ransom	1162	**1055**	Lamoure	4	0.4	C	3B	1500	975	6
2296	ND	Sheyenne	Ransom	1162	**1055**	Ladelle Channeled	2	0.2	I	4A	2250	1460	6
2296	ND	Sheyenne	Ransom	1162	**1055**	Laprairie	2	0.2	I	4A	2250	1460	6
2296	ND	Sheyenne	Ransom	1162	**1055**	Rauville	1	0.1	C	3B	1500	975	6
2296	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	38.0	I	4A	2250	1460	6
2296	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	6.1	I	4A	2250	1460	6
2296	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	1.4	I	4A	2250	1460	6
2296	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	1.4	I	4A	2250	1460	6
2296	ND	Sheyenne	Ransom	1162	**2225**	Sioux	66	0.3	N/I	1A/10	3000	1950	12
2296	ND	Sheyenne	Ransom	1162	**2225**	Renshaw Cobbly	26	0.1	I	6A	3000	1950	9
2296	ND	Sheyenne	Ransom	1162	**2225**	Fordville	6	0.0	I	6B	3000	1950	9
2296	ND	Sheyenne	Ransom	1162	**2225**	Buse	2	0.0	N/C	1A/3D	1800	1170	6
2296	ND	Sheyenne	Ransom	1162	**493**	Darnen	80	15.1	I	4A	2250	1460	6
2296	ND	Sheyenne	Ransom	1162	**493**	Svea	15	2.8	C	3D	1800	1170	6
2296	ND	Sheyenne	Ransom	1162	**493**	Barnes	3	0.6	C	3D	1800	1170	6
2296	ND	Sheyenne	Ransom	1162	**493**	Sioux	2	0.4	N/I	1A/10	3000	1950	12
2358	ND	Sheyenne	Cass	1068	**35**	Fairdale	80	5.2	I	4A	2250	1460	6
2358	ND	Sheyenne	Cass	1068	**35**	Ladelle	10	0.7	I	4A	2250	1460	6
2358	ND	Sheyenne	Cass	1068	**35**	Cashel	5	0.3	C	3B	1500	975	6
2358	ND	Sheyenne	Cass	1068	**35**	Fargo	3	0.2	C	2C	1000	650	6
2358	ND	Sheyenne	Cass	1068	**35**	Hegne	2	0.1	C	2C	1000	650	6
2358	ND	Sheyenne	Cass	1068	**57**	Fairdale	80	0.3	I	4A	2250	1460	6
2358	ND	Sheyenne	Cass	1068	**57**	Cashel	10	0.0	C	3B	1500	975	6
2358	ND	Sheyenne	Cass	1068	**57**	Ladelle	5	0.0	I	4A	2250	1460	6
2358	ND	Sheyenne	Cass	1068	**57**	Fargo	3	0.0	C	2C	1000	650	6
2358	ND	Sheyenne	Cass	1068	**57**	Hegne	2	0.0	C	2C	1000	650	6
240	ND	Sheyenne	Barnes	1253	**9**	Nutley	95	9.4	C	2B	1000	650	6
240	ND	Sheyenne	Barnes	1253	**9**	Fargo	5	0.5	C	2C	1000	650	6
2411	ND	Sheyenne	Ransom	1162	**1043**	La Prairie	80	16.4	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**1043**	Fairdale	12	2.5	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**1043**	Fordville	4	0.8	I	6B	3000	1950	9
2411	ND	Sheyenne	Ransom	1162	**1043**	Laprairie Channeled	3	0.6	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**1043**	Rauville	1	0.2	C	3B	1500	975	6
2411	ND	Sheyenne	Ransom	1162	**1205**	Maddock	74	5.9	I	8A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1205**	Arvilla	7	0.6	I	8A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1205**	Fordville	5	0.4	I	6B	3000	1950	9
2411	ND	Sheyenne	Ransom	1162	**1205**	Hecla	5	0.4	I	8A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1205**	Dickey	4	0.3	C	5A	1800	1170	9
2411	ND	Sheyenne	Ransom	1162	**1205**	Serden	3	0.2	N/I	1A/9	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1205**	Barnes	2	0.2	C	3D	1800	1170	6
2411	ND	Sheyenne	Ransom	1162	**1221**	Maddock	58	30.1	I	8A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1221**	Hecla	25	13.0	I	8A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1221**	Hamar Lfs Pd	6	3.1	C	2B	1000	650	6
2411	ND	Sheyenne	Ransom	1162	**1221**	Aylmer	3	1.6	I	9A	3000	1950	12

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
2411	ND	Sheyenne	Ransom	1162	**1221**	Serden	3	1.6	N/I	1A/9	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1221**	Buse	2	1.0	N/C	1A/3D	1800	1170	6
2411	ND	Sheyenne	Ransom	1162	**1221**	Swenoda	2	1.0	C	5A	1800	1170	9
2411	ND	Sheyenne	Ransom	1162	**1221**	Ulen	1	0.5	C	8B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1403**	Overly	70	40.1	C	3A	1500	975	6
2411	ND	Sheyenne	Ransom	1162	**1403**	Great Bend	19	10.9	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**1403**	Gardena	5	2.9	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**1403**	Bearden	3	1.7	C	3B	1500	975	6
2411	ND	Sheyenne	Ransom	1162	**1403**	Perella	2	1.1	C	3B	1500	975	6
2411	ND	Sheyenne	Ransom	1162	**1403**	Tonka	1	0.6	C	2C	1000	650	6
2411	ND	Sheyenne	Ransom	1162	**1577**	Rosewood	63	4.2	C	8B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1577**	Fossum	15	1.0	C	3D	1800	1170	6
2411	ND	Sheyenne	Ransom	1162	**1577**	Ulen	12	0.8	C	8B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1577**	Rosewood Vpd	5	0.3	C	8B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1577**	Venlo	5	0.3	C	8B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1788**	Swenoda	45	19.8	C	5A	1800	1170	9
2411	ND	Sheyenne	Ransom	1162	**1788**	Barnes	25	11.0	C	3D	1800	1170	6
2411	ND	Sheyenne	Ransom	1162	**1788**	Embden	11	4.8	I	7A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**1788**	Svea	11	4.8	C	3D	1800	1170	6
2411	ND	Sheyenne	Ransom	1162	**1788**	Buse	5	2.2	N/C	1A/3D	1800	1170	6
2411	ND	Sheyenne	Ransom	1162	**1788**	Towner	3	1.3	C	5A	1800	1170	9
2411	ND	Sheyenne	Ransom	1162	**2049**	Wyndmere	78	8.4	C	7B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**2049**	Divide	8	0.9	C	6C	3000	1950	6
2411	ND	Sheyenne	Ransom	1162	**2049**	Tiffany	4	0.4	C	7B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**2049**	Arveson	3	0.3	C	7B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**2049**	Embden	3	0.3	I	7A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**2049**	Tonka	3	0.3	C	2C	1000	650	6
2411	ND	Sheyenne	Ransom	1162	**2049**	Stirum	1	0.1	N	1B			
2411	ND	Sheyenne	Ransom	1162	**2091**	Zell	70	4.2	N/I	1A/4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**2091**	Buse	10	0.6	N/C	1A/3D	1800	1170	6
2411	ND	Sheyenne	Ransom	1162	**2091**	Eckman	7	0.4	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**2091**	Gardena	7	0.4	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**2091**	Langhei	3	0.2	N/C	1A/3D	1800	1170	6
2411	ND	Sheyenne	Ransom	1162	**2091**	Sioux	3	0.2	N/I	1A/10	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**2211**	Eckman	55	1.4	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**2211**	Gardena	30	0.8	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**2211**	Zell	8	0.2	N/I	1A/4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**2211**	Embden	5	0.1	I	7A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**2211**	Swenoda	2	0.1	C	5A	1800	1170	9
2411	ND	Sheyenne	Ransom	1162	**571**	Embden	71	17.2	I	7A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**571**	Clontarf	9	2.2	I	8A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**571**	Egeland	9	2.2	I	7A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**571**	Hecla	5	1.2	I	8A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**571**	Wyndmere	4	1.0	C	7B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**571**	Svea	1	0.2	C	3D	1800	1170	6
2411	ND	Sheyenne	Ransom	1162	**571**	Tiffany	1	0.2	C	7B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**64**	Arveson	64	11.0	C	7B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**64**	Wyndmere	18	3.1	C	7B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**64**	Borup	8	1.4	C	4B	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**64**	Divide	4	0.7	C	6C	3000	1950	6
2411	ND	Sheyenne	Ransom	1162	**64**	Glyndon	2	0.3	C	4B	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**64**	Stirum	2	0.3	N	1B			
2411	ND	Sheyenne	Ransom	1162	**64**	Tiffany	2	0.3	C	7B	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**726**	Fordville	65	70.3	I	6B	3000	1950	9
2411	ND	Sheyenne	Ransom	1162	**726**	Renshaw	25	27.0	I	6A	3000	1950	9
2411	ND	Sheyenne	Ransom	1162	**726**	Svea	4	4.3	C	3D	1800	1170	6
2411	ND	Sheyenne	Ransom	1162	**726**	Divide	3	3.2	C	6C	3000	1950	6
2411	ND	Sheyenne	Ransom	1162	**726**	Arvilla	2	2.2	I	8A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**726**	Sioux	1	1.1	N/I	1A/10	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**76**	Arvilla	79	0.1	I	8A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**76**	Brantford	10	0.0	I	6A	3000	1950	9
2411	ND	Sheyenne	Ransom	1162	**76**	Fordville	3	0.0	I	6B	3000	1950	9
2411	ND	Sheyenne	Ransom	1162	**76**	Divide	2	0.0	C	6C	3000	1950	6
2411	ND	Sheyenne	Ransom	1162	**76**	Embden	2	0.0	I	7A	3000	1950	12

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
2411	ND	Sheyenne	Ransom	1162	**76**	Hecla	2	0.0	I	8A	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**76**	Sioux	2	0.0	N/I	1A/10	3000	1950	12
2411	ND	Sheyenne	Ransom	1162	**772**	Gardena	60	5.5	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**772**	Eckman	27	2.5	I	4A	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**772**	Overly	7	0.6	C	3A	1500	975	6
2411	ND	Sheyenne	Ransom	1162	**772**	Glyndon	3	0.3	C	4B	2250	1460	6
2411	ND	Sheyenne	Ransom	1162	**772**	Zell	3	0.3	N/I	1A/4A	2250	1460	6
2424C	ND	Sheyenne	Ransom	1162	**1403**	Overly	70	17.6	C	3A	1500	975	6
2424C	ND	Sheyenne	Ransom	1162	**1403**	Great Bend	19	4.8	I	4A	2250	1460	6
2424C	ND	Sheyenne	Ransom	1162	**1403**	Gardena	5	1.3	I	4A	2250	1460	6
2424C	ND	Sheyenne	Ransom	1162	**1403**	Bearden	3	0.8	C	3B	1500	975	6
2424C	ND	Sheyenne	Ransom	1162	**1403**	Perella	2	0.5	C	3B	1500	975	6
2424C	ND	Sheyenne	Ransom	1162	**1403**	Tonka	1	0.3	C	2C	1000	650	6
2424C	ND	Sheyenne	Ransom	1162	**1472**	Rauville	80	6.7	C	3B	1500	975	6
2424C	ND	Sheyenne	Ransom	1162	**1472**	Marysland	15	1.3	C	6C	3000	1950	6
2424C	ND	Sheyenne	Ransom	1162	**1472**	Lamoure	5	0.4	C	3B	1500	975	6
2424C	ND	Sheyenne	Ransom	1162	**1834**	Tonka	84	4.3	C	2C	1000	650	6
2424C	ND	Sheyenne	Ransom	1162	**1834**	Hamerly	12	0.6	C	3B	1500	975	6
2424C	ND	Sheyenne	Ransom	1162	**1834**	Vallers	4	0.2	C	3B	1500	975	6
2424C	ND	Sheyenne	Ransom	1162	**2211**	Eckman	55	2.3	I	4A	2250	1460	6
2424C	ND	Sheyenne	Ransom	1162	**2211**	Gardena	30	1.2	I	4A	2250	1460	6
2424C	ND	Sheyenne	Ransom	1162	**2211**	Zell	8	0.3	N/I	1A/4A	2250	1460	6
2424C	ND	Sheyenne	Ransom	1162	**2211**	Embden	5	0.2	I	7A	3000	1950	12
2424C	ND	Sheyenne	Ransom	1162	**2211**	Swenoda	2	0.1	C	5A	1800	1170	9
2424C	ND	Sheyenne	Ransom	1162	**64**	Arveson	64	13.1	C	7B	3000	1950	12
2424C	ND	Sheyenne	Ransom	1162	**64**	Wyndmere	18	3.7	C	7B	3000	1950	12
2424C	ND	Sheyenne	Ransom	1162	**64**	Borup	8	1.6	C	4B	2250	1460	6
2424C	ND	Sheyenne	Ransom	1162	**64**	Divide	4	0.8	C	6C	3000	1950	6
2424C	ND	Sheyenne	Ransom	1162	**64**	Glyndon	2	0.4	C	4B	2250	1460	6
2424C	ND	Sheyenne	Ransom	1162	**64**	Stirum	2	0.4	N	1B			
2424C	ND	Sheyenne	Ransom	1162	**64**	Tiffany	2	0.4	C	7B	3000	1950	12
2424C	ND	Sheyenne	Ransom	1162	**726**	Fordville	65	19.6	I	6B	3000	1950	9
2424C	ND	Sheyenne	Ransom	1162	**726**	Renshaw	25	7.5	I	6A	3000	1950	9
2424C	ND	Sheyenne	Ransom	1162	**726**	Svea	4	1.2	C	3D	1800	1170	6
2424C	ND	Sheyenne	Ransom	1162	**726**	Divide	3	0.9	C	6C	3000	1950	6
2424C	ND	Sheyenne	Ransom	1162	**726**	Arvilla	2	0.6	I	8A	3000	1950	12
2424C	ND	Sheyenne	Ransom	1162	**726**	Sioux	1	0.3	N/I	1A/10	3000	1950	12
2710	ND	Sheyenne	Ransom	1162	**1043**	La Prairie	80	63.0	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**1043**	Fairdale	12	9.5	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**1043**	Fordville	4	3.2	I	6B	3000	1950	9
2710	ND	Sheyenne	Ransom	1162	**1043**	Laprairie Channeled	3	2.4	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**1043**	Rauville	1	0.8	C	3B	1500	975	6
2710	ND	Sheyenne	Ransom	1162	**118**	Barnes	40	2.2	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**118**	Buse	32	1.7	N/C	1A/3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**118**	Svea	22	1.2	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**118**	Hamerly	4	0.2	C	3B	1500	975	6
2710	ND	Sheyenne	Ransom	1162	**118**	Tonka	2	0.1	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**120**	Barnes	48	14.3	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**120**	Buse	35	10.4	N/C	1A/3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**120**	Svea	14	4.2	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**120**	Tonka	2	0.6	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**120**	Zell	1	0.3	N/I	1A/4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**1427**	Parnell	84	6.2	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**1427**	Vallers	12	0.9	C	3B	1500	975	6
2710	ND	Sheyenne	Ransom	1162	**1427**	Southam	2	0.1	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**1427**	Tonka	2	0.1	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**156**	Barnes	56	26.3	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**156**	Svea	28	13.2	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**156**	Buse	7	3.3	N/C	1A/3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**156**	Tonka	4	1.9	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**156**	Parnell	3	1.4	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**156**	Hamerly	1	0.5	C	3B	1500	975	6
2710	ND	Sheyenne	Ransom	1162	**156**	Vallers	1	0.5	C	3B	1500	975	6
2710	ND	Sheyenne	Ransom	1162	**1709**	Southam	85	2.3	C	2C	1000	650	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
2710	ND	Sheyenne	Ransom	1162	**1709**	Parnell	10	0.3	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**1709**	Vallers	5	0.1	C	3B	1500	975	6
2710	ND	Sheyenne	Ransom	1162	**1772**	Svea	50	171.9	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**1772**	Gardena	29	99.7	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**1772**	Embden	7	24.1	I	7A	3000	1950	12
2710	ND	Sheyenne	Ransom	1162	**1772**	Barnes	6	20.6	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**1772**	Cresbard	3	10.3	N	2A			
2710	ND	Sheyenne	Ransom	1162	**1772**	Lankin	3	10.3	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**1772**	Buse	1	3.4	N/C	1A/3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**1772**	Hamerly	1	3.4	C	3B	1500	975	6
2710	ND	Sheyenne	Ransom	1162	**2091**	Zell	70	1.1	N/I	1A/4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**2091**	Buse	10	0.2	N/C	1A/3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**2091**	Eckman	7	0.1	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**2091**	Gardena	7	0.1	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**2091**	Langhei	3	0.0	N/C	1A/3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**2091**	Sioux	3	0.0	N/I	1A/10	3000	1950	12
2710	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	1.9	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	0.3	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	0.1	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	0.1	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**2225**	Sioux	66	11.6	N/I	1A/10	3000	1950	12
2710	ND	Sheyenne	Ransom	1162	**2225**	Renshaw Cobbly	26	4.6	I	6A	3000	1950	9
2710	ND	Sheyenne	Ransom	1162	**2225**	Fordville	6	1.1	I	6B	3000	1950	9
2710	ND	Sheyenne	Ransom	1162	**2225**	Buse	2	0.4	N/C	1A/3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**314**	Buse	53	2.2	N/C	1A/3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**314**	Barnes	31	1.3	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**314**	Svea	11	0.5	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**314**	Darnen	4	0.2	I	4A	2250	1460	6
2710	ND	Sheyenne	Ransom	1162	**314**	Tonka	1	0.0	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**883**	Hamerly	55	5.5	C	3B	1500	975	6
2710	ND	Sheyenne	Ransom	1162	**883**	Tonka	24	2.4	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**883**	Parnell	10	1.0	C	2C	1000	650	6
2710	ND	Sheyenne	Ransom	1162	**883**	Svea	4	0.4	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**883**	Barnes	2	0.2	C	3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**883**	Vallers	2	0.2	C	3B	1500	975	6
2710	ND	Sheyenne	Ransom	1162	**883**	Buse	1	0.1	N/C	1A/3D	1800	1170	6
2710	ND	Sheyenne	Ransom	1162	**883**	Cresbard	1	0.1	N	2A			
2710	ND	Sheyenne	Ransom	1162	**883**	Perella	1	0.1	C	3B	1500	975	6
3605	ND	Sheyenne	Ransom	1162	**1205**	Maddock	74	21.7	I	8A	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**1205**	Arvilla	7	2.1	I	8A	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**1205**	Fordville	5	1.5	I	6B	3000	1950	9
3605	ND	Sheyenne	Ransom	1162	**1205**	Hecla	5	1.5	I	8A	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**1205**	Dickey	4	1.2	C	5A	1800	1170	9
3605	ND	Sheyenne	Ransom	1162	**1205**	Serden	3	0.9	N/I	1A/9	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**1205**	Barnes	2	0.6	C	3D	1800	1170	6
3605	ND	Sheyenne	Ransom	1162	**1472**	Rauville	80	0.9	C	3B	1500	975	6
3605	ND	Sheyenne	Ransom	1162	**1472**	Marysland	15	0.2	C	6C	3000	1950	6
3605	ND	Sheyenne	Ransom	1162	**1472**	Lamoure	5	0.1	C	3B	1500	975	6
3605	ND	Sheyenne	Ransom	1162	**2221**	Lohnes	92	47.5	I	9A	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**2221**	Maddock	4	2.1	I	8A	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**2221**	Claire	2	1.0	I	9A	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**2221**	Hecla	2	1.0	I	8A	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**76**	Arvilla	79	175.8	I	8A	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**76**	Brantford	10	22.3	I	6A	3000	1950	9
3605	ND	Sheyenne	Ransom	1162	**76**	Fordville	3	6.7	I	6B	3000	1950	9
3605	ND	Sheyenne	Ransom	1162	**76**	Divide	2	4.5	C	6C	3000	1950	6
3605	ND	Sheyenne	Ransom	1162	**76**	Embden	2	4.5	I	7A	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**76**	Hecla	2	4.5	I	8A	3000	1950	12
3605	ND	Sheyenne	Ransom	1162	**76**	Sioux	2	4.5	N/I	1A/10	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**1043**	La Prairie	80	20.0	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**1043**	Fairdale	12	3.0	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**1043**	Fordville	4	1.0	I	6B	3000	1950	9
3606	ND	Sheyenne	Ransom	1162	**1043**	Laprairie Channeled	3	0.7	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**1043**	Rauville	1	0.2	C	3B	1500	975	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
3606	ND	Sheyenne	Ransom	1162	**1205**	Maddock	74	0.0	I	8A	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**1205**	Arvilla	7	0.0	I	8A	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**1205**	Fordville	5	0.0	I	6B	3000	1950	9
3606	ND	Sheyenne	Ransom	1162	**1205**	Hecla	5	0.0	I	8A	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**1205**	Dickey	4	0.0	C	5A	1800	1170	9
3606	ND	Sheyenne	Ransom	1162	**1205**	Serden	3	0.0	N/I	1A/9	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**1205**	Barnes	2	0.0	C	3D	1800	1170	6
3606	ND	Sheyenne	Ransom	1162	**1472**	Rauville	80	0.9	C	3B	1500	975	6
3606	ND	Sheyenne	Ransom	1162	**1472**	Marysland	15	0.2	C	6C	3000	1950	6
3606	ND	Sheyenne	Ransom	1162	**1472**	Lamoure	5	0.1	C	3B	1500	975	6
3606	ND	Sheyenne	Ransom	1162	**1788**	Swenoda	45	2.0	C	5A	1800	1170	9
3606	ND	Sheyenne	Ransom	1162	**1788**	Barnes	25	1.1	C	3D	1800	1170	6
3606	ND	Sheyenne	Ransom	1162	**1788**	Embden	11	0.5	I	7A	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**1788**	Svea	11	0.5	C	3D	1800	1170	6
3606	ND	Sheyenne	Ransom	1162	**1788**	Buse	5	0.2	N/C	1A/3D	1800	1170	6
3606	ND	Sheyenne	Ransom	1162	**1788**	Towner	3	0.1	C	5A	1800	1170	9
3606	ND	Sheyenne	Ransom	1162	**1834**	Tonka	84	3.1	C	2C	1000	650	6
3606	ND	Sheyenne	Ransom	1162	**1834**	Hamerly	12	0.4	C	3B	1500	975	6
3606	ND	Sheyenne	Ransom	1162	**1834**	Vallers	4	0.1	C	3B	1500	975	6
3606	ND	Sheyenne	Ransom	1162	**2091**	Zell	70	4.0	N/I	1A/4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**2091**	Buse	10	0.6	N/C	1A/3D	1800	1170	6
3606	ND	Sheyenne	Ransom	1162	**2091**	Eckman	7	0.4	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**2091**	Gardena	7	0.4	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**2091**	Langhei	3	0.2	N/C	1A/3D	1800	1170	6
3606	ND	Sheyenne	Ransom	1162	**2091**	Sioux	3	0.2	N/I	1A/10	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	7.1	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	1.1	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	0.3	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	0.3	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**726**	Fordville	65	22.2	I	6B	3000	1950	9
3606	ND	Sheyenne	Ransom	1162	**726**	Renshaw	25	8.5	I	6A	3000	1950	9
3606	ND	Sheyenne	Ransom	1162	**726**	Svea	4	1.4	C	3D	1800	1170	6
3606	ND	Sheyenne	Ransom	1162	**726**	Divide	3	1.0	C	6C	3000	1950	6
3606	ND	Sheyenne	Ransom	1162	**726**	Arvilla	2	0.7	I	8A	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**726**	Sioux	1	0.3	N/I	1A/10	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**76**	Arvilla	79	3.3	I	8A	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**76**	Brantford	10	0.4	I	6A	3000	1950	9
3606	ND	Sheyenne	Ransom	1162	**76**	Fordville	3	0.1	I	6B	3000	1950	9
3606	ND	Sheyenne	Ransom	1162	**76**	Divide	2	0.1	C	6C	3000	1950	6
3606	ND	Sheyenne	Ransom	1162	**76**	Embden	2	0.1	I	7A	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**76**	Hecla	2	0.1	I	8A	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**76**	Sioux	2	0.1	N/I	1A/10	3000	1950	12
3606	ND	Sheyenne	Ransom	1162	**772**	Gardena	60	32.2	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**772**	Eckman	27	14.5	I	4A	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**772**	Overly	7	3.8	C	3A	1500	975	6
3606	ND	Sheyenne	Ransom	1162	**772**	Glyndon	3	1.6	C	4B	2250	1460	6
3606	ND	Sheyenne	Ransom	1162	**772**	Zell	3	1.6	N/I	1A/4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**1043**	La Prairie	80	27.5	I	4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**1043**	Fairdale	12	4.1	I	4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**1043**	Fordville	4	1.4	I	6B	3000	1950	9
3614	ND	Sheyenne	Ransom	1162	**1043**	Laprairie Channeled	3	1.0	I	4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**1043**	Rauville	1	0.3	C	3B	1500	975	6
3614	ND	Sheyenne	Ransom	1162	**120**	Barnes	48	1.7	C	3D	1800	1170	6
3614	ND	Sheyenne	Ransom	1162	**120**	Buse	35	1.3	N/C	1A/3D	1800	1170	6
3614	ND	Sheyenne	Ransom	1162	**120**	Svea	14	0.5	C	3D	1800	1170	6
3614	ND	Sheyenne	Ransom	1162	**120**	Tonka	2	0.1	C	2C	1000	650	6
3614	ND	Sheyenne	Ransom	1162	**120**	Zell	1	0.0	N/I	1A/4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	24.5	I	4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	3.9	I	4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	0.9	I	4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	0.9	I	4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**450**	Colvin	86	10.4	C	3B	1500	975	6
3614	ND	Sheyenne	Ransom	1162	**450**	Borup	4	0.5	C	4B	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**450**	Marysland	4	0.5	C	6C	3000	1950	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
3614	ND	Sheyenne	Ransom	1162	**450**	Parnell	3	0.4	C	2C	1000	650	6
3614	ND	Sheyenne	Ransom	1162	**450**	Divide	2	0.2	C	6C	3000	1950	6
3614	ND	Sheyenne	Ransom	1162	**450**	Perella	1	0.1	C	3B	1500	975	6
3614	ND	Sheyenne	Ransom	1162	**571**	Embden	71	21.1	I	7A	3000	1950	12
3614	ND	Sheyenne	Ransom	1162	**571**	Clontarf	9	2.7	I	8A	3000	1950	12
3614	ND	Sheyenne	Ransom	1162	**571**	Egeland	9	2.7	I	7A	3000	1950	12
3614	ND	Sheyenne	Ransom	1162	**571**	Hecla	5	1.5	I	8A	3000	1950	12
3614	ND	Sheyenne	Ransom	1162	**571**	Wyndmere	4	1.2	C	7B	3000	1950	12
3614	ND	Sheyenne	Ransom	1162	**571**	Svea	1	0.3	C	3D	1800	1170	6
3614	ND	Sheyenne	Ransom	1162	**571**	Tiffany	1	0.3	C	7B	3000	1950	12
3614	ND	Sheyenne	Ransom	1162	**772**	Gardena	60	11.5	I	4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**772**	Eckman	27	5.2	I	4A	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**772**	Overly	7	1.3	C	3A	1500	975	6
3614	ND	Sheyenne	Ransom	1162	**772**	Glyndon	3	0.6	C	4B	2250	1460	6
3614	ND	Sheyenne	Ransom	1162	**772**	Zell	3	0.6	N/I	1A/4A	2250	1460	6
3715	ND	Sheyenne	Ransom	1162	**120**	Barnes	48	1.9	C	3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**120**	Buse	35	1.4	N/C	1A/3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**120**	Svea	14	0.6	C	3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**120**	Tonka	2	0.1	C	2C	1000	650	6
3715	ND	Sheyenne	Ransom	1162	**120**	Zell	1	0.0	N/I	1A/4A	2250	1460	6
3715	ND	Sheyenne	Ransom	1162	**1427**	Parnell	84	0.2	C	2C	1000	650	6
3715	ND	Sheyenne	Ransom	1162	**1427**	Vallers	12	0.0	C	3B	1500	975	6
3715	ND	Sheyenne	Ransom	1162	**1427**	Southam	2	0.0	C	2C	1000	650	6
3715	ND	Sheyenne	Ransom	1162	**1427**	Tonka	2	0.0	C	2C	1000	650	6
3715	ND	Sheyenne	Ransom	1162	**154**	Barnes	46	14.3	C	3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**154**	Svea	39	12.1	C	3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**154**	Hamerly	7	2.2	C	3B	1500	975	6
3715	ND	Sheyenne	Ransom	1162	**154**	Tonka	5	1.6	C	2C	1000	650	6
3715	ND	Sheyenne	Ransom	1162	**154**	Buse	2	0.6	N/C	1A/3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**154**	Parnell	1	0.3	C	2C	1000	650	6
3715	ND	Sheyenne	Ransom	1162	**156**	Barnes	56	22.8	C	3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**156**	Svea	28	11.4	C	3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**156**	Buse	7	2.9	N/C	1A/3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**156**	Tonka	4	1.6	C	2C	1000	650	6
3715	ND	Sheyenne	Ransom	1162	**156**	Parnell	3	1.2	C	2C	1000	650	6
3715	ND	Sheyenne	Ransom	1162	**156**	Hamerly	1	0.4	C	3B	1500	975	6
3715	ND	Sheyenne	Ransom	1162	**156**	Vallers	1	0.4	C	3B	1500	975	6
3715	ND	Sheyenne	Ransom	1162	**1834**	Tonka	84	4.9	C	2C	1000	650	6
3715	ND	Sheyenne	Ransom	1162	**1834**	Hamerly	12	0.7	C	3B	1500	975	6
3715	ND	Sheyenne	Ransom	1162	**1834**	Vallers	4	0.2	C	3B	1500	975	6
3715	ND	Sheyenne	Ransom	1162	**2209**	Buse	40	3.3	N/C	1A/3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**2209**	Barnes	36	3.0	C	3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**2209**	Svea	12	1.0	C	3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**2209**	Forman	5	0.4	C	3D	1800	1170	6
3715	ND	Sheyenne	Ransom	1162	**2209**	Sioux	5	0.4	N/I	1A/10	3000	1950	12
3715	ND	Sheyenne	Ransom	1162	**2209**	Maddock	2	0.2	I	8A	3000	1950	12
3756	ND	Sheyenne	Ransom	1162	**1043**	La Prairie	80	0.1	I	4A	2250	1460	6
3756	ND	Sheyenne	Ransom	1162	**1043**	Fairdale	12	0.0	I	4A	2250	1460	6
3756	ND	Sheyenne	Ransom	1162	**1043**	Fordville	4	0.0	I	6B	3000	1950	9
3756	ND	Sheyenne	Ransom	1162	**1043**	Laprairie Channeled	3	0.0	I	4A	2250	1460	6
3756	ND	Sheyenne	Ransom	1162	**1043**	Rauville	1	0.0	C	3B	1500	975	6
3756	ND	Sheyenne	Ransom	1162	**1788**	Swenoda	45	9.4	C	5A	1800	1170	9
3756	ND	Sheyenne	Ransom	1162	**1788**	Barnes	25	5.2	C	3D	1800	1170	6
3756	ND	Sheyenne	Ransom	1162	**1788**	Embden	11	2.3	I	7A	3000	1950	12
3756	ND	Sheyenne	Ransom	1162	**1788**	Svea	11	2.3	C	3D	1800	1170	6
3756	ND	Sheyenne	Ransom	1162	**1788**	Buse	5	1.0	N/C	1A/3D	1800	1170	6
3756	ND	Sheyenne	Ransom	1162	**1788**	Towner	3	0.6	C	5A	1800	1170	9
3756	ND	Sheyenne	Ransom	1162	**2221**	Lohnes	92	29.8	I	9A	3000	1950	12
3756	ND	Sheyenne	Ransom	1162	**2221**	Maddock	4	1.3	I	8A	3000	1950	12
3756	ND	Sheyenne	Ransom	1162	**2221**	Claire	2	0.6	I	9A	3000	1950	12
3756	ND	Sheyenne	Ransom	1162	**2221**	Hecla	2	0.6	I	8A	3000	1950	12
3756	ND	Sheyenne	Ransom	1162	**726**	Fordville	65	3.9	I	6B	3000	1950	9
3756	ND	Sheyenne	Ransom	1162	**726**	Renshaw	25	1.5	I	6A	3000	1950	9
3756	ND	Sheyenne	Ransom	1162	**726**	Svea	4	0.2	C	3D	1800	1170	6

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Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
3756	ND	Sheyenne	Ransom	1162	**726**	Divide	3	0.2	C	6C	3000	1950	6
3756	ND	Sheyenne	Ransom	1162	**726**	Arvilla	2	0.1	I	8A	3000	1950	12
3756	ND	Sheyenne	Ransom	1162	**726**	Sioux	1	0.1	N/I	1A/10	3000	1950	12
3779	ND	Sheyenne	Cass	1068	**10**	Fargo	47	1.1	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**10**	Ryan	30	0.7	N	1B			
3779	ND	Sheyenne	Cass	1068	**10**	Hegne	10	0.2	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**10**	Nahon	5	0.1	N	1B			
3779	ND	Sheyenne	Cass	1068	**10**	Dovray	4	0.1	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**10**	Enloe	4	0.1	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**35**	Fairdale	80	6.5	I	4A	2250	1460	6
3779	ND	Sheyenne	Cass	1068	**35**	Ladelle	10	0.8	I	4A	2250	1460	6
3779	ND	Sheyenne	Cass	1068	**35**	Cashel	5	0.4	C	3B	1500	975	6
3779	ND	Sheyenne	Cass	1068	**35**	Fargo	3	0.2	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**35**	Hegne	2	0.2	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**40**	Fargo	50	5.7	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**40**	Hegne	30	3.4	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**40**	Dovray	5	0.6	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**40**	Enloe	5	0.6	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**40**	Fargo Depressional	5	0.6	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**40**	Fargo Saline	5	0.6	N	1C			
3779	ND	Sheyenne	Cass	1068	**57**	Fairdale	80	1.6	I	4A	2250	1460	6
3779	ND	Sheyenne	Cass	1068	**57**	Cashel	10	0.2	C	3B	1500	975	6
3779	ND	Sheyenne	Cass	1068	**57**	Ladelle	5	0.1	I	4A	2250	1460	6
3779	ND	Sheyenne	Cass	1068	**57**	Fargo	3	0.1	C	2C	1000	650	6
3779	ND	Sheyenne	Cass	1068	**57**	Hegne	2	0.0	C	2C	1000	650	6
397	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	0.8	I	4A	2250	1460	6
397	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	0.1	I	4A	2250	1460	6
397	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	0.0	I	4A	2250	1460	6
397	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	0.0	I	4A	2250	1460	6
4001	ND	Red	Grand Forks	296	**126**	Bearden	85	222.3	C	3B	1500	975	6
4001	ND	Red	Grand Forks	296	**126**	Ojata	4	10.5	N	1C			
4001	ND	Red	Grand Forks	296	**126**	Perella	4	10.5	C	3B	1500	975	6
4001	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	7.8	N	1C			
4001	ND	Red	Grand Forks	296	**126**	Colvin	2	5.2	C	3B	1500	975	6
4001	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	5.2	N	1C			
4001	ND	Red	Grand Forks	296	**26**	Bearden	65	20.3	C	3B	1500	975	6
4001	ND	Red	Grand Forks	296	**26**	Overly	25	7.8	C	3A	1500	975	6
4001	ND	Red	Grand Forks	296	**26**	Colvin	5	1.6	C	3B	1500	975	6
4001	ND	Red	Grand Forks	296	**26**	Perella	5	1.6	C	3B	1500	975	6
4001	ND	Red	Grand Forks	296	**43e**	Cashel	85	5.6	C	3B	1500	975	6
4001	ND	Red	Grand Forks	296	**43e**	Wahpeton	6	0.4	C	3B	1500	975	6
4001	ND	Red	Grand Forks	296	**43e**	Dovray Channeled	5	0.3	C	2C	1000	650	6
4001	ND	Red	Grand Forks	296	**43e**	Ladelle	4	0.3	I	4A	2250	1460	6
4143	ND	Red	Grand Forks	296	**126**	Bearden	85	231.6	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**126**	Ojata	4	10.9	N	1C			
4143	ND	Red	Grand Forks	296	**126**	Perella	4	10.9	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	8.2	N	1C			
4143	ND	Red	Grand Forks	296	**126**	Colvin	2	5.5	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	5.5	N	1C			
4143	ND	Red	Grand Forks	296	**25**	Overly	85	19.9	C	3A	1500	975	6
4143	ND	Red	Grand Forks	296	**25**	Perella	6	1.4	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**25**	Bearden	5	1.2	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**25**	Colvin	4	0.9	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**270**	Bearden	85	17.7	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**270**	Bearden Nonsaline	5	1.0	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**270**	Colvin	3	0.6	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**270**	Ojata	3	0.6	N	1C			
4143	ND	Red	Grand Forks	296	**270**	Overly	2	0.4	C	3A	1500	975	6
4143	ND	Red	Grand Forks	296	**270**	Perella	2	0.4	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**43b**	Cashel	85	6.2	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**43b**	Ladelle	5	0.4	I	4A	2250	1460	6
4143	ND	Red	Grand Forks	296	**43b**	Wahpeton	4	0.3	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**43b**	Bearden	3	0.2	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**43b**	Dovray Channeled	3	0.2	C	2C	1000	650	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
4143	ND	Red	Grand Forks	296	**43e**	Cashel	85	4.1	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**43e**	Wahpeton	6	0.3	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**43e**	Dovray Channeled	5	0.2	C	2C	1000	650	6
4143	ND	Red	Grand Forks	296	**43e**	Ladelle	4	0.2	I	4A	2250	1460	6
4143	ND	Red	Grand Forks	296	**73**	Glyndon	87	38.5	C	4B	2250	1460	6
4143	ND	Red	Grand Forks	296	**73**	Borup	6	2.7	C	4B	2250	1460	6
4143	ND	Red	Grand Forks	296	**73**	Tiffany	4	1.8	C	7B	3000	1950	12
4143	ND	Red	Grand Forks	296	**73**	Gardena	3	1.3	I	4A	2250	1460	6
4143	ND	Red	Grand Forks	296	**79d**	Zell	55	7.5	N/I	1A/4A	2250	1460	6
4143	ND	Red	Grand Forks	296	**79d**	Ladelle	30	4.1	I	4A	2250	1460	6
4143	ND	Red	Grand Forks	296	**79d**	Lamoure	6	0.8	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**79d**	Bearden	4	0.5	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**79d**	Rauville	3	0.4	C	3B	1500	975	6
4143	ND	Red	Grand Forks	296	**79d**	Ojata	2	0.3	N	1C			
4189	ND	Sheyenne	Cass	1068	**10**	Fargo	47	8.9	C	2C	1000	650	6
4189	ND	Sheyenne	Cass	1068	**10**	Ryan	30	5.7	N	1B			
4189	ND	Sheyenne	Cass	1068	**10**	Hegne	10	1.9	C	2C	1000	650	6
4189	ND	Sheyenne	Cass	1068	**10**	Nahon	5	0.9	N	1B			
4189	ND	Sheyenne	Cass	1068	**10**	Dovray	4	0.8	C	2C	1000	650	6
4189	ND	Sheyenne	Cass	1068	**10**	Enloe	4	0.8	C	2C	1000	650	6
4189	ND	Sheyenne	Cass	1068	**24**	Cashel	75	9.3	C	3B	1500	975	6
4189	ND	Sheyenne	Cass	1068	**24**	Fargo	10	1.2	C	2C	1000	650	6
4189	ND	Sheyenne	Cass	1068	**24**	Wahpeton	8	1.0	C	3B	1500	975	6
4189	ND	Sheyenne	Cass	1068	**24**	Fairdale	5	0.6	I	4A	2250	1460	6
4189	ND	Sheyenne	Cass	1068	**24**	Hegne	2	0.2	C	2C	1000	650	6
4189	ND	Sheyenne	Cass	1068	**25**	Cashel	75	3.5	C	3B	1500	975	6
4189	ND	Sheyenne	Cass	1068	**25**	Fargo Channeled	10	0.5	C	2C	1000	650	6
4189	ND	Sheyenne	Cass	1068	**25**	Wahpeton	8	0.4	C	3B	1500	975	6
4189	ND	Sheyenne	Cass	1068	**25**	Fairdale	5	0.2	I	4A	2250	1460	6
4189	ND	Sheyenne	Cass	1068	**25**	Hegne	2	0.1	C	2C	1000	650	6
4189	ND	Sheyenne	Cass	1068	**57**	Fairdale	80	0.0	I	4A	2250	1460	6
4189	ND	Sheyenne	Cass	1068	**57**	Cashel	10	0.0	C	3B	1500	975	6
4189	ND	Sheyenne	Cass	1068	**57**	Ladelle	5	0.0	I	4A	2250	1460	6
4189	ND	Sheyenne	Cass	1068	**57**	Fargo	3	0.0	C	2C	1000	650	6
4189	ND	Sheyenne	Cass	1068	**57**	Hegne	2	0.0	C	2C	1000	650	6
4190	ND	Red	Walsh	99	**Bna**	Bearden	85	115.3	C	3B	1500	975	6
4190	ND	Red	Walsh	99	**Bna**	Colvin	5	6.8	C	3B	1500	975	6
4190	ND	Red	Walsh	99	**Bna**	Hegne	4	5.4	C	2C	1000	650	6
4190	ND	Red	Walsh	99	**Bna**	Perella	4	5.4	C	3B	1500	975	6
4190	ND	Red	Walsh	99	**Bna**	Glyndon	2	2.7	C	4B	2250	1460	6
4210	ND	Sheyenne	Cass	1068	**32**	Fargo	80	0.3	C	2C	1000	650	6
4210	ND	Sheyenne	Cass	1068	**32**	Hegne	13	0.0	C	2C	1000	650	6
4210	ND	Sheyenne	Cass	1068	**32**	Enloe	5	0.0	C	2C	1000	650	6
4210	ND	Sheyenne	Cass	1068	**32**	Ryan	2	0.0	N	1B			
4210	ND	Sheyenne	Cass	1068	**36**	Fargo	73	15.2	C	2C	1000	650	6
4210	ND	Sheyenne	Cass	1068	**36**	Hegne	12	2.5	C	2C	1000	650	6
4210	ND	Sheyenne	Cass	1068	**36**	Dovray	5	1.0	C	2C	1000	650	6
4210	ND	Sheyenne	Cass	1068	**36**	Enloe	4	0.8	C	2C	1000	650	6
4210	ND	Sheyenne	Cass	1068	**36**	Cashel	2	0.4	C	3B	1500	975	6
4210	ND	Sheyenne	Cass	1068	**36**	Ryan	2	0.4	N	1B			
4210	ND	Sheyenne	Cass	1068	**36**	Wahpeton	2	0.4	C	3B	1500	975	6
4210	ND	Sheyenne	Cass	1068	**47**	Fargo	85	1.0	C	2C	1000	650	6
4210	ND	Sheyenne	Cass	1068	**47**	Hegne	8	0.1	C	2C	1000	650	6
4210	ND	Sheyenne	Cass	1068	**47**	Wahpeton	3	0.0	C	3B	1500	975	6
4210	ND	Sheyenne	Cass	1068	**47**	Cashel	2	0.0	C	3B	1500	975	6
4210	ND	Sheyenne	Cass	1068	**47**	Ryan	2	0.0	N	1B			
4282	ND	Red	Walsh	99	**Bna**	Bearden	85	6.1	C	3B	1500	975	6
4282	ND	Red	Walsh	99	**Bna**	Colvin	5	0.4	C	3B	1500	975	6
4282	ND	Red	Walsh	99	**Bna**	Hegne	4	0.3	C	2C	1000	650	6
4282	ND	Red	Walsh	99	**Bna**	Perella	4	0.3	C	3B	1500	975	6
4282	ND	Red	Walsh	99	**Bna**	Glyndon	2	0.1	C	4B	2250	1460	6
4282	ND	Red	Walsh	99	**Hma**	Hegne	55	67.0	C	2C	1000	650	6
4282	ND	Red	Walsh	99	**Hma**	Fargo	35	42.7	C	2C	1000	650	6
4282	ND	Red	Walsh	99	**Hma**	Dovray	4	4.9	C	2C	1000	650	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
4282	ND	Red	Walsh	99	**Hma**	Grano Sic Vpd	3	3.7	C	2C	1000	650	6
4282	ND	Red	Walsh	99	**Hma**	Hattie	3	3.7	C	2B	1000	650	6
4325	ND	Red	Walsh	99	**Bna**	Bearden	85	255.2	C	3B	1500	975	6
4325	ND	Red	Walsh	99	**Bna**	Colvin	5	15.0	C	3B	1500	975	6
4325	ND	Red	Walsh	99	**Bna**	Hegne	4	12.0	C	2C	1000	650	6
4325	ND	Red	Walsh	99	**Bna**	Perella	4	12.0	C	3B	1500	975	6
4325	ND	Red	Walsh	99	**Bna**	Glyndon	2	6.0	C	4B	2250	1460	6
4325	ND	Red	Walsh	99	**Cce**	Cashel	95	0.2	C	3B	1500	975	6
4325	ND	Red	Walsh	99	**Cce**	Fargo	5	0.0	C	2C	1000	650	6
4325	ND	Red	Walsh	99	**Pu**	Perella	85	3.6	C	3B	1500	975	6
4325	ND	Red	Walsh	99	**Pu**	Colvin Sicl	4	0.2	C	3B	1500	975	6
4325	ND	Red	Walsh	99	**Pu**	Perella Sil	4	0.2	C	3B	1500	975	6
4325	ND	Red	Walsh	99	**Pu**	Overly	3	0.1	C	3A	1500	975	6
4325	ND	Red	Walsh	99	**Pu**	Bearden	2	0.1	C	3B	1500	975	6
4325	ND	Red	Walsh	99	**Pu**	Glyndon	2	0.1	C	4B	2250	1460	6
4325	ND	Red	Walsh	99	**Wa**	Wahpeton	85	78.1	C	3B	1500	975	6
4325	ND	Red	Walsh	99	**Wa**	Fargo	5	4.6	C	2C	1000	650	6
4325	ND	Red	Walsh	99	**Wa**	Cashel	4	3.7	C	3B	1500	975	6
4325	ND	Red	Walsh	99	**Wa**	Magnus	3	2.8	C	2B	1000	650	6
4325	ND	Red	Walsh	99	**Wa**	Nutley	3	2.8	C	2B	1000	650	6
4328	ND	Red	Traill	375	**Be**	Bearden	90	145.9	C	3B	1500	975	6
4328	ND	Red	Traill	375	**Be**	Perella	7	11.3	C	3B	1500	975	6
4328	ND	Red	Traill	375	**Be**	Overly	3	4.9	C	3A	1500	975	6
4328	ND	Red	Traill	375	**Gwd**	Great Bend	95	5.3	I	4A	2250	1460	6
4328	ND	Red	Traill	375	**Gwd**	Zell	5	0.3	N/I	1A/4A	2250	1460	6
4328	ND	Red	Traill	375	**Lu**	Ludden	90	2.9	C	2C	1000	650	6
4328	ND	Red	Traill	375	**Lu**	Cashel	10	0.3	C	3B	1500	975	6
4328	ND	Red	Traill	375	**Or**	Overly	94	14.0	C	3A	1500	975	6
4328	ND	Red	Traill	375	**Or**	Bearden	3	0.4	C	3B	1500	975	6
4328	ND	Red	Traill	375	**Or**	Beotia	2	0.3	C	3A	1500	975	6
4328	ND	Red	Traill	375	**Or**	Roliss	1	0.1	C	3B	1500	975	6
4328	ND	Red	Traill	375	**Ovb**	Overly	55	0.3	C	3A	1500	975	6
4328	ND	Red	Traill	375	**Ovb**	Great Bend	40	0.2	I	4A	2250	1460	6
4328	ND	Red	Traill	375	**Ovb**	Beotia	5	0.0	C	3A	1500	975	6
4328	ND	Red	Traill	375	**Pe**	Perella	95	11.1	C	3B	1500	975	6
4328	ND	Red	Traill	375	**Pe**	Bearden	3	0.4	C	3B	1500	975	6
4328	ND	Red	Traill	375	**Pe**	Colvin	2	0.2	C	3B	1500	975	6
4328	ND	Red	Traill	375	**Waa**	Wahpeton	95	2.5	C	3B	1500	975	6
4328	ND	Red	Traill	375	**Waa**	Cashel	3	0.1	C	3B	1500	975	6
4328	ND	Red	Traill	375	**Waa**	Nutley	2	0.1	C	2B	1000	650	6
4332	ND	Red	Grand Forks	296	**126**	Bearden	85	103.2	C	3B	1500	975	6
4332	ND	Red	Grand Forks	296	**126**	Ojata	4	4.9	N	1C			
4332	ND	Red	Grand Forks	296	**126**	Perella	4	4.9	C	3B	1500	975	6
4332	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	3.6	N	1C			
4332	ND	Red	Grand Forks	296	**126**	Colvin	2	2.4	C	3B	1500	975	6
4332	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	2.4	N	1C			
4332	ND	Red	Grand Forks	296	**79c**	Zell	50	5.0	N/I	1A/4A	2250	1460	6
4332	ND	Red	Grand Forks	296	**79c**	Ladelle	35	3.5	I	4A	2250	1460	6
4332	ND	Red	Grand Forks	296	**79c**	Bearden	5	0.5	C	3B	1500	975	6
4332	ND	Red	Grand Forks	296	**79c**	Lamoure	5	0.5	C	3B	1500	975	6
4332	ND	Red	Grand Forks	296	**79c**	Rauville	3	0.3	C	3B	1500	975	6
4332	ND	Red	Grand Forks	296	**79c**	Ojata	2	0.2	N	1C			
4332	ND	Red	Grand Forks	296	**79d**	Zell	55	2.1	N/I	1A/4A	2250	1460	6
4332	ND	Red	Grand Forks	296	**79d**	Ladelle	30	1.2	I	4A	2250	1460	6
4332	ND	Red	Grand Forks	296	**79d**	Lamoure	6	0.2	C	3B	1500	975	6
4332	ND	Red	Grand Forks	296	**79d**	Bearden	4	0.2	C	3B	1500	975	6
4332	ND	Red	Grand Forks	296	**79d**	Rauville	3	0.1	C	3B	1500	975	6
4332	ND	Red	Grand Forks	296	**79d**	Ojata	2	0.1	N	1C			
4335	ND	Red	Walsh	296	**Ffa**	Fargo	85	44.8	C	2C	1000	650	6
4335	ND	Red	Walsh	296	**Ffa**	Dovray Pd	6	3.2	C	2C	1000	650	6
4335	ND	Red	Walsh	296	**Ffa**	Grano	5	2.6	C	2C	1000	650	6
4335	ND	Red	Walsh	296	**Ffa**	Hegne	4	2.1	C	2C	1000	650	6
4335	ND	Red	Walsh	296	**Hma**	Hegne	55	42.5	C	2C	1000	650	6
4335	ND	Red	Walsh	296	**Hma**	Fargo	35	27.0	C	2C	1000	650	6

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Permit Number	State	River	County	Control Point	Mapid	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
4335	ND	Red	Walsh	296	**Hma**	Dovray	4	3.1	C	2C	1000	650	6
4335	ND	Red	Walsh	296	**Hma**	Grano Sic Vpd	3	2.3	C	2C	1000	650	6
4335	ND	Red	Walsh	296	**Hma**	Hattie	3	2.3	C	2B	1000	650	6
4348	ND	Red	Grand Forks	296	**126**	Bearden	85	91.4	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**126**	Ojata	4	4.3	N	1C			
4348	ND	Red	Grand Forks	296	**126**	Perella	4	4.3	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	3.2	N	1C			
4348	ND	Red	Grand Forks	296	**126**	Colvin	2	2.2	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	2.2	N	1C			
4348	ND	Red	Grand Forks	296	**43b**	Cashel	85	30.8	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**43b**	Ladelle	5	1.8	I	4A	2250	1460	6
4348	ND	Red	Grand Forks	296	**43b**	Wahpeton	4	1.4	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**43b**	Bearden	3	1.1	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**43b**	Dovray Channeled	3	1.1	C	2C	1000	650	6
4348	ND	Red	Grand Forks	296	**43e**	Cashel	85	21.2	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**43e**	Wahpeton	6	1.5	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**43e**	Dovray Channeled	5	1.2	C	2C	1000	650	6
4348	ND	Red	Grand Forks	296	**43e**	Ladelle	4	1.0	I	4A	2250	1460	6
4348	ND	Red	Grand Forks	296	**79d**	Zell	55	3.3	N/I	1A/4A	2250	1460	6
4348	ND	Red	Grand Forks	296	**79d**	Ladelle	30	1.8	I	4A	2250	1460	6
4348	ND	Red	Grand Forks	296	**79d**	Lamoure	6	0.4	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**79d**	Bearden	4	0.2	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**79d**	Rauville	3	0.2	C	3B	1500	975	6
4348	ND	Red	Grand Forks	296	**79d**	Ojata	2	0.1	N	1C			
4364	ND	Red	Traill	375	**Be**	Bearden	90	120.6	C	3B	1500	975	6
4364	ND	Red	Traill	375	**Be**	Perella	7	9.4	C	3B	1500	975	6
4364	ND	Red	Traill	375	**Be**	Overly	3	4.0	C	3A	1500	975	6
4380	ND	Red	Grand Forks	296	**126**	Bearden	85	0.8	C	3B	1500	975	6
4380	ND	Red	Grand Forks	296	**126**	Ojata	4	0.0	N	1C			
4380	ND	Red	Grand Forks	296	**126**	Perella	4	0.0	C	3B	1500	975	6
4380	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	0.0	N	1C			
4380	ND	Red	Grand Forks	296	**126**	Colvin	2	0.0	C	3B	1500	975	6
4380	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	0.0	N	1C			
4380	ND	Red	Grand Forks	296	**43b**	Cashel	85	8.6	C	3B	1500	975	6
4380	ND	Red	Grand Forks	296	**43b**	Ladelle	5	0.5	I	4A	2250	1460	6
4380	ND	Red	Grand Forks	296	**43b**	Wahpeton	4	0.4	C	3B	1500	975	6
4380	ND	Red	Grand Forks	296	**43b**	Bearden	3	0.3	C	3B	1500	975	6
4380	ND	Red	Grand Forks	296	**43b**	Dovray Channeled	3	0.3	C	2C	1000	650	6
4380	ND	Red	Grand Forks	296	**43e**	Cashel	85	1.4	C	3B	1500	975	6
4380	ND	Red	Grand Forks	296	**43e**	Wahpeton	6	0.1	C	3B	1500	975	6
4380	ND	Red	Grand Forks	296	**43e**	Dovray Channeled	5	0.1	C	2C	1000	650	6
4380	ND	Red	Grand Forks	296	**43e**	Ladelle	4	0.1	I	4A	2250	1460	6
4385	ND	Red	Grand Forks	296	**126**	Bearden	85	117.4	C	3B	1500	975	6
4385	ND	Red	Grand Forks	296	**126**	Ojata	4	5.5	N	1C			
4385	ND	Red	Grand Forks	296	**126**	Perella	4	5.5	C	3B	1500	975	6
4385	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	4.1	N	1C			
4385	ND	Red	Grand Forks	296	**126**	Colvin	2	2.8	C	3B	1500	975	6
4385	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	2.8	N	1C			
4403	ND	Red	Pembina	99	**Bna**	Bearden	95	150.5	C	3B	1500	975	6
4403	ND	Red	Pembina	99	**Bna**	Colvin	3	4.8	C	3B	1500	975	6
4403	ND	Red	Pembina	99	**Bna**	Perella	2	3.2	C	3B	1500	975	6
4403	ND	Red	Pembina	99	**Ch**	Colvin	95	1.9	C	3B	1500	975	6
4403	ND	Red	Pembina	99	**Ch**	Perella	3	0.1	C	3B	1500	975	6
4403	ND	Red	Pembina	99	**Ch**	Colvin Saline	2	0.0	N	1C			
4403	ND	Red	Pembina	99	**Ff**	Fargo	90	1.0	C	2C	1000	650	6
4403	ND	Red	Pembina	99	**Ff**	Hegne	8	0.1	C	2C	1000	650	6
4403	ND	Red	Pembina	99	**Ff**	Ryan	2	0.0	N	1B			
4403	ND	Red	Pembina	99	**Gfa**	Glyndon	95	31.9	C	4B	2250	1460	6
4403	ND	Red	Pembina	99	**Gfa**	Borup	5	1.7	C	4B	2250	1460	6
4403	ND	Red	Pembina	99	**Pu**	Perella	95	2.5	C	3B	1500	975	6
4403	ND	Red	Pembina	99	**Pu**	Colvin	3	0.1	C	3B	1500	975	6
4403	ND	Red	Pembina	99	**Pu**	Dovray	2	0.1	C	2C	1000	650	6
4403	ND	Red	Pembina	99	**Waa**	Wahpeton	95	35.3	C	3B	1500	975	6
4403	ND	Red	Pembina	99	**Waa**	Fargo	3	1.1	C	2C	1000	650	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
4403	ND	Red	Pembina	99	**Waa**	Cashel	2	0.7	C	3B	1500	975	6
4403	ND	Red	Pembina	99	**Wab**	Wahpeton	95	14.8	C	3B	1500	975	6
4403	ND	Red	Pembina	99	**Wab**	Fargo	5	0.8	C	2C	1000	650	6
4434	ND	Red	Grand Forks	296	**11**	Dovray	95	7.0	C	2C	1000	650	6
4434	ND	Red	Grand Forks	296	**11**	Bearden	5	0.4	C	3B	1500	975	6
4434	ND	Red	Grand Forks	296	**43b**	Cashel	85	22.2	C	3B	1500	975	6
4434	ND	Red	Grand Forks	296	**43b**	Ladelle	5	1.3	I	4A	2250	1460	6
4434	ND	Red	Grand Forks	296	**43b**	Wahpeton	4	1.0	C	3B	1500	975	6
4434	ND	Red	Grand Forks	296	**43b**	Bearden	3	0.8	C	3B	1500	975	6
4434	ND	Red	Grand Forks	296	**43b**	Dovray Channeled	3	0.8	C	2C	1000	650	6
4434	ND	Red	Grand Forks	296	**45**	Wahpeton	85	22.3	C	3B	1500	975	6
4434	ND	Red	Grand Forks	296	**45**	Laprairie	6	1.6	I	4A	2250	1460	6
4434	ND	Red	Grand Forks	296	**45**	Cashel	5	1.3	C	3B	1500	975	6
4434	ND	Red	Grand Forks	296	**45**	Perella	4	1.0	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**11**	Dovray	95	7.1	C	2C	1000	650	6
4435	ND	Red	Grand Forks	296	**11**	Bearden	5	0.4	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**41**	Bearden	50	19.6	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**41**	Perella	35	13.8	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**41**	Bearden Saline	6	2.4	N	1C			
4435	ND	Red	Grand Forks	296	**41**	Overly	5	2.0	C	3A	1500	975	6
4435	ND	Red	Grand Forks	296	**41**	Wahpeton	4	1.6	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**43b**	Cashel	85	59.5	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**43b**	Ladelle	5	3.5	I	4A	2250	1460	6
4435	ND	Red	Grand Forks	296	**43b**	Wahpeton	4	2.8	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**43b**	Bearden	3	2.1	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**43b**	Dovray Channeled	3	2.1	C	2C	1000	650	6
4435	ND	Red	Grand Forks	296	**43e**	Cashel	85	17.4	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**43e**	Wahpeton	6	1.2	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**43e**	Dovray Channeled	5	1.0	C	2C	1000	650	6
4435	ND	Red	Grand Forks	296	**43e**	Ladelle	4	0.8	I	4A	2250	1460	6
4435	ND	Red	Grand Forks	296	**45**	Wahpeton	85	32.7	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**45**	Laprairie	6	2.3	I	4A	2250	1460	6
4435	ND	Red	Grand Forks	296	**45**	Cashel	5	1.9	C	3B	1500	975	6
4435	ND	Red	Grand Forks	296	**45**	Perella	4	1.5	C	3B	1500	975	6
4650	ND	Sheyenne	Ransom	1162	**1221**	Maddock	58	10.8	I	8A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**1221**	Hecla	25	4.7	I	8A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**1221**	Hamar Lfs Pd	6	1.1	C	2B	1000	650	6
4650	ND	Sheyenne	Ransom	1162	**1221**	Aylmer	3	0.6	I	9A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**1221**	Serden	3	0.6	N/I	1A/9	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**1221**	Buse	2	0.4	N/C	1A/3D	1800	1170	6
4650	ND	Sheyenne	Ransom	1162	**1221**	Swenoda	2	0.4	C	5A	1800	1170	9
4650	ND	Sheyenne	Ransom	1162	**1221**	Ulen	1	0.2	C	8B	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**2221**	Lohnes	92	19.0	I	9A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**2221**	Maddock	4	0.8	I	8A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**2221**	Claire	2	0.4	I	9A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**2221**	Hecla	2	0.4	I	8A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**76**	Arvilla	79	0.7	I	8A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**76**	Brantford	10	0.1	I	6A	3000	1950	9
4650	ND	Sheyenne	Ransom	1162	**76**	Fordville	3	0.0	I	6B	3000	1950	9
4650	ND	Sheyenne	Ransom	1162	**76**	Divide	2	0.0	C	6C	3000	1950	6
4650	ND	Sheyenne	Ransom	1162	**76**	Embden	2	0.0	I	7A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**76**	Hecla	2	0.0	I	8A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**76**	Sioux	2	0.0	N/I	1A/10	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**939**	Hecla	62	0.7	I	8A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**939**	Hamar	24	0.3	C	2B	1000	650	6
4650	ND	Sheyenne	Ransom	1162	**939**	Ulen	4	0.0	C	8B	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**939**	Aylmer	3	0.0	I	9A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**939**	Maddock	3	0.0	I	8A	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**939**	Hamar Lfs Pd	2	0.0	C	2B	1000	650	6
4650	ND	Sheyenne	Ransom	1162	**939**	Rosewood	1	0.0	C	8B	3000	1950	12
4650	ND	Sheyenne	Ransom	1162	**939**	Wyndmere	1	0.0	C	7B	3000	1950	12
4670	ND	Red	Grand Forks	296	**126**	Bearden	85	3.5	C	3B	1500	975	6
4670	ND	Red	Grand Forks	296	**126**	Ojata	4	0.2	N	1C			
4670	ND	Red	Grand Forks	296	**126**	Perella	4	0.2	C	3B	1500	975	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
4670	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	0.1	N	1C			
4670	ND	Red	Grand Forks	296	**126**	Colvin	2	0.1	C	3B	1500	975	6
4670	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	0.1	N	1C			
4670	ND	Red	Grand Forks	296	**73**	Glyndon	87	693.8	C	4B	2250	1460	6
4670	ND	Red	Grand Forks	296	**73**	Borup	6	47.8	C	4B	2250	1460	6
4670	ND	Red	Grand Forks	296	**73**	Tiffany	4	31.9	C	7B	3000	1950	12
4670	ND	Red	Grand Forks	296	**73**	Gardena	3	23.9	I	4A	2250	1460	6
4670	ND	Red	Grand Forks	296	**79b**	Zell	45	9.8	N/I	1A/4A	2250	1460	6
4670	ND	Red	Grand Forks	296	**79b**	Ladelle	40	8.7	I	4A	2250	1460	6
4670	ND	Red	Grand Forks	296	**79b**	Bearden	6	1.3	C	3B	1500	975	6
4670	ND	Red	Grand Forks	296	**79b**	Rauville	4	0.9	C	3B	1500	975	6
4670	ND	Red	Grand Forks	296	**79b**	Lamoure	3	0.7	C	3B	1500	975	6
4670	ND	Red	Grand Forks	296	**79b**	Ojata	2	0.4	N	1C			
4685	ND	Red	Grand Forks	296	**73**	Glyndon	87	275.0	C	4B	2250	1460	6
4685	ND	Red	Grand Forks	296	**73**	Borup	6	19.0	C	4B	2250	1460	6
4685	ND	Red	Grand Forks	296	**73**	Tiffany	4	12.6	C	7B	3000	1950	12
4685	ND	Red	Grand Forks	296	**73**	Gardena	3	9.5	I	4A	2250	1460	6
4685	ND	Red	Grand Forks	296	**79b**	Zell	45	21.6	N/I	1A/4A	2250	1460	6
4685	ND	Red	Grand Forks	296	**79b**	Ladelle	40	19.2	I	4A	2250	1460	6
4685	ND	Red	Grand Forks	296	**79b**	Bearden	6	2.9	C	3B	1500	975	6
4685	ND	Red	Grand Forks	296	**79b**	Rauville	4	1.9	C	3B	1500	975	6
4685	ND	Red	Grand Forks	296	**79b**	Lamoure	3	1.4	C	3B	1500	975	6
4685	ND	Red	Grand Forks	296	**79b**	Ojata	2	1.0	N	1C			
4685	ND	Red	Grand Forks	296	**79c**	Zell	50	3.8	N/I	1A/4A	2250	1460	6
4685	ND	Red	Grand Forks	296	**79c**	Ladelle	35	2.6	I	4A	2250	1460	6
4685	ND	Red	Grand Forks	296	**79c**	Bearden	5	0.4	C	3B	1500	975	6
4685	ND	Red	Grand Forks	296	**79c**	Lamoure	5	0.4	C	3B	1500	975	6
4685	ND	Red	Grand Forks	296	**79c**	Rauville	3	0.2	C	3B	1500	975	6
4685	ND	Red	Grand Forks	296	**79c**	Ojata	2	0.2	N	1C			
4689	ND	Red	Walsh	296	**Caa**	Cashel	85	160.7	C	3B	1500	975	6
4689	ND	Red	Walsh	296	**Caa**	Wahpeton	7	13.2	C	3B	1500	975	6
4689	ND	Red	Walsh	296	**Caa**	Hegne	5	9.5	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Caa**	Fairdale	3	5.7	I	4A	2250	1460	6
4689	ND	Red	Walsh	296	**Cab**	Cashel	85	34.9	C	3B	1500	975	6
4689	ND	Red	Walsh	296	**Cab**	Fairdale	7	2.9	I	4A	2250	1460	6
4689	ND	Red	Walsh	296	**Cab**	Wahpeton	5	2.1	C	3B	1500	975	6
4689	ND	Red	Walsh	296	**Cab**	Hegne	3	1.2	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Ffa**	Fargo	85	4.6	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Ffa**	Dovray Pd	6	0.3	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Ffa**	Grano	5	0.3	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Ffa**	Hegne	4	0.2	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Fha**	Fargo	55	0.8	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Fha**	Hegne	35	0.5	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Fha**	Hegne Clay	6	0.1	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Fha**	Dovray	4	0.1	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Gs**	Grano	50	3.0	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Gs**	Hegne	35	2.1	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Gs**	Fargo	6	0.4	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Gs**	Ludden	5	0.3	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Gs**	Dovray Vpd	4	0.2	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Wa**	Wahpeton	85	8.8	C	3B	1500	975	6
4689	ND	Red	Walsh	296	**Wa**	Fargo	5	0.5	C	2C	1000	650	6
4689	ND	Red	Walsh	296	**Wa**	Cashel	4	0.4	C	3B	1500	975	6
4689	ND	Red	Walsh	296	**Wa**	Magnus	3	0.3	C	2B	1000	650	6
4689	ND	Red	Walsh	296	**Wa**	Nutley	3	0.3	C	2B	1000	650	6
4693	ND	Red	Grand Forks	296	**126**	Bearden	85	3.3	C	3B	1500	975	6
4693	ND	Red	Grand Forks	296	**126**	Ojata	4	0.2	N	1C			
4693	ND	Red	Grand Forks	296	**126**	Perella	4	0.2	C	3B	1500	975	6
4693	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	0.1	N	1C			
4693	ND	Red	Grand Forks	296	**126**	Colvin	2	0.1	C	3B	1500	975	6
4693	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	0.1	N	1C			
4693	ND	Red	Grand Forks	296	**73**	Glyndon	87	199.7	C	4B	2250	1460	6
4693	ND	Red	Grand Forks	296	**73**	Borup	6	13.8	C	4B	2250	1460	6
4693	ND	Red	Grand Forks	296	**73**	Tiffany	4	9.2	C	7B	3000	1950	12

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Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
4693	ND	Red	Grand Forks	296	**73**	Gardena	3	6.9	I	4A	2250	1460	6
4736	ND	Red	Walsh	296	**Caa**	Cashel	85	47.1	C	3B	1500	975	6
4736	ND	Red	Walsh	296	**Caa**	Wahpeton	7	3.9	C	3B	1500	975	6
4736	ND	Red	Walsh	296	**Caa**	Hegne	5	2.8	C	2C	1000	650	6
4736	ND	Red	Walsh	296	**Caa**	Fairdale	3	1.7	I	4A	2250	1460	6
4736	ND	Red	Walsh	296	**Cab**	Cashel	85	20.9	C	3B	1500	975	6
4736	ND	Red	Walsh	296	**Cab**	Fairdale	7	1.7	I	4A	2250	1460	6
4736	ND	Red	Walsh	296	**Cab**	Wahpeton	5	1.2	C	3B	1500	975	6
4736	ND	Red	Walsh	296	**Cab**	Hegne	3	0.7	C	2C	1000	650	6
4736	ND	Red	Walsh	296	**Ffa**	Fargo	85	20.6	C	2C	1000	650	6
4736	ND	Red	Walsh	296	**Ffa**	Dovray Pd	6	1.5	C	2C	1000	650	6
4736	ND	Red	Walsh	296	**Ffa**	Grano	5	1.2	C	2C	1000	650	6
4736	ND	Red	Walsh	296	**Ffa**	Hegne	4	1.0	C	2C	1000	650	6
4736	ND	Red	Walsh	296	**Wa**	Wahpeton	85	152.9	C	3B	1500	975	6
4736	ND	Red	Walsh	296	**Wa**	Fargo	5	9.0	C	2C	1000	650	6
4736	ND	Red	Walsh	296	**Wa**	Cashel	4	7.2	C	3B	1500	975	6
4736	ND	Red	Walsh	296	**Wa**	Magnus	3	5.4	C	2B	1000	650	6
4736	ND	Red	Walsh	296	**Wa**	Nutley	3	5.4	C	2B	1000	650	6
4740	ND	Red	Grand Forks	296	**43b**	Cashel	85	66.4	C	3B	1500	975	6
4740	ND	Red	Grand Forks	296	**43b**	Ladelle	5	3.9	I	4A	2250	1460	6
4740	ND	Red	Grand Forks	296	**43b**	Wahpeton	4	3.1	C	3B	1500	975	6
4740	ND	Red	Grand Forks	296	**43b**	Bearden	3	2.3	C	3B	1500	975	6
4740	ND	Red	Grand Forks	296	**43b**	Dovray Channeled	3	2.3	C	2C	1000	650	6
4740	ND	Red	Grand Forks	296	**45**	Wahpeton	85	1.2	C	3B	1500	975	6
4740	ND	Red	Grand Forks	296	**45**	Laprairie	6	0.1	I	4A	2250	1460	6
4740	ND	Red	Grand Forks	296	**45**	Cashel	5	0.1	C	3B	1500	975	6
4740	ND	Red	Grand Forks	296	**45**	Perella	4	0.1	C	3B	1500	975	6
4747	ND	Sheyenne	Ransom	1162	**1221**	Maddock	58	4.6	I	8A	3000	1950	12
4747	ND	Sheyenne	Ransom	1162	**1221**	Hecla	25	2.0	I	8A	3000	1950	12
4747	ND	Sheyenne	Ransom	1162	**1221**	Hamar Lfs Pd	6	0.5	C	2B	1000	650	6
4747	ND	Sheyenne	Ransom	1162	**1221**	Aylmer	3	0.2	I	9A	3000	1950	12
4747	ND	Sheyenne	Ransom	1162	**1221**	Serden	3	0.2	N/I	1A/9	3000	1950	12
4747	ND	Sheyenne	Ransom	1162	**1221**	Buse	2	0.2	N/C	1A/3D	1800	1170	6
4747	ND	Sheyenne	Ransom	1162	**1221**	Swenoda	2	0.2	C	5A	1800	1170	9
4747	ND	Sheyenne	Ransom	1162	**1221**	Ulen	1	0.1	C	8B	3000	1950	12
4747	ND	Sheyenne	Ransom	1162	**2091**	Zell	70	2.1	N/I	1A/4A	2250	1460	6
4747	ND	Sheyenne	Ransom	1162	**2091**	Buse	10	0.3	N/C	1A/3D	1800	1170	6
4747	ND	Sheyenne	Ransom	1162	**2091**	Eckman	7	0.2	I	4A	2250	1460	6
4747	ND	Sheyenne	Ransom	1162	**2091**	Gardena	7	0.2	I	4A	2250	1460	6
4747	ND	Sheyenne	Ransom	1162	**2091**	Langhei	3	0.1	N/C	1A/3D	1800	1170	6
4747	ND	Sheyenne	Ransom	1162	**2091**	Sioux	3	0.1	N/I	1A/10	3000	1950	12
4747	ND	Sheyenne	Ransom	1162	**726**	Fordville	65	30.1	I	6B	3000	1950	9
4747	ND	Sheyenne	Ransom	1162	**726**	Renshaw	25	11.6	I	6A	3000	1950	9
4747	ND	Sheyenne	Ransom	1162	**726**	Svea	4	1.9	C	3D	1800	1170	6
4747	ND	Sheyenne	Ransom	1162	**726**	Divide	3	1.4	C	6C	3000	1950	6
4747	ND	Sheyenne	Ransom	1162	**726**	Arvilla	2	0.9	I	8A	3000	1950	12
4747	ND	Sheyenne	Ransom	1162	**726**	Sioux	1	0.5	N/I	1A/10	3000	1950	12
4747	ND	Sheyenne	Ransom	1162	**772**	Gardena	60	34.9	I	4A	2250	1460	6
4747	ND	Sheyenne	Ransom	1162	**772**	Eckman	27	15.7	I	4A	2250	1460	6
4747	ND	Sheyenne	Ransom	1162	**772**	Overly	7	4.1	C	3A	1500	975	6
4747	ND	Sheyenne	Ransom	1162	**772**	Glyndon	3	1.7	C	4B	2250	1460	6
4747	ND	Sheyenne	Ransom	1162	**772**	Zell	3	1.7	N/I	1A/4A	2250	1460	6
4773	ND	Red	Grand Forks	296	**126**	Bearden	85	97.8	C	3B	1500	975	6
4773	ND	Red	Grand Forks	296	**126**	Ojata	4	4.6	N	1C			
4773	ND	Red	Grand Forks	296	**126**	Perella	4	4.6	C	3B	1500	975	6
4773	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	3.5	N	1C			
4773	ND	Red	Grand Forks	296	**126**	Colvin	2	2.3	C	3B	1500	975	6
4773	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	2.3	N	1C			
4773	ND	Red	Grand Forks	296	**26**	Bearden	65	11.8	C	3B	1500	975	6
4773	ND	Red	Grand Forks	296	**26**	Overly	25	4.5	C	3A	1500	975	6
4773	ND	Red	Grand Forks	296	**26**	Colvin	5	0.9	C	3B	1500	975	6
4773	ND	Red	Grand Forks	296	**26**	Perella	5	0.9	C	3B	1500	975	6
4773	ND	Red	Grand Forks	296	**79b**	Zell	45	5.2	N/I	1A/4A	2250	1460	6
4773	ND	Red	Grand Forks	296	**79b**	Ladelle	40	4.6	I	4A	2250	1460	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
4773	ND	Red	Grand Forks	296	**79b**	Bearden	6	0.7	C	3B	1500	975	6
4773	ND	Red	Grand Forks	296	**79b**	Rauville	4	0.5	C	3B	1500	975	6
4773	ND	Red	Grand Forks	296	**79b**	Lamoure	3	0.3	C	3B	1500	975	6
4773	ND	Red	Grand Forks	296	**79b**	Ojata	2	0.2	N	1C			
4774	ND	Red	Grand Forks	296	**126**	Bearden	85	33.5	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**126**	Ojata	4	1.6	N	1C			
4774	ND	Red	Grand Forks	296	**126**	Perella	4	1.6	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	1.2	N	1C			
4774	ND	Red	Grand Forks	296	**126**	Colvin	2	0.8	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	0.8	N	1C			
4774	ND	Red	Grand Forks	296	**25**	Overly	85	69.1	C	3A	1500	975	6
4774	ND	Red	Grand Forks	296	**25**	Perella	6	4.9	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**25**	Bearden	5	4.1	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**25**	Colvin	4	3.3	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**26**	Bearden	65	6.5	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**26**	Overly	25	2.5	C	3A	1500	975	6
4774	ND	Red	Grand Forks	296	**26**	Colvin	5	0.5	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**26**	Perella	5	0.5	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**79b**	Zell	45	14.7	N/I	1A/4A	2250	1460	6
4774	ND	Red	Grand Forks	296	**79b**	Ladelle	40	13.0	I	4A	2250	1460	6
4774	ND	Red	Grand Forks	296	**79b**	Bearden	6	2.0	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**79b**	Rauville	4	1.3	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**79b**	Lamoure	3	1.0	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**79b**	Ojata	2	0.7	N	1C			
4774	ND	Red	Grand Forks	296	**79c**	Zell	50	2.5	N/I	1A/4A	2250	1460	6
4774	ND	Red	Grand Forks	296	**79c**	Ladelle	35	1.7	I	4A	2250	1460	6
4774	ND	Red	Grand Forks	296	**79c**	Bearden	5	0.2	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**79c**	Lamoure	5	0.2	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**79c**	Rauville	3	0.1	C	3B	1500	975	6
4774	ND	Red	Grand Forks	296	**79c**	Ojata	2	0.1	N	1C			
4780	ND	Sheyenne	Ransom	1162	**1043**	La Prairie	80	1.6	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**1043**	Fairdale	12	0.2	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**1043**	Fordville	4	0.1	I	6B	3000	1950	9
4780	ND	Sheyenne	Ransom	1162	**1043**	Laprairie Channeled	3	0.1	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**1043**	Rauville	1	0.0	C	3B	1500	975	6
4780	ND	Sheyenne	Ransom	1162	**1055**	Ladelle	91	14.0	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**1055**	Lamoure	4	0.6	C	3B	1500	975	6
4780	ND	Sheyenne	Ransom	1162	**1055**	Ladelle Channeled	2	0.3	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**1055**	Laprairie	2	0.3	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**1055**	Rauville	1	0.2	C	3B	1500	975	6
4780	ND	Sheyenne	Ransom	1162	**1403**	Overly	70	12.0	C	3A	1500	975	6
4780	ND	Sheyenne	Ransom	1162	**1403**	Great Bend	19	3.2	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**1403**	Gardena	5	0.9	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**1403**	Bearden	3	0.5	C	3B	1500	975	6
4780	ND	Sheyenne	Ransom	1162	**1403**	Perella	2	0.3	C	3B	1500	975	6
4780	ND	Sheyenne	Ransom	1162	**1403**	Tonka	1	0.2	C	2C	1000	650	6
4780	ND	Sheyenne	Ransom	1162	**1842**	Towner	61	26.9	C	5A	1800	1170	9
4780	ND	Sheyenne	Ransom	1162	**1842**	Lohnes	15	6.6	I	9A	3000	1950	12
4780	ND	Sheyenne	Ransom	1162	**1842**	Maddock	10	4.4	I	8A	3000	1950	12
4780	ND	Sheyenne	Ransom	1162	**1842**	Arvilla	5	2.2	I	8A	3000	1950	12
4780	ND	Sheyenne	Ransom	1162	**1842**	Fordville	5	2.2	I	6B	3000	1950	9
4780	ND	Sheyenne	Ransom	1162	**1842**	Hamar	2	0.9	C	2B	1000	650	6
4780	ND	Sheyenne	Ransom	1162	**1842**	Hecla	2	0.9	I	8A	3000	1950	12
4780	ND	Sheyenne	Ransom	1162	**2091**	Zell	70	1.9	N/I	1A/4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**2091**	Buse	10	0.3	N/C	1A/3D	1800	1170	6
4780	ND	Sheyenne	Ransom	1162	**2091**	Eckman	7	0.2	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**2091**	Gardena	7	0.2	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**2091**	Langhei	3	0.1	N/C	1A/3D	1800	1170	6
4780	ND	Sheyenne	Ransom	1162	**2091**	Sioux	3	0.1	N/I	1A/10	3000	1950	12
4780	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	19.6	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	3.1	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	0.7	I	4A	2250	1460	6
4780	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	0.7	I	4A	2250	1460	6
4873	ND	Red	Grand Forks	296	**126**	Bearden	85	252.8	C	3B	1500	975	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
4873	ND	Red	Grand Forks	296	**126**	Ojata	4	11.9	N	1C			
4873	ND	Red	Grand Forks	296	**126**	Perella	4	11.9	C	3B	1500	975	6
4873	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	8.9	N	1C			
4873	ND	Red	Grand Forks	296	**126**	Colvin	2	5.9	C	3B	1500	975	6
4873	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	5.9	N	1C			
4887	ND	Red	Grand Forks	296	**126**	Bearden	85	67.9	C	3B	1500	975	6
4887	ND	Red	Grand Forks	296	**126**	Ojata	4	3.2	N	1C			
4887	ND	Red	Grand Forks	296	**126**	Perella	4	3.2	C	3B	1500	975	6
4887	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	2.4	N	1C			
4887	ND	Red	Grand Forks	296	**126**	Colvin	2	1.6	C	3B	1500	975	6
4887	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	1.6	N	1C			
4887	ND	Red	Grand Forks	296	**73**	Glyndon	87	53.0	C	4B	2250	1460	6
4887	ND	Red	Grand Forks	296	**73**	Borup	6	3.7	C	4B	2250	1460	6
4887	ND	Red	Grand Forks	296	**73**	Tiffany	4	2.4	C	7B	3000	1950	12
4887	ND	Red	Grand Forks	296	**73**	Gardena	3	1.8	I	4A	2250	1460	6
4887	ND	Red	Grand Forks	296	**79b**	Zell	45	8.6	N/I	1A/4A	2250	1460	6
4887	ND	Red	Grand Forks	296	**79b**	Ladelle	40	7.6	I	4A	2250	1460	6
4887	ND	Red	Grand Forks	296	**79b**	Bearden	6	1.1	C	3B	1500	975	6
4887	ND	Red	Grand Forks	296	**79b**	Rauville	4	0.8	C	3B	1500	975	6
4887	ND	Red	Grand Forks	296	**79b**	Lamoure	3	0.6	C	3B	1500	975	6
4887	ND	Red	Grand Forks	296	**79b**	Ojata	2	0.4	N	1C			
4887	ND	Red	Grand Forks	296	**79c**	Zell	50	1.6	N/I	1A/4A	2250	1460	6
4887	ND	Red	Grand Forks	296	**79c**	Ladelle	35	1.1	I	4A	2250	1460	6
4887	ND	Red	Grand Forks	296	**79c**	Bearden	5	0.2	C	3B	1500	975	6
4887	ND	Red	Grand Forks	296	**79c**	Lamoure	5	0.2	C	3B	1500	975	6
4887	ND	Red	Grand Forks	296	**79c**	Rauville	3	0.1	C	3B	1500	975	6
4887	ND	Red	Grand Forks	296	**79c**	Ojata	2	0.1	N	1C			
4899	ND	Red	Grand Forks	296	**25**	Overly	85	8.9	C	3A	1500	975	6
4899	ND	Red	Grand Forks	296	**25**	Perella	6	0.6	C	3B	1500	975	6
4899	ND	Red	Grand Forks	296	**25**	Bearden	5	0.5	C	3B	1500	975	6
4899	ND	Red	Grand Forks	296	**25**	Colvin	4	0.4	C	3B	1500	975	6
4999	ND	Sheyenne	Nelson	1317	**Bh**	Binford	85	27.1	I	8A	3000	1950	12
4999	ND	Sheyenne	Nelson	1317	**Bh**	Walum	7	2.2	I	8A	3000	1950	12
4999	ND	Sheyenne	Nelson	1317	**Bh**	Vang	6	1.9	I	6B	3000	1950	9
4999	ND	Sheyenne	Nelson	1317	**Bh**	Tolna	2	0.6	C	7B	3000	1950	12
4999	ND	Sheyenne	Nelson	1317	**Bv**	Brantford	45	19.8	I	6A	3000	1950	9
4999	ND	Sheyenne	Nelson	1317	**Bv**	Kensal	40	17.6	I	6A	3000	1950	9
4999	ND	Sheyenne	Nelson	1317	**Bv**	Vang	9	4.0	I	6B	3000	1950	9
4999	ND	Sheyenne	Nelson	1317	**Bv**	Tolna	6	2.6	C	7B	3000	1950	12
4999	ND	Sheyenne	Nelson	1317	**Bxd**	Buse	55	0.8	N/C	1A/3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**Bxd**	Edgeley	30	0.5	N	3C			
4999	ND	Sheyenne	Nelson	1317	**Bxd**	Barnes	7	0.1	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**Bxd**	Kloten	5	0.1	N	1e			
4999	ND	Sheyenne	Nelson	1317	**Bxd**	Walsh	3	0.0	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**Cz**	Cresbard	45	17.9	N	2A			
4999	ND	Sheyenne	Nelson	1317	**Cz**	Cavour	35	13.9	N	1B			
4999	ND	Sheyenne	Nelson	1317	**Cz**	Vallers	10	4.0	C	3B	1500	975	6
4999	ND	Sheyenne	Nelson	1317	**Cz**	Hamerly	3	1.2	C	3B	1500	975	6
4999	ND	Sheyenne	Nelson	1317	**Cz**	Parnell	3	1.2	C	2C	1000	650	6
4999	ND	Sheyenne	Nelson	1317	**Cz**	Svea	2	0.8	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**Cz**	Tonka	2	0.8	C	2C	1000	650	6
4999	ND	Sheyenne	Nelson	1317	**Le**	Lamoure	84	2.7	C	3B	1500	975	6
4999	ND	Sheyenne	Nelson	1317	**Le**	Lamoure Saline	6	0.2	N	1C			
4999	ND	Sheyenne	Nelson	1317	**Le**	Ladelle	5	0.2	I	4A	2250	1460	6
4999	ND	Sheyenne	Nelson	1317	**Le**	Ludden	4	0.1	C	2C	1000	650	6
4999	ND	Sheyenne	Nelson	1317	**Le**	Lallie Vpd	1	0.0	N	1C			
4999	ND	Sheyenne	Nelson	1317	**Mx**	Miranda	45	6.3	N	1B			
4999	ND	Sheyenne	Nelson	1317	**Mx**	Cavour	35	4.9	N	1B			
4999	ND	Sheyenne	Nelson	1317	**Mx**	Parnell	6	0.8	C	2C	1000	650	6
4999	ND	Sheyenne	Nelson	1317	**Mx**	Hamerly	5	0.7	C	3B	1500	975	6
4999	ND	Sheyenne	Nelson	1317	**Mx**	Tonka	5	0.7	C	2C	1000	650	6
4999	ND	Sheyenne	Nelson	1317	**Mx**	Vallers	4	0.6	C	3B	1500	975	6
4999	ND	Sheyenne	Nelson	1317	**St**	Svea	84	0.2	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**St**	Hamerly	4	0.0	C	3B	1500	975	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
4999	ND	Sheyenne	Nelson	1317	**St**	Barnes	3	0.0	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**St**	Tonka	3	0.0	C	2C	1000	650	6
4999	ND	Sheyenne	Nelson	1317	**St**	Cresbard	2	0.0	N	2A			
4999	ND	Sheyenne	Nelson	1317	**St**	Parnell	2	0.0	C	2C	1000	650	6
4999	ND	Sheyenne	Nelson	1317	**St**	Wyard	2	0.0	C	4B	2250	1460	6
4999	ND	Sheyenne	Nelson	1317	**Wca**	Walsh	85	9.4	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**Wca**	Vang	6	0.7	I	6B	3000	1950	9
4999	ND	Sheyenne	Nelson	1317	**Wca**	Edgeley	4	0.4	N	3C			
4999	ND	Sheyenne	Nelson	1317	**Wca**	Svea	3	0.3	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**Wca**	Laprairie	2	0.2	I	4A	2250	1460	6
4999	ND	Sheyenne	Nelson	1317	**Wcb**	Walsh	84	10.4	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**Wcb**	Edgeley	6	0.7	N	3C			
4999	ND	Sheyenne	Nelson	1317	**Wcb**	Vang	4	0.5	I	6B	3000	1950	9
4999	ND	Sheyenne	Nelson	1317	**Wcb**	Laprairie	3	0.4	I	4A	2250	1460	6
4999	ND	Sheyenne	Nelson	1317	**Wcb**	Svea	2	0.2	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**Wcb**	Lamoure	1	0.1	C	3B	1500	975	6
4999	ND	Sheyenne	Nelson	1317	**Wcc**	Walsh	84	7.7	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**Wcc**	Edgeley	6	0.6	N	3C			
4999	ND	Sheyenne	Nelson	1317	**Wcc**	Barnes	4	0.4	C	3D	1800	1170	6
4999	ND	Sheyenne	Nelson	1317	**Wcc**	Vang	3	0.3	I	6B	3000	1950	9
4999	ND	Sheyenne	Nelson	1317	**Wcc**	Laprairie	2	0.2	I	4A	2250	1460	6
4999	ND	Sheyenne	Nelson	1317	**Wcc**	Lamoure	1	0.1	C	3B	1500	975	6
4999	ND	Sheyenne	Nelson	1317	**Wf**	Warsing	85	6.5	I	6A	3000	1950	9
4999	ND	Sheyenne	Nelson	1317	**Wf**	Divide	6	0.5	C	6C	3000	1950	6
4999	ND	Sheyenne	Nelson	1317	**Wf**	Warsing	5	0.4	I	6A	3000	1950	9
4999	ND	Sheyenne	Nelson	1317	**Wf**	Renshaw	4	0.3	I	6A	3000	1950	9
5115	ND	Sheyenne	Cass	1068	**18**	Bearden	60	6.1	C	3B	1500	975	6
5115	ND	Sheyenne	Cass	1068	**18**	Overly	15	1.5	C	3A	1500	975	6
5115	ND	Sheyenne	Cass	1068	**18**	Perella	10	1.0	C	3B	1500	975	6
5115	ND	Sheyenne	Cass	1068	**18**	Fargo	5	0.5	C	2C	1000	650	6
5115	ND	Sheyenne	Cass	1068	**18**	Hegne	5	0.5	C	2C	1000	650	6
5115	ND	Sheyenne	Cass	1068	**18**	Colvin	3	0.3	C	3B	1500	975	6
5115	ND	Sheyenne	Cass	1068	**18**	Lindaas	2	0.2	C	2C	1000	650	6
5115	ND	Sheyenne	Cass	1068	**41**	Hegne	50	5.2	C	2C	1000	650	6
5115	ND	Sheyenne	Cass	1068	**41**	Fargo	30	3.1	C	2C	1000	650	6
5115	ND	Sheyenne	Cass	1068	**41**	Bearden	5	0.5	C	3B	1500	975	6
5115	ND	Sheyenne	Cass	1068	**41**	Dovray	5	0.5	C	2C	1000	650	6
5115	ND	Sheyenne	Cass	1068	**41**	Enloe	5	0.5	C	2C	1000	650	6
5115	ND	Sheyenne	Cass	1068	**41**	Hegne Saline	5	0.5	N	1C			
515	ND	Sheyenne	Cass	1068	**37**	Fargo	76	0.2	C	2C	1000	650	6
515	ND	Sheyenne	Cass	1068	**37**	Hegne	10	0.0	C	2C	1000	650	6
515	ND	Sheyenne	Cass	1068	**37**	Dovray	5	0.0	C	2C	1000	650	6
515	ND	Sheyenne	Cass	1068	**37**	Enloe	5	0.0	C	2C	1000	650	6
515	ND	Sheyenne	Cass	1068	**37**	Ryan	2	0.0	N	1B			
515	ND	Sheyenne	Cass	1068	**37**	Cashel	1	0.0	C	3B	1500	975	6
515	ND	Sheyenne	Cass	1068	**37**	Wahpeton	1	0.0	C	3B	1500	975	6
515	ND	Sheyenne	Cass	1068	**38**	Fargo	68	2.3	C	2C	1000	650	6
515	ND	Sheyenne	Cass	1068	**38**	Fargo Sic	10	0.3	C	2C	1000	650	6
515	ND	Sheyenne	Cass	1068	**38**	Hegne	10	0.3	C	2C	1000	650	6
515	ND	Sheyenne	Cass	1068	**38**	Dovray	5	0.2	C	2C	1000	650	6
515	ND	Sheyenne	Cass	1068	**38**	Overly	5	0.2	C	3A	1500	975	6
515	ND	Sheyenne	Cass	1068	**38**	Ryan	2	0.1	N	1B			
540072	MN	Red	Marshall	296	**1356**	Water Miscellaneous	100	2.7	N	0			
540072	MN	Red	Marshall	296	**157a**	Wahpeton	90	14.7	C	3B	1500	975	6
540072	MN	Red	Marshall	296	**157a**	Fargo and Similar Soils	4	0.7	C	2C	1000	650	6
540072	MN	Red	Marshall	296	**157a**	Colvin and Similar Soils	3	0.5	C	3B	1500	975	6
540072	MN	Red	Marshall	296	**157a**	Northcote and Similar Soils	3	0.5	C	2C	1000	650	6
540072	MN	Red	Marshall	296	**1963**	Bearden	50	1.1	C	3B	1500	975	6
540072	MN	Red	Marshall	296	**1963**	Colvin	40	0.9	C	3B	1500	975	6
540072	MN	Red	Marshall	296	**1963**	Fargo and Similar Soils	4	0.1	C	2C	1000	650	6
540072	MN	Red	Marshall	296	**1963**	Glyndon and Similar Soils	3	0.1	C	4B	2250	1460	6
540072	MN	Red	Marshall	296	**1963**	Hegne and Similar Soils	3	0.1	C	2C	1000	650	6
540072	MN	Red	Marshall	296	**1964**	Colvin	50	101.9	C	3B	1500	975	6
540072	MN	Red	Marshall	296	**1964**	Fargo	40	81.5	C	2C	1000	650	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
540072	MN	Red	Marshall	296	**1964**	Hegne and Similar Soils	4	8.2	C	2C	1000	650	6
540072	MN	Red	Marshall	296	**1964**	Bearden and Similar Soils	3	6.1	C	3B	1500	975	6
540072	MN	Red	Marshall	296	**1964**	Northcote and Similar Soils	3	6.1	C	2C	1000	650	6
592	ND	Sheyenne	Barnes	1253	**36**	Fargo	90	30.2	C	2C	1000	650	6
592	ND	Sheyenne	Barnes	1253	**36**	Dovray	5	1.7	C	2C	1000	650	6
592	ND	Sheyenne	Barnes	1253	**36**	Lismore	3	1.0	C	3D	1800	1170	6
592	ND	Sheyenne	Barnes	1253	**36**	Ryan	2	0.7	N	1B			
592	ND	Sheyenne	Barnes	1253	**83f**	Kloten	55	1.1	N	1e			
592	ND	Sheyenne	Barnes	1253	**83f**	Buse	30	0.6	N/C	1A/3D	1800	1170	6
592	ND	Sheyenne	Barnes	1253	**83f**	Edgeley	7	0.1	N	3C			
592	ND	Sheyenne	Barnes	1253	**83f**	Barnes	2	0.0	C	3D	1800	1170	6
592	ND	Sheyenne	Barnes	1253	**83f**	Nutley	2	0.0	C	2B	1000	650	6
592	ND	Sheyenne	Barnes	1253	**83f**	Sioux	2	0.0	N/I	1A/10	3000	1950	12
592	ND	Sheyenne	Barnes	1253	**83f**	Lamoure	1	0.0	C	3B	1500	975	6
592	ND	Sheyenne	Barnes	1253	**83f**	Sinai	1	0.0	C	2B	1000	650	6
592	ND	Sheyenne	Barnes	1253	**85**	Exline	80	1.1	N	1B			
592	ND	Sheyenne	Barnes	1253	**85**	Nahon	10	0.1	N	1B			
592	ND	Sheyenne	Barnes	1253	**85**	Overly	10	0.1	C	3A	1500	975	6
592	ND	Sheyenne	Barnes	1253	**9b**	Nutley	95	8.9	C	2B	1000	650	6
592	ND	Sheyenne	Barnes	1253	**9b**	Edgeley Var.	3	0.3	N	3C			
592	ND	Sheyenne	Barnes	1253	**9b**	Fargo	2	0.2	C	2C	1000	650	6
592	ND	Sheyenne	Barnes	1253	**9d**	Nutley	85	13.4	C	2B	1000	650	6
592	ND	Sheyenne	Barnes	1253	**9d**	Edgeley Var.	11	1.7	N	3C			
592	ND	Sheyenne	Barnes	1253	**9d**	Buse	2	0.3	N/C	1A/3D	1800	1170	6
592	ND	Sheyenne	Barnes	1253	**9d**	Kloten	2	0.3	N	1e			
617C	ND	Red	Grand Forks	296	**126**	Bearden	85	4.7	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**126**	Ojata	4	0.2	N	1C			
617C	ND	Red	Grand Forks	296	**126**	Perella	4	0.2	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**126**	Bearden Saline	3	0.2	N	1C			
617C	ND	Red	Grand Forks	296	**126**	Colvin	2	0.1	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**126**	Colvin Saline	2	0.1	N	1C			
617C	ND	Red	Grand Forks	296	**46**	Ladelle	85	1.1	I	4A	2250	1460	6
617C	ND	Red	Grand Forks	296	**46**	Ludden	6	0.1	C	2C	1000	650	6
617C	ND	Red	Grand Forks	296	**46**	Rauville	5	0.1	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**46**	Lamoure Channeled	4	0.1	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**79c**	Zell	50	0.2	N/I	1A/4A	2250	1460	6
617C	ND	Red	Grand Forks	296	**79c**	Ladelle	35	0.2	I	4A	2250	1460	6
617C	ND	Red	Grand Forks	296	**79c**	Bearden	5	0.0	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**79c**	Lamoure	5	0.0	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**79c**	Rauville	3	0.0	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**79c**	Ojata	2	0.0	N	1C			
617C	ND	Red	Grand Forks	296	**79d**	Zell	55	1.1	N/I	1A/4A	2250	1460	6
617C	ND	Red	Grand Forks	296	**79d**	Ladelle	30	0.6	I	4A	2250	1460	6
617C	ND	Red	Grand Forks	296	**79d**	Lamoure	6	0.1	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**79d**	Bearden	4	0.1	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**79d**	Rauville	3	0.1	C	3B	1500	975	6
617C	ND	Red	Grand Forks	296	**79d**	Ojata	2	0.0	N	1C			
629	ND	Sheyenne	Barnes	1253	**83f**	Kloten	55	2.9	N	1e			
629	ND	Sheyenne	Barnes	1253	**83f**	Buse	30	1.6	N/C	1A/3D	1800	1170	6
629	ND	Sheyenne	Barnes	1253	**83f**	Edgeley	7	0.4	N	3C			
629	ND	Sheyenne	Barnes	1253	**83f**	Barnes	2	0.1	C	3D	1800	1170	6
629	ND	Sheyenne	Barnes	1253	**83f**	Nutley	2	0.1	C	2B	1000	650	6
629	ND	Sheyenne	Barnes	1253	**83f**	Sioux	2	0.1	N/I	1A/10	3000	1950	12
629	ND	Sheyenne	Barnes	1253	**83f**	Lamoure	1	0.1	C	3B	1500	975	6
629	ND	Sheyenne	Barnes	1253	**83f**	Sinai	1	0.1	C	2B	1000	650	6
629	ND	Sheyenne	Barnes	1253	**9**	Nutley	95	28.0	C	2B	1000	650	6
629	ND	Sheyenne	Barnes	1253	**9**	Fargo	5	1.5	C	2C	1000	650	6
629	ND	Sheyenne	Barnes	1253	**9b**	Nutley	95	3.5	C	2B	1000	650	6
629	ND	Sheyenne	Barnes	1253	**9b**	Edgeley Var.	3	0.1	N	3C			
629	ND	Sheyenne	Barnes	1253	**9b**	Fargo	2	0.1	C	2C	1000	650	6
629	ND	Sheyenne	Barnes	1253	**9d**	Nutley	85	4.1	C	2B	1000	650	6
629	ND	Sheyenne	Barnes	1253	**9d**	Edgeley Var.	11	0.5	N	3C			
629	ND	Sheyenne	Barnes	1253	**9d**	Buse	2	0.1	N/C	1A/3D	1800	1170	6
629	ND	Sheyenne	Barnes	1253	**9d**	Kloten	2	0.1	N	1e			

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
641	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	1.3	I	4A	2250	1460	6
641	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	0.2	I	4A	2250	1460	6
641	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	0.0	I	4A	2250	1460	6
641	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	0.0	I	4A	2250	1460	6
653A	ND	Sheyenne	Barnes	1253	**36**	Fargo	90	0.6	C	2C	1000	650	6
653A	ND	Sheyenne	Barnes	1253	**36**	Dovray	5	0.0	C	2C	1000	650	6
653A	ND	Sheyenne	Barnes	1253	**36**	Lismore	3	0.0	C	3D	1800	1170	6
653A	ND	Sheyenne	Barnes	1253	**36**	Ryan	2	0.0	N	1B			
653A	ND	Sheyenne	Barnes	1253	**56**	Ladelle	75	3.9	I	4A	2250	1460	6
653A	ND	Sheyenne	Barnes	1253	**56**	Fairdale	18	0.9	I	4A	2250	1460	6
653A	ND	Sheyenne	Barnes	1253	**56**	Sinai	5	0.3	C	2B	1000	650	6
653A	ND	Sheyenne	Barnes	1253	**56**	Lamoure	2	0.1	C	3B	1500	975	6
653A	ND	Sheyenne	Barnes	1253	**9**	Nutley	95	6.8	C	2B	1000	650	6
653A	ND	Sheyenne	Barnes	1253	**9**	Fargo	5	0.4	C	2C	1000	650	6
698	ND	Sheyenne	Ransom	1162	**1043**	La Prairie	80	2.8	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**1043**	Fairdale	12	0.4	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**1043**	Fordville	4	0.1	I	6B	3000	1950	9
698	ND	Sheyenne	Ransom	1162	**1043**	Laprairie Channeled	3	0.1	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**1043**	Rauville	1	0.0	C	3B	1500	975	6
698	ND	Sheyenne	Ransom	1162	**120**	Barnes	48	2.8	C	3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**120**	Buse	35	2.0	N/C	1A/3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**120**	Svea	14	0.8	C	3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**120**	Tonka	2	0.1	C	2C	1000	650	6
698	ND	Sheyenne	Ransom	1162	**120**	Zell	1	0.1	N/I	1A/4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**1403**	Overly	70	76.0	C	3A	1500	975	6
698	ND	Sheyenne	Ransom	1162	**1403**	Great Bend	19	20.6	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**1403**	Gardena	5	5.4	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**1403**	Bearden	3	3.3	C	3B	1500	975	6
698	ND	Sheyenne	Ransom	1162	**1403**	Perella	2	2.2	C	3B	1500	975	6
698	ND	Sheyenne	Ransom	1162	**1403**	Tonka	1	1.1	C	2C	1000	650	6
698	ND	Sheyenne	Ransom	1162	**156**	Barnes	56	5.7	C	3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**156**	Svea	28	2.8	C	3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**156**	Buse	7	0.7	N/C	1A/3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**156**	Tonka	4	0.4	C	2C	1000	650	6
698	ND	Sheyenne	Ransom	1162	**156**	Parnell	3	0.3	C	2C	1000	650	6
698	ND	Sheyenne	Ransom	1162	**156**	Hamerly	1	0.1	C	3B	1500	975	6
698	ND	Sheyenne	Ransom	1162	**156**	Vallers	1	0.1	C	3B	1500	975	6
698	ND	Sheyenne	Ransom	1162	**2091**	Zell	70	6.6	N/I	1A/4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**2091**	Buse	10	0.9	N/C	1A/3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**2091**	Eckman	7	0.7	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**2091**	Gardena	7	0.7	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**2091**	Langhei	3	0.3	N/C	1A/3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**2091**	Sioux	3	0.3	N/I	1A/10	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**2209**	Buse	40	5.4	N/C	1A/3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**2209**	Barnes	36	4.8	C	3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**2209**	Svea	12	1.6	C	3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**2209**	Forman	5	0.7	C	3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**2209**	Sioux	5	0.7	N/I	1A/10	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**2209**	Maddock	2	0.3	I	8A	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	2.6	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	0.4	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	0.1	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	0.1	I	4A	2250	1460	6
698	ND	Sheyenne	Ransom	1162	**2221**	Lohnes	92	9.0	I	9A	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**2221**	Maddock	4	0.4	I	8A	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**2221**	Claire	2	0.2	I	9A	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**2221**	Hecla	2	0.2	I	8A	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**726**	Fordville	65	19.8	I	6B	3000	1950	9
698	ND	Sheyenne	Ransom	1162	**726**	Renshaw	25	7.6	I	6A	3000	1950	9
698	ND	Sheyenne	Ransom	1162	**726**	Svea	4	1.2	C	3D	1800	1170	6
698	ND	Sheyenne	Ransom	1162	**726**	Divide	3	0.9	C	6C	3000	1950	6
698	ND	Sheyenne	Ransom	1162	**726**	Arvilla	2	0.6	I	8A	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**726**	Sioux	1	0.3	N/I	1A/10	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**76**	Arvilla	79	4.9	I	8A	3000	1950	12

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Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
698	ND	Sheyenne	Ransom	1162	**76**	Brantford	10	0.6	I	6A	3000	1950	9
698	ND	Sheyenne	Ransom	1162	**76**	Fordville	3	0.2	I	6B	3000	1950	9
698	ND	Sheyenne	Ransom	1162	**76**	Divide	2	0.1	C	6C	3000	1950	6
698	ND	Sheyenne	Ransom	1162	**76**	Embden	2	0.1	I	7A	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**76**	Hecla	2	0.1	I	8A	3000	1950	12
698	ND	Sheyenne	Ransom	1162	**76**	Sioux	2	0.1	N/I	1A/10	3000	1950	12
734244	MN	Red	Polk	296	**1006**	Fluvaquents	45	13.5	N	1A/1D			
734244	MN	Red	Polk	296	**1006**	Haploborolls	45	13.5	N	1A			
734244	MN	Red	Polk	296	**1006**	Rauville	4	1.2	C	3B	1500	975	6
734244	MN	Red	Polk	296	**1006**	Fairdale	3	0.9	I	4A	2250	1460	6
734244	MN	Red	Polk	296	**1006**	Soils With Greater Slopes	3	0.9	?	?			
734244	MN	Red	Polk	296	**1963**	Bearden	50	25.0	C	3B	1500	975	6
734244	MN	Red	Polk	296	**1963**	Colvin	40	20.0	C	3B	1500	975	6
734244	MN	Red	Polk	296	**1963**	Fargo	5	2.5	C	2C	1000	650	6
734244	MN	Red	Polk	296	**1963**	Perella	5	2.5	C	3B	1500	975	6
734244	MN	Red	Polk	296	**422b**	Bygland	90	68.4	C	3A	1500	975	6
734244	MN	Red	Polk	296	**422b**	Bearden	5	3.8	C	3B	1500	975	6
734244	MN	Red	Polk	296	**422b**	Lindaas	5	3.8	C	2C	1000	650	6
734244	MN	Red	Polk	296	**67b**	Bearden	90	16.5	C	3B	1500	975	6
734244	MN	Red	Polk	296	**67b**	Colvin	3	0.5	C	3B	1500	975	6
734244	MN	Red	Polk	296	**67b**	Zell	3	0.5	N/I	1A/4A	2250	1460	6
734244	MN	Red	Polk	296	**67b**	Glyndon	2	0.4	C	4B	2250	1460	6
734244	MN	Red	Polk	296	**67b**	Lesser Or Greater Slopes	2	0.4	?	?			
734244	MN	Red	Polk	296	**694d2**	Zell	90	13.0	N/I	1A/4A	2250	1460	6
734244	MN	Red	Polk	296	**694d2**	Fairdale	4	0.6	I	4A	2250	1460	6
734244	MN	Red	Polk	296	**694d2**	Hattie	3	0.4	C	2B	1000	650	6
734244	MN	Red	Polk	296	**694d2**	Glyndon	2	0.3	C	4B	2250	1460	6
734244	MN	Red	Polk	296	**694d2**	Lesser Or Greater Slopes	1	0.1	?	?			
757	ND	Sheyenne	Ransom	1162	**1834**	Tonka	84	2.2	C	2C	1000	650	6
757	ND	Sheyenne	Ransom	1162	**1834**	Hamerly	12	0.3	C	3B	1500	975	6
757	ND	Sheyenne	Ransom	1162	**1834**	Vallers	4	0.1	C	3B	1500	975	6
757	ND	Sheyenne	Ransom	1162	**1842**	Towner	61	2.6	C	5A	1800	1170	9
757	ND	Sheyenne	Ransom	1162	**1842**	Lohnes	15	0.6	I	9A	3000	1950	12
757	ND	Sheyenne	Ransom	1162	**1842**	Maddock	10	0.4	I	8A	3000	1950	12
757	ND	Sheyenne	Ransom	1162	**1842**	Arvilla	5	0.2	I	8A	3000	1950	12
757	ND	Sheyenne	Ransom	1162	**1842**	Fordville	5	0.2	I	6B	3000	1950	9
757	ND	Sheyenne	Ransom	1162	**1842**	Hamar	2	0.1	C	2B	1000	650	6
757	ND	Sheyenne	Ransom	1162	**1842**	Hecla	2	0.1	I	8A	3000	1950	12
757	ND	Sheyenne	Ransom	1162	**2091**	Zell	70	2.7	N/I	1A/4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**2091**	Buse	10	0.4	N/C	1A/3D	1800	1170	6
757	ND	Sheyenne	Ransom	1162	**2091**	Eckman	7	0.3	I	4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**2091**	Gardena	7	0.3	I	4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**2091**	Langhei	3	0.1	N/C	1A/3D	1800	1170	6
757	ND	Sheyenne	Ransom	1162	**2091**	Sioux	3	0.1	N/I	1A/10	3000	1950	12
757	ND	Sheyenne	Ransom	1162	**2213**	Eckman	50	0.2	I	4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**2213**	Zell	35	0.1	N/I	1A/4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**2213**	Gardena	8	0.0	I	4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**2213**	Buse	5	0.0	N/C	1A/3D	1800	1170	6
757	ND	Sheyenne	Ransom	1162	**2213**	Renshaw	2	0.0	I	6A	3000	1950	9
757	ND	Sheyenne	Ransom	1162	**2215**	Fairdale	81	93.2	I	4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**2215**	Laprairie	13	15.0	I	4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**2215**	Fairdale Channeled	3	3.5	I	4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**2215**	Ladelle	3	3.5	I	4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**76**	Arvilla	79	0.1	I	8A	3000	1950	12
757	ND	Sheyenne	Ransom	1162	**76**	Brantford	10	0.0	I	6A	3000	1950	9
757	ND	Sheyenne	Ransom	1162	**76**	Fordville	3	0.0	I	6B	3000	1950	9
757	ND	Sheyenne	Ransom	1162	**76**	Divide	2	0.0	C	6C	3000	1950	6
757	ND	Sheyenne	Ransom	1162	**76**	Embden	2	0.0	I	7A	3000	1950	12
757	ND	Sheyenne	Ransom	1162	**76**	Hecla	2	0.0	I	8A	3000	1950	12
757	ND	Sheyenne	Ransom	1162	**76**	Sioux	2	0.0	N/I	1A/10	3000	1950	12
757	ND	Sheyenne	Ransom	1162	**772**	Gardena	60	10.3	I	4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**772**	Eckman	27	4.6	I	4A	2250	1460	6
757	ND	Sheyenne	Ransom	1162	**772**	Overly	7	1.2	C	3A	1500	975	6
757	ND	Sheyenne	Ransom	1162	**772**	Glyndon	3	0.5	C	4B	2250	1460	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
757	ND	Sheyenne	Ransom	1162	**772**	Zell	3	0.5	N/I	1A/4A	2250	1460	6
811094	MN	Red	Polk	296	**1006**	Fluvaquents	45	4.1	N	1A/1D			
811094	MN	Red	Polk	296	**1006**	Haploborolls	45	4.1	N	1A			
811094	MN	Red	Polk	296	**1006**	Rauville	4	0.4	C	3B	1500	975	6
811094	MN	Red	Polk	296	**1006**	Fairdale	3	0.3	I	4A	2250	1460	6
811094	MN	Red	Polk	296	**1006**	Soils With Greater Slopes	3	0.3	?	?			
811094	MN	Red	Polk	296	**1916**	Lindaas	90	7.5	C	2C	1000	650	6
811094	MN	Red	Polk	296	**1916**	Bearden	5	0.4	C	3B	1500	975	6
811094	MN	Red	Polk	296	**1916**	Bygland	5	0.4	C	3A	1500	975	6
811094	MN	Red	Polk	296	**422a**	Bygland	90	43.6	C	3A	1500	975	6
811094	MN	Red	Polk	296	**422a**	Bearden	5	2.4	C	3B	1500	975	6
811094	MN	Red	Polk	296	**422a**	Lindaas	5	2.4	C	2C	1000	650	6
811094	MN	Red	Polk	296	**422b**	Bygland	90	15.3	C	3A	1500	975	6
811094	MN	Red	Polk	296	**422b**	Bearden	5	0.9	C	3B	1500	975	6
811094	MN	Red	Polk	296	**422b**	Lindaas	5	0.9	C	2C	1000	650	6
811094	MN	Red	Polk	296	**450**	Rauville	90	42.9	C	3B	1500	975	6
811094	MN	Red	Polk	296	**450**	Fairdale	5	2.4	I	4A	2250	1460	6
811094	MN	Red	Polk	296	**450**	Ladelle	5	2.4	I	4A	2250	1460	6
811094	MN	Red	Polk	296	**667b**	Fairdale	90	215.0	I	4A	2250	1460	6
811094	MN	Red	Polk	296	**667b**	Fluvaquents	4	9.6	N	1A/1D			
811094	MN	Red	Polk	296	**667b**	Zell	3	7.2	N/I	1A/4A	2250	1460	6
811094	MN	Red	Polk	296	**667b**	Rauville	2	4.8	C	3B	1500	975	6
811094	MN	Red	Polk	296	**667b**	Soils With Greater Slopes	1	2.4	?	?			
881268	MN	Red	Polk	296	**1006**	Fluvaquents	45	2.0	N	1A/1D			
881268	MN	Red	Polk	296	**1006**	Haploborolls	45	2.0	N	1A			
881268	MN	Red	Polk	296	**1006**	Rauville	4	0.2	C	3B	1500	975	6
881268	MN	Red	Polk	296	**1006**	Fairdale	3	0.1	I	4A	2250	1460	6
881268	MN	Red	Polk	296	**1006**	Soils With Greater Slopes	3	0.1	?	?			
881268	MN	Red	Polk	296	**1866**	Colvin	50	12.5	C	3B	1500	975	6
881268	MN	Red	Polk	296	**1866**	Perella	40	10.0	C	3B	1500	975	6
881268	MN	Red	Polk	296	**1866**	Bearden	7	1.8	C	3B	1500	975	6
881268	MN	Red	Polk	296	**1866**	Fargo	3	0.8	C	2C	1000	650	6
881268	MN	Red	Polk	296	**1963**	Bearden	50	82.0	C	3B	1500	975	6
881268	MN	Red	Polk	296	**1963**	Colvin	40	65.6	C	3B	1500	975	6
881268	MN	Red	Polk	296	**1963**	Fargo	5	8.2	C	2C	1000	650	6
881268	MN	Red	Polk	296	**1963**	Perella	5	8.2	C	3B	1500	975	6
881268	MN	Red	Polk	296	**667b**	Fairdale	90	24.9	I	4A	2250	1460	6
881268	MN	Red	Polk	296	**667b**	Fluvaquents	4	1.1	N	1A/1D			
881268	MN	Red	Polk	296	**667b**	Zell	3	0.8	N/I	1A/4A	2250	1460	6
881268	MN	Red	Polk	296	**667b**	Rauville	2	0.6	C	3B	1500	975	6
881268	MN	Red	Polk	296	**667b**	Soils With Greater Slopes	1	0.3	?	?			
881268	MN	Red	Polk	296	**67a**	Bearden	90	75.5	C	3B	1500	975	6
881268	MN	Red	Polk	296	**67a**	Colvin	3	2.5	C	3B	1500	975	6
881268	MN	Red	Polk	296	**67a**	Fargo	3	2.5	C	2C	1000	650	6
881268	MN	Red	Polk	296	**67a**	Glyndon	2	1.7	C	4B	2250	1460	6
881268	MN	Red	Polk	296	**67a**	Wheatville	2	1.7	C	3B	1500	975	6
881268	MN	Red	Polk	296	**67b**	Bearden	90	8.4	C	3B	1500	975	6
881268	MN	Red	Polk	296	**67b**	Colvin	3	0.3	C	3B	1500	975	6
881268	MN	Red	Polk	296	**67b**	Zell	3	0.3	N/I	1A/4A	2250	1460	6
881268	MN	Red	Polk	296	**67b**	Glyndon	2	0.2	C	4B	2250	1460	6
881268	MN	Red	Polk	296	**67b**	Lesser Or Greater Slopes	2	0.2	?	?			
901041	MN	Red	Polk	296	**1916**	Lindaas	90	0.3	C	2C	1000	650	6
901041	MN	Red	Polk	296	**1916**	Bearden	5	0.0	C	3B	1500	975	6
901041	MN	Red	Polk	296	**1916**	Bygland	5	0.0	C	3A	1500	975	6
901041	MN	Red	Polk	296	**1963**	Bearden	50	36.0	C	3B	1500	975	6
901041	MN	Red	Polk	296	**1963**	Colvin	40	28.8	C	3B	1500	975	6
901041	MN	Red	Polk	296	**1963**	Fargo	5	3.6	C	2C	1000	650	6
901041	MN	Red	Polk	296	**1963**	Perella	5	3.6	C	3B	1500	975	6
901041	MN	Red	Polk	296	**47**	Colvin	90	19.0	C	3B	1500	975	6
901041	MN	Red	Polk	296	**47**	Bearden	3	0.6	C	3B	1500	975	6
901041	MN	Red	Polk	296	**47**	Perella	3	0.6	C	3B	1500	975	6
901041	MN	Red	Polk	296	**47**	Fargo	2	0.4	C	2C	1000	650	6
901041	MN	Red	Polk	296	**47**	Hegne	1	0.2	C	2C	1000	650	6
901041	MN	Red	Polk	296	**47**	Nielsville	1	0.2	C	3B	1500	975	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
901041	MN	Red	Polk	296	**506**	Overly	90	17.3	C	3A	1500	975	6
901041	MN	Red	Polk	296	**506**	Lindaas	3	0.6	C	2C	1000	650	6
901041	MN	Red	Polk	296	**506**	Bearden	2	0.4	C	3B	1500	975	6
901041	MN	Red	Polk	296	**506**	Bygland	2	0.4	C	3A	1500	975	6
901041	MN	Red	Polk	296	**506**	Colvin	2	0.4	C	3B	1500	975	6
901041	MN	Red	Polk	296	**506**	Perella	1	0.2	C	3B	1500	975	6
901041	MN	Red	Polk	296	**93a**	Bearden	90	18.0	C	3B	1500	975	6
901041	MN	Red	Polk	296	**93a**	Colvin	3	0.6	C	3B	1500	975	6
901041	MN	Red	Polk	296	**93a**	Fargo	3	0.6	C	2C	1000	650	6
901041	MN	Red	Polk	296	**93a**	Glyndon	2	0.4	C	4B	2250	1460	6
901041	MN	Red	Polk	296	**93a**	Wheatville	2	0.4	C	3B	1500	975	6
901098	MN	Red	Polk	375	**1006**	Fluvaquents	45	4.6	N	1A/1D			
901098	MN	Red	Polk	375	**1006**	Haploborolls	45	4.6	N	1A			
901098	MN	Red	Polk	375	**1006**	Rauville	4	0.4	C	3B	1500	975	6
901098	MN	Red	Polk	375	**1006**	Fairdale	3	0.3	I	4A	2250	1460	6
901098	MN	Red	Polk	375	**1006**	Soils With Greater Slopes	3	0.3	?	?			
901098	MN	Red	Polk	375	**1916**	Lindaas	90	0.4	C	2C	1000	650	6
901098	MN	Red	Polk	375	**1916**	Bearden	5	0.0	C	3B	1500	975	6
901098	MN	Red	Polk	375	**1916**	Bygland	5	0.0	C	3A	1500	975	6
901098	MN	Red	Polk	375	**422a**	Bygland	90	62.1	C	3A	1500	975	6
901098	MN	Red	Polk	375	**422a**	Bearden	5	3.5	C	3B	1500	975	6
901098	MN	Red	Polk	375	**422a**	Lindaas	5	3.5	C	2C	1000	650	6
901098	MN	Red	Polk	375	**422b**	Bygland	90	13.9	C	3A	1500	975	6
901098	MN	Red	Polk	375	**422b**	Bearden	5	0.8	C	3B	1500	975	6
901098	MN	Red	Polk	375	**422b**	Lindaas	5	0.8	C	2C	1000	650	6
901098	MN	Red	Polk	375	**422c2**	Bygland	90	15.4	C	3A	1500	975	6
901098	MN	Red	Polk	375	**422c2**	Lindaas	3	0.5	C	2C	1000	650	6
901098	MN	Red	Polk	375	**422c2**	Zell	3	0.5	N/I	1A/4A	2250	1460	6
901098	MN	Red	Polk	375	**422c2**	Fairdale	2	0.3	I	4A	2250	1460	6
901098	MN	Red	Polk	375	**422c2**	Lesser Or Greater Slopes	2	0.3	?	?			
901098	MN	Red	Polk	375	**667b**	Fairdale	90	9.0	I	4A	2250	1460	6
901098	MN	Red	Polk	375	**667b**	Fluvaquents	4	0.4	N	1A/1D			
901098	MN	Red	Polk	375	**667b**	Zell	3	0.3	N/I	1A/4A	2250	1460	6
901098	MN	Red	Polk	375	**667b**	Rauville	2	0.2	C	3B	1500	975	6
901098	MN	Red	Polk	375	**667b**	Soils With Greater Slopes	1	0.1	?	?			
901098	MN	Red	Polk	375	**694d2**	Zell	90	16.0	N/I	1A/4A	2250	1460	6
901098	MN	Red	Polk	375	**694d2**	Fairdale	4	0.7	I	4A	2250	1460	6
901098	MN	Red	Polk	375	**694d2**	Hattie	3	0.5	C	2B	1000	650	6
901098	MN	Red	Polk	375	**694d2**	Glyndon	2	0.4	C	4B	2250	1460	6
901098	MN	Red	Polk	375	**694d2**	Lesser Or Greater Slopes	1	0.2	?	?			
901108	MN	Red	Polk	296	**1006**	Fluvaquents	45	2.8	N	1A/1D			
901108	MN	Red	Polk	296	**1006**	Haploborolls	45	2.8	N	1A			
901108	MN	Red	Polk	296	**1006**	Rauville	4	0.2	C	3B	1500	975	6
901108	MN	Red	Polk	296	**1006**	Fairdale	3	0.2	I	4A	2250	1460	6
901108	MN	Red	Polk	296	**1006**	Soils With Greater Slopes	3	0.2	?	?			
901108	MN	Red	Polk	296	**1916**	Lindaas	90	6.1	C	2C	1000	650	6
901108	MN	Red	Polk	296	**1916**	Bearden	5	0.3	C	3B	1500	975	6
901108	MN	Red	Polk	296	**1916**	Bygland	5	0.3	C	3A	1500	975	6
901108	MN	Red	Polk	296	**422a**	Bygland	90	41.7	C	3A	1500	975	6
901108	MN	Red	Polk	296	**422a**	Bearden	5	2.3	C	3B	1500	975	6
901108	MN	Red	Polk	296	**422a**	Lindaas	5	2.3	C	2C	1000	650	6
901108	MN	Red	Polk	296	**422c2**	Bygland	90	1.7	C	3A	1500	975	6
901108	MN	Red	Polk	296	**422c2**	Lindaas	3	0.1	C	2C	1000	650	6
901108	MN	Red	Polk	296	**422c2**	Zell	3	0.1	N/I	1A/4A	2250	1460	6
901108	MN	Red	Polk	296	**422c2**	Fairdale	2	0.0	I	4A	2250	1460	6
901108	MN	Red	Polk	296	**422c2**	Lesser Or Greater Slopes	2	0.0	?	?			
901108	MN	Red	Polk	296	**450**	Rauville	90	1.9	C	3B	1500	975	6
901108	MN	Red	Polk	296	**450**	Fairdale	5	0.1	I	4A	2250	1460	6
901108	MN	Red	Polk	296	**450**	Ladelle	5	0.1	I	4A	2250	1460	6
901108	MN	Red	Polk	296	**667b**	Fairdale	90	63.2	I	4A	2250	1460	6
901108	MN	Red	Polk	296	**667b**	Fluvaquents	4	2.8	N	1A/1D			
901108	MN	Red	Polk	296	**667b**	Zell	3	2.1	N/I	1A/4A	2250	1460	6
901108	MN	Red	Polk	296	**667b**	Rauville	2	1.4	C	3B	1500	975	6
901108	MN	Red	Polk	296	**667b**	Soils With Greater Slopes	1	0.7	?	?			

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Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
901108	MN	Red	Polk	296	**667c2**	Fairdale	90	79.6	I	4A	2250	1460	6
901108	MN	Red	Polk	296	**667c2**	Fluvaquents	4	3.5	N	1A/1D			
901108	MN	Red	Polk	296	**667c2**	Zell	3	2.7	N/I	1A/4A	2250	1460	6
901108	MN	Red	Polk	296	**667c2**	Rauville	2	1.8	C	3B	1500	975	6
901108	MN	Red	Polk	296	**667c2**	Lesser Or Greater Slopes	1	0.9	?	?			
901108	MN	Red	Polk	296	**W**	Water	100	0.2	N	0			
901134	MN	Red	Polk	296	**1006**	Fluvaquents	45	2.7	N	1A/1D			
901134	MN	Red	Polk	296	**1006**	Haploborolls	45	2.7	N	1A			
901134	MN	Red	Polk	296	**1006**	Rauville	4	0.2	C	3B	1500	975	6
901134	MN	Red	Polk	296	**1006**	Fairdale	3	0.2	I	4A	2250	1460	6
901134	MN	Red	Polk	296	**1006**	Soils With Greater Slopes	3	0.2	?	?			
901134	MN	Red	Polk	296	**1963**	Bearden	50	17.8	C	3B	1500	975	6
901134	MN	Red	Polk	296	**1963**	Colvin	40	14.3	C	3B	1500	975	6
901134	MN	Red	Polk	296	**1963**	Fargo	5	1.8	C	2C	1000	650	6
901134	MN	Red	Polk	296	**1963**	Perella	5	1.8	C	3B	1500	975	6
901134	MN	Red	Polk	296	**667b**	Fairdale	90	44.0	I	4A	2250	1460	6
901134	MN	Red	Polk	296	**667b**	Fluvaquents	4	2.0	N	1A/1D			
901134	MN	Red	Polk	296	**667b**	Zell	3	1.5	N/I	1A/4A	2250	1460	6
901134	MN	Red	Polk	296	**667b**	Rauville	2	1.0	C	3B	1500	975	6
901134	MN	Red	Polk	296	**667b**	Soils With Greater Slopes	1	0.5	?	?			
901158	MN	Red	Polk	375	**1006**	Fluvaquents	45	0.8	N	1A/1D			
901158	MN	Red	Polk	375	**1006**	Haploborolls	45	0.8	N	1A			
901158	MN	Red	Polk	375	**1006**	Rauville	4	0.1	C	3B	1500	975	6
901158	MN	Red	Polk	375	**1006**	Fairdale	3	0.1	I	4A	2250	1460	6
901158	MN	Red	Polk	375	**1006**	Soils With Greater Slopes	3	0.1	?	?			
901158	MN	Red	Polk	375	**1916**	Lindaas	90	1.2	C	2C	1000	650	6
901158	MN	Red	Polk	375	**1916**	Bearden	5	0.1	C	3B	1500	975	6
901158	MN	Red	Polk	375	**1916**	Bygland	5	0.1	C	3A	1500	975	6
901158	MN	Red	Polk	375	**422a**	Bygland	90	43.8	C	3A	1500	975	6
901158	MN	Red	Polk	375	**422a**	Bearden	5	2.4	C	3B	1500	975	6
901158	MN	Red	Polk	375	**422a**	Lindaas	5	2.4	C	2C	1000	650	6
901158	MN	Red	Polk	375	**422b**	Bygland	90	12.2	C	3A	1500	975	6
901158	MN	Red	Polk	375	**422b**	Bearden	5	0.7	C	3B	1500	975	6
901158	MN	Red	Polk	375	**422b**	Lindaas	5	0.7	C	2C	1000	650	6
901158	MN	Red	Polk	375	**422c2**	Bygland	90	3.9	C	3A	1500	975	6
901158	MN	Red	Polk	375	**422c2**	Lindaas	3	0.1	C	2C	1000	650	6
901158	MN	Red	Polk	375	**422c2**	Zell	3	0.1	N/I	1A/4A	2250	1460	6
901158	MN	Red	Polk	375	**422c2**	Fairdale	2	0.1	I	4A	2250	1460	6
901158	MN	Red	Polk	375	**422c2**	Lesser Or Greater Slopes	2	0.1	?	?			
901158	MN	Red	Polk	375	**47**	Colvin	90	0.1	C	3B	1500	975	6
901158	MN	Red	Polk	375	**47**	Bearden	3	0.0	C	3B	1500	975	6
901158	MN	Red	Polk	375	**47**	Perella	3	0.0	C	3B	1500	975	6
901158	MN	Red	Polk	375	**47**	Fargo	2	0.0	C	2C	1000	650	6
901158	MN	Red	Polk	375	**47**	Hegne	1	0.0	C	2C	1000	650	6
901158	MN	Red	Polk	375	**47**	Nielsville	1	0.0	C	3B	1500	975	6
901333	MN	Red	Polk	375	**1866**	Colvin	50	118.4	C	3B	1500	975	6
901333	MN	Red	Polk	375	**1866**	Perella	40	94.7	C	3B	1500	975	6
901333	MN	Red	Polk	375	**1866**	Bearden	7	16.6	C	3B	1500	975	6
901333	MN	Red	Polk	375	**1866**	Fargo	3	7.1	C	2C	1000	650	6
901333	MN	Red	Polk	375	**1916**	Lindaas	90	0.2	C	2C	1000	650	6
901333	MN	Red	Polk	375	**1916**	Bearden	5	0.0	C	3B	1500	975	6
901333	MN	Red	Polk	375	**1916**	Bygland	5	0.0	C	3A	1500	975	6
901333	MN	Red	Polk	375	**422a**	Bygland	90	112.2	C	3A	1500	975	6
901333	MN	Red	Polk	375	**422a**	Bearden	5	6.2	C	3B	1500	975	6
901333	MN	Red	Polk	375	**422a**	Lindaas	5	6.2	C	2C	1000	650	6
901333	MN	Red	Polk	375	**47**	Colvin	90	69.4	C	3B	1500	975	6
901333	MN	Red	Polk	375	**47**	Bearden	3	2.3	C	3B	1500	975	6
901333	MN	Red	Polk	375	**47**	Perella	3	2.3	C	3B	1500	975	6
901333	MN	Red	Polk	375	**47**	Fargo	2	1.5	C	2C	1000	650	6
901333	MN	Red	Polk	375	**47**	Hegne	1	0.8	C	2C	1000	650	6
901333	MN	Red	Polk	375	**47**	Nielsville	1	0.8	C	3B	1500	975	6
911251	MN	Red	Polk	296	**1006**	Fluvaquents	45	0.2	N	1A/1D			
911251	MN	Red	Polk	296	**1006**	Haploborolls	45	0.2	N	1A			
911251	MN	Red	Polk	296	**1006**	Rauville	4	0.0	C	3B	1500	975	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

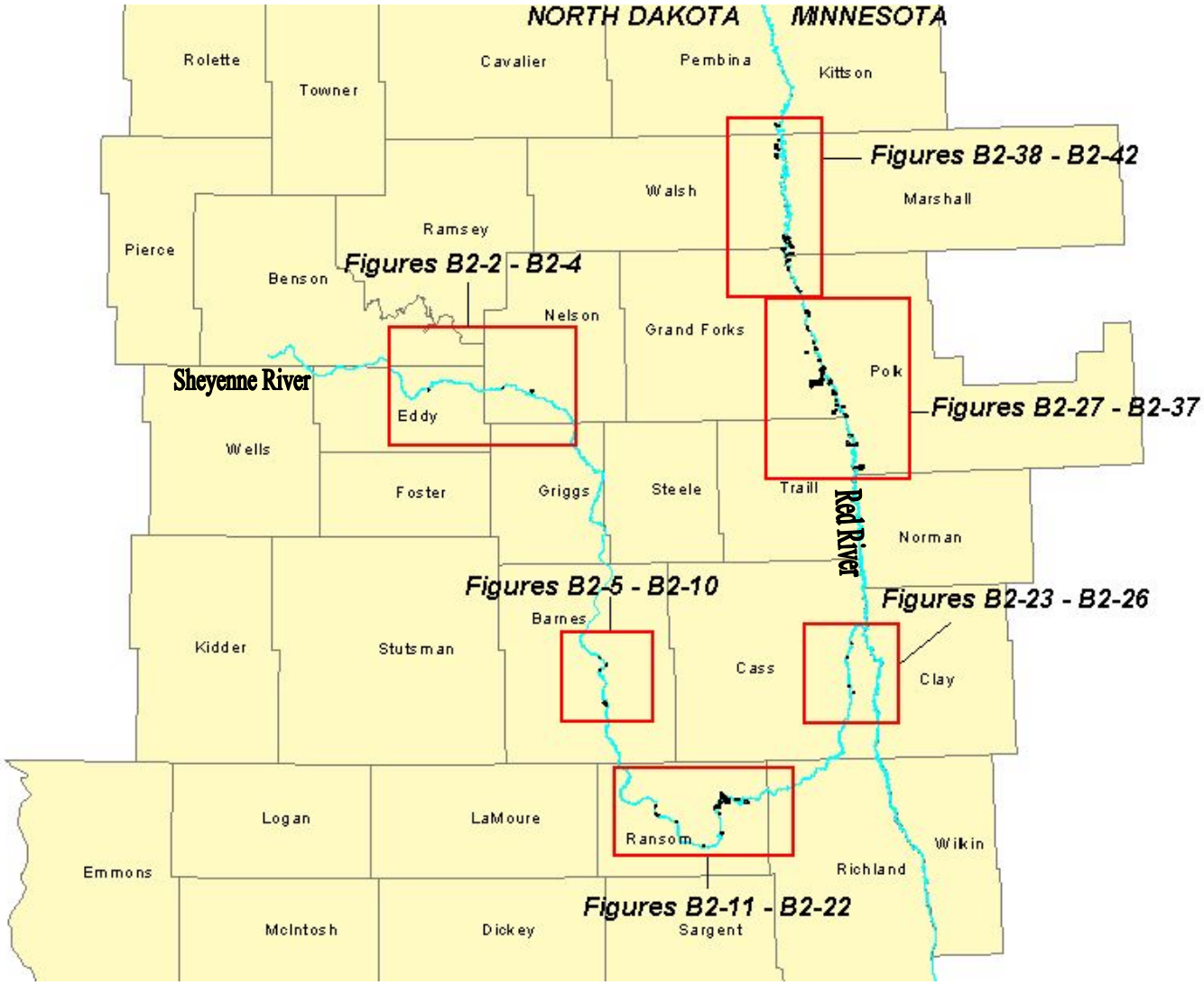
Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
911251	MN	Red	Polk	296	**1006**	Fairdale	3	0.0	I	4A	2250	1460	6
911251	MN	Red	Polk	296	**1006**	Soils With Greater Slopes	3	0.0	?	?			
911251	MN	Red	Polk	296	**1916**	Lindaas	90	28.4	C	2C	1000	650	6
911251	MN	Red	Polk	296	**1916**	Bearden	5	1.6	C	3B	1500	975	6
911251	MN	Red	Polk	296	**1916**	Bygland	5	1.6	C	3A	1500	975	6
911251	MN	Red	Polk	296	**422a**	Bygland	90	21.0	C	3A	1500	975	6
911251	MN	Red	Polk	296	**422a**	Bearden	5	1.2	C	3B	1500	975	6
911251	MN	Red	Polk	296	**422a**	Lindaas	5	1.2	C	2C	1000	650	6
911251	MN	Red	Polk	296	**422b**	Bygland	90	2.8	C	3A	1500	975	6
911251	MN	Red	Polk	296	**422b**	Bearden	5	0.2	C	3B	1500	975	6
911251	MN	Red	Polk	296	**422b**	Lindaas	5	0.2	C	2C	1000	650	6
911251	MN	Red	Polk	296	**450**	Rauville	90	0.9	C	3B	1500	975	6
911251	MN	Red	Polk	296	**450**	Fairdale	5	0.1	I	4A	2250	1460	6
911251	MN	Red	Polk	296	**450**	Ladelle	5	0.1	I	4A	2250	1460	6
911251	MN	Red	Polk	296	**506**	Overly	90	34.9	C	3A	1500	975	6
911251	MN	Red	Polk	296	**506**	Lindaas	3	1.2	C	2C	1000	650	6
911251	MN	Red	Polk	296	**506**	Bearden	2	0.8	C	3B	1500	975	6
911251	MN	Red	Polk	296	**506**	Bygland	2	0.8	C	3A	1500	975	6
911251	MN	Red	Polk	296	**506**	Colvin	2	0.8	C	3B	1500	975	6
911251	MN	Red	Polk	296	**506**	Perella	1	0.4	C	3B	1500	975	6
911251	MN	Red	Polk	296	**667b**	Fairdale	90	29.1	I	4A	2250	1460	6
911251	MN	Red	Polk	296	**667b**	Fluvaquents	4	1.3	N	1A/1D			
911251	MN	Red	Polk	296	**667b**	Zell	3	1.0	N/I	1A/4A	2250	1460	6
911251	MN	Red	Polk	296	**667b**	Rauville	2	0.6	C	3B	1500	975	6
911251	MN	Red	Polk	296	**667b**	Soils With Greater Slopes	1	0.3	?	?			
911251	MN	Red	Polk	296	**667c2**	Fairdale	90	17.3	I	4A	2250	1460	6
911251	MN	Red	Polk	296	**667c2**	Fluvaquents	4	0.8	N	1A/1D			
911251	MN	Red	Polk	296	**667c2**	Zell	3	0.6	N/I	1A/4A	2250	1460	6
911251	MN	Red	Polk	296	**667c2**	Rauville	2	0.4	C	3B	1500	975	6
911251	MN	Red	Polk	296	**667c2**	Lesser Or Greater Slopes	1	0.2	?	?			
911251	MN	Red	Polk	296	**694d2**	Zell	90	0.4	N/I	1A/4A	2250	1460	6
911251	MN	Red	Polk	296	**694d2**	Fairdale	4	0.0	I	4A	2250	1460	6
911251	MN	Red	Polk	296	**694d2**	Hattie	3	0.0	C	2B	1000	650	6
911251	MN	Red	Polk	296	**694d2**	Glyndon	2	0.0	C	4B	2250	1460	6
911251	MN	Red	Polk	296	**694d2**	Lesser Or Greater Slopes	1	0.0	?	?			
911251	MN	Red	Polk	296	**W**	Water	100	2.1	N	0			
911276	MN	Red	Polk	375	**1006**	Fluvaquents	45	0.5	N	1A/1D			
911276	MN	Red	Polk	375	**1006**	Haploborolls	45	0.5	N	1A			
911276	MN	Red	Polk	375	**1006**	Rauville	4	0.0	C	3B	1500	975	6
911276	MN	Red	Polk	375	**1006**	Fairdale	3	0.0	I	4A	2250	1460	6
911276	MN	Red	Polk	375	**1006**	Soils With Greater Slopes	3	0.0	?	?			
911276	MN	Red	Polk	375	**422a**	Bygland	90	21.8	C	3A	1500	975	6
911276	MN	Red	Polk	375	**422a**	Bearden	5	1.2	C	3B	1500	975	6
911276	MN	Red	Polk	375	**422a**	Lindaas	5	1.2	C	2C	1000	650	6
911276	MN	Red	Polk	375	**422b**	Bygland	90	32.7	C	3A	1500	975	6
911276	MN	Red	Polk	375	**422b**	Bearden	5	1.8	C	3B	1500	975	6
911276	MN	Red	Polk	375	**422b**	Lindaas	5	1.8	C	2C	1000	650	6
911276	MN	Red	Polk	375	**450**	Rauville	90	1.9	C	3B	1500	975	6
911276	MN	Red	Polk	375	**450**	Fairdale	5	0.1	I	4A	2250	1460	6
911276	MN	Red	Polk	375	**450**	Ladelle	5	0.1	I	4A	2250	1460	6
911276	MN	Red	Polk	375	**667c2**	Fairdale	90	5.7	I	4A	2250	1460	6
911276	MN	Red	Polk	375	**667c2**	Fluvaquents	4	0.3	N	1A/1D			
911276	MN	Red	Polk	375	**667c2**	Zell	3	0.2	N/I	1A/4A	2250	1460	6
911276	MN	Red	Polk	375	**667c2**	Rauville	2	0.1	C	3B	1500	975	6
911276	MN	Red	Polk	375	**667c2**	Lesser Or Greater Slopes	1	0.1	?	?			
921200	MN	Red	Polk	375	**1916**	Lindaas	90	15.7	C	2C	1000	650	6
921200	MN	Red	Polk	375	**1916**	Bearden	5	0.9	C	3B	1500	975	6
921200	MN	Red	Polk	375	**1916**	Bygland	5	0.9	C	3A	1500	975	6
921200	MN	Red	Polk	375	**422a**	Bygland	90	107.3	C	3A	1500	975	6
921200	MN	Red	Polk	375	**422a**	Bearden	5	6.0	C	3B	1500	975	6
921200	MN	Red	Polk	375	**422a**	Lindaas	5	6.0	C	2C	1000	650	6
921200	MN	Red	Polk	375	**506**	Overly	90	3.7	C	3A	1500	975	6
921200	MN	Red	Polk	375	**506**	Lindaas	3	0.1	C	2C	1000	650	6
921200	MN	Red	Polk	375	**506**	Bearden	2	0.1	C	3B	1500	975	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
921200	MN	Red	Polk	375	**506**	Bygland	2	0.1	C	3A	1500	975	6
921200	MN	Red	Polk	375	**506**	Colvin	2	0.1	C	3B	1500	975	6
921200	MN	Red	Polk	375	**506**	Perella	1	0.0	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**1006**	Fluvaquents	45	1.9	N	1A/1D			
921218	MN	Red	Marshall	296	**1006**	Haploborolls	45	1.9	N	1A			
921218	MN	Red	Marshall	296	**1006**	Soils With Steeper Slopes	4	0.2	?	?			
921218	MN	Red	Marshall	296	**1006**	Dominantly Clayey Soils	3	0.1	?	?			
921218	MN	Red	Marshall	296	**1006**	Dominantly Sandy Soils	3	0.1	?	?			
921218	MN	Red	Marshall	296	**157a**	Wahpeton	90	17.4	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**157a**	Fargo and Similar Soils	4	0.8	C	2C	1000	650	6
921218	MN	Red	Marshall	296	**157a**	Colvin and Similar Soils	3	0.6	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**157a**	Northcote and Similar Soils	3	0.6	C	2C	1000	650	6
921218	MN	Red	Marshall	296	**1963**	Bearden	50	8.5	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**1963**	Colvin	40	6.8	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**1963**	Fargo and Similar Soils	4	0.7	C	2C	1000	650	6
921218	MN	Red	Marshall	296	**1963**	Glyndon and Similar Soils	3	0.5	C	4B	2250	1460	6
921218	MN	Red	Marshall	296	**1963**	Hegne and Similar Soils	3	0.5	C	2C	1000	650	6
921218	MN	Red	Marshall	296	**1964**	Colvin	50	83.2	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**1964**	Fargo	40	66.5	C	2C	1000	650	6
921218	MN	Red	Marshall	296	**1964**	Hegne and Similar Soils	4	6.7	C	2C	1000	650	6
921218	MN	Red	Marshall	296	**1964**	Bearden and Similar Soils	3	5.0	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**1964**	Northcote and Similar Soils	3	5.0	C	2C	1000	650	6
921218	MN	Red	Marshall	296	**57a**	Fargo	90	71.6	C	2C	1000	650	6
921218	MN	Red	Marshall	296	**57a**	Colvin and Similar Soils	5	4.0	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**57a**	Hegne and Similar Soils	5	4.0	C	2C	1000	650	6
921218	MN	Red	Marshall	296	**67b**	Bearden	90	10.2	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**67b**	Colvin and Similar Soils	4	0.5	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**67b**	Fargo and Similar Soils	3	0.3	C	2C	1000	650	6
921218	MN	Red	Marshall	296	**67b**	Glyndon and Similar Soils	3	0.3	C	4B	2250	1460	6
921218	MN	Red	Marshall	296	**93a**	Bearden	90	8.0	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**93a**	Colvin and Similar Soils	5	0.4	C	3B	1500	975	6
921218	MN	Red	Marshall	296	**93a**	Fargo and Similar Soils	5	0.4	C	2C	1000	650	6
931177	MN	Red	Polk	296	**1916**	Lindaas	90	7.2	C	2C	1000	650	6
931177	MN	Red	Polk	296	**1916**	Bearden	5	0.4	C	3B	1500	975	6
931177	MN	Red	Polk	296	**1916**	Bygland	5	0.4	C	3A	1500	975	6
931177	MN	Red	Polk	296	**1964**	Colvin	50	4.8	C	3B	1500	975	6
931177	MN	Red	Polk	296	**1964**	Fargo	40	3.8	C	2C	1000	650	6
931177	MN	Red	Polk	296	**1964**	Bearden	5	0.5	C	3B	1500	975	6
931177	MN	Red	Polk	296	**1964**	Hegne	5	0.5	C	2C	1000	650	6
931177	MN	Red	Polk	296	**422a**	Bygland	90	31.7	C	3A	1500	975	6
931177	MN	Red	Polk	296	**422a**	Bearden	5	1.8	C	3B	1500	975	6
931177	MN	Red	Polk	296	**422a**	Lindaas	5	1.8	C	2C	1000	650	6
931177	MN	Red	Polk	296	**422b**	Bygland	90	17.9	C	3A	1500	975	6
931177	MN	Red	Polk	296	**422b**	Bearden	5	1.0	C	3B	1500	975	6
931177	MN	Red	Polk	296	**422b**	Lindaas	5	1.0	C	2C	1000	650	6
931177	MN	Red	Polk	296	**667b**	Fairdale	90	31.0	I	4A	2250	1460	6
931177	MN	Red	Polk	296	**667b**	Fluvaquents	4	1.4	N	1A/1D			
931177	MN	Red	Polk	296	**667b**	Zell	3	1.0	N/I	1A/4A	2250	1460	6
931177	MN	Red	Polk	296	**667b**	Rauville	2	0.7	C	3B	1500	975	6
931177	MN	Red	Polk	296	**667b**	Soils With Greater Slopes	1	0.3	?	?			
931177	MN	Red	Polk	296	**67b**	Bearden	90	7.8	C	3B	1500	975	6
931177	MN	Red	Polk	296	**67b**	Colvin	3	0.3	C	3B	1500	975	6
931177	MN	Red	Polk	296	**67b**	Zell	3	0.3	N/I	1A/4A	2250	1460	6
931177	MN	Red	Polk	296	**67b**	Glyndon	2	0.2	C	4B	2250	1460	6
931177	MN	Red	Polk	296	**67b**	Lesser Or Greater Slopes	2	0.2	?	?			
941144	MN	Red	Polk	296	**1916**	Lindaas	90	9.7	C	2C	1000	650	6
941144	MN	Red	Polk	296	**1916**	Bearden	5	0.5	C	3B	1500	975	6
941144	MN	Red	Polk	296	**1916**	Bygland	5	0.5	C	3A	1500	975	6
941144	MN	Red	Polk	296	**422a**	Bygland	90	19.6	C	3A	1500	975	6
941144	MN	Red	Polk	296	**422a**	Bearden	5	1.1	C	3B	1500	975	6
941144	MN	Red	Polk	296	**422a**	Lindaas	5	1.1	C	2C	1000	650	6
941144	MN	Red	Polk	296	**422c2**	Bygland	90	6.5	C	3A	1500	975	6
941144	MN	Red	Polk	296	**422c2**	Lindaas	3	0.2	C	2C	1000	650	6
941144	MN	Red	Polk	296	**422c2**	Zell	3	0.2	N/I	1A/4A	2250	1460	6

Table B1-1 Descriptive legend for Soil Map Units Digitized on Irrigated Land

Permit Number	State	River	County	Control Point	**Mapid**	Soil	Percent Compositio	Acreage	Irrigibility Group	Irrigibility	Ecmax	TDSmax	SARmax
941144	MN	Red	Polk	296	**422c2**	Fairdale	2	0.1	I	4A	2250	1460	6
941144	MN	Red	Polk	296	**422c2**	Lesser Or Greater Slopes	2	0.1	?	?			
941144	MN	Red	Polk	296	**450**	Rauville	90	3.0	C	3B	1500	975	6
941144	MN	Red	Polk	296	**450**	Fairdale	5	0.2	I	4A	2250	1460	6
941144	MN	Red	Polk	296	**450**	Ladelle	5	0.2	I	4A	2250	1460	6
941144	MN	Red	Polk	296	**506**	Overly	90	27.0	C	3A	1500	975	6
941144	MN	Red	Polk	296	**506**	Lindaas	3	0.9	C	2C	1000	650	6
941144	MN	Red	Polk	296	**506**	Bearden	2	0.6	C	3B	1500	975	6
941144	MN	Red	Polk	296	**506**	Bygland	2	0.6	C	3A	1500	975	6
941144	MN	Red	Polk	296	**506**	Colvin	2	0.6	C	3B	1500	975	6
941144	MN	Red	Polk	296	**506**	Perella	1	0.3	C	3B	1500	975	6
941144	MN	Red	Polk	296	**667b**	Fairdale	90	14.7	I	4A	2250	1460	6
941144	MN	Red	Polk	296	**667b**	Fluvaquents	4	0.7	N	1A/1D			
941144	MN	Red	Polk	296	**667b**	Zell	3	0.5	N/I	1A/4A	2250	1460	6
941144	MN	Red	Polk	296	**667b**	Rauville	2	0.3	C	3B	1500	975	6
941144	MN	Red	Polk	296	**667b**	Soils With Greater Slopes	1	0.2	?	?			
941144	MN	Red	Polk	296	**667c2**	Fairdale	90	6.9	I	4A	2250	1460	6
941144	MN	Red	Polk	296	**667c2**	Fluvaquents	4	0.3	N	1A/1D			
941144	MN	Red	Polk	296	**667c2**	Zell	3	0.2	N/I	1A/4A	2250	1460	6
941144	MN	Red	Polk	296	**667c2**	Rauville	2	0.2	C	3B	1500	975	6
941144	MN	Red	Polk	296	**667c2**	Lesser Or Greater Slopes	1	0.1	?	?			
941144	MN	Red	Polk	296	**694d2**	Zell	90	5.8	N/I	1A/4A	2250	1460	6
941144	MN	Red	Polk	296	**694d2**	Fairdale	4	0.3	I	4A	2250	1460	6
941144	MN	Red	Polk	296	**694d2**	Hattie	3	0.2	C	2B	1000	650	6
941144	MN	Red	Polk	296	**694d2**	Glyndon	2	0.1	C	4B	2250	1460	6
941144	MN	Red	Polk	296	**694d2**	Lesser Or Greater Slopes	1	0.1	?	?			
941144	MN	Red	Polk	296	**93a**	Bearden	90	12.6	C	3B	1500	975	6
941144	MN	Red	Polk	296	**93a**	Colvin	3	0.4	C	3B	1500	975	6
941144	MN	Red	Polk	296	**93a**	Fargo	3	0.4	C	2C	1000	650	6
941144	MN	Red	Polk	296	**93a**	Glyndon	2	0.3	C	4B	2250	1460	6
941144	MN	Red	Polk	296	**93a**	Wheatville	2	0.3	C	3B	1500	975	6
951080	MN	Red	Polk	296	**1963**	Bearden	50	42.4	C	3B	1500	975	6
951080	MN	Red	Polk	296	**1963**	Colvin	40	33.9	C	3B	1500	975	6
951080	MN	Red	Polk	296	**1963**	Fargo	5	4.2	C	2C	1000	650	6
951080	MN	Red	Polk	296	**1963**	Perella	5	4.2	C	3B	1500	975	6
951080	MN	Red	Polk	296	**67a**	Bearden	90	14.5	C	3B	1500	975	6
951080	MN	Red	Polk	296	**67a**	Colvin	3	0.5	C	3B	1500	975	6
951080	MN	Red	Polk	296	**67a**	Fargo	3	0.5	C	2C	1000	650	6
951080	MN	Red	Polk	296	**67a**	Glyndon	2	0.3	C	4B	2250	1460	6
951080	MN	Red	Polk	296	**67a**	Wheatville	2	0.3	C	3B	1500	975	6



Irrigation Permit Locations

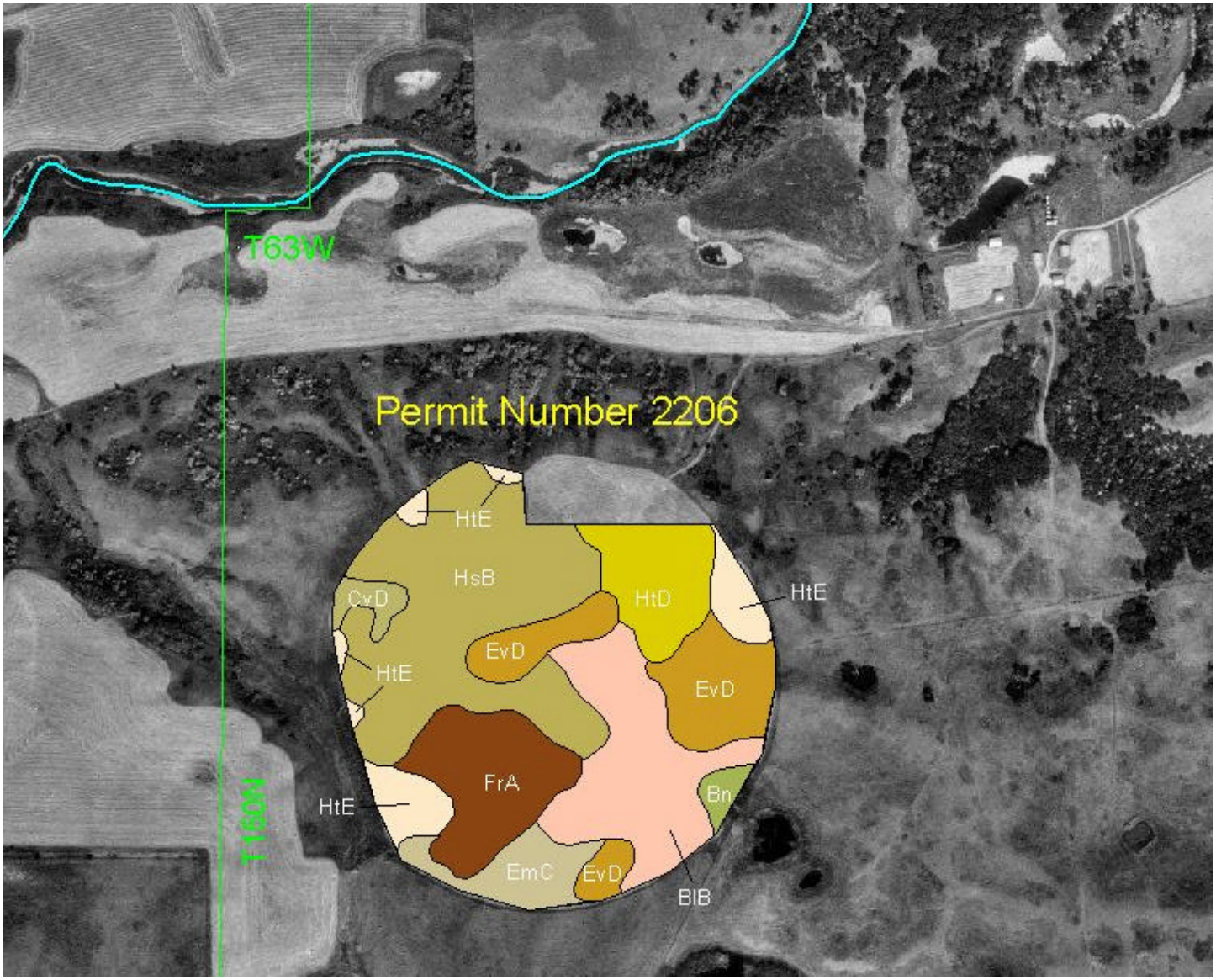
Devils Lake, North Dakota

N

FIGURE B2-1

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-2

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026

Irrigation Permits

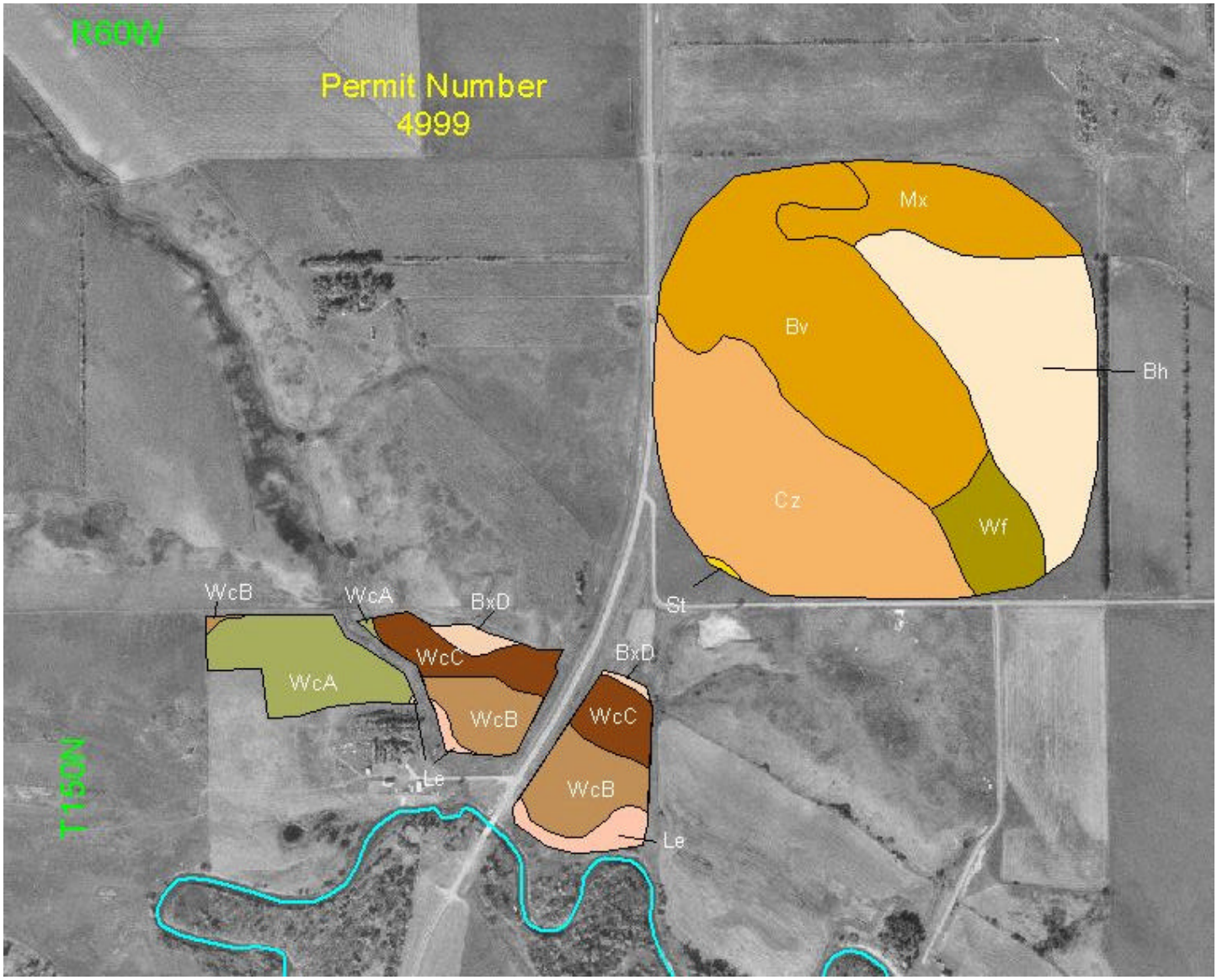
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-3

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

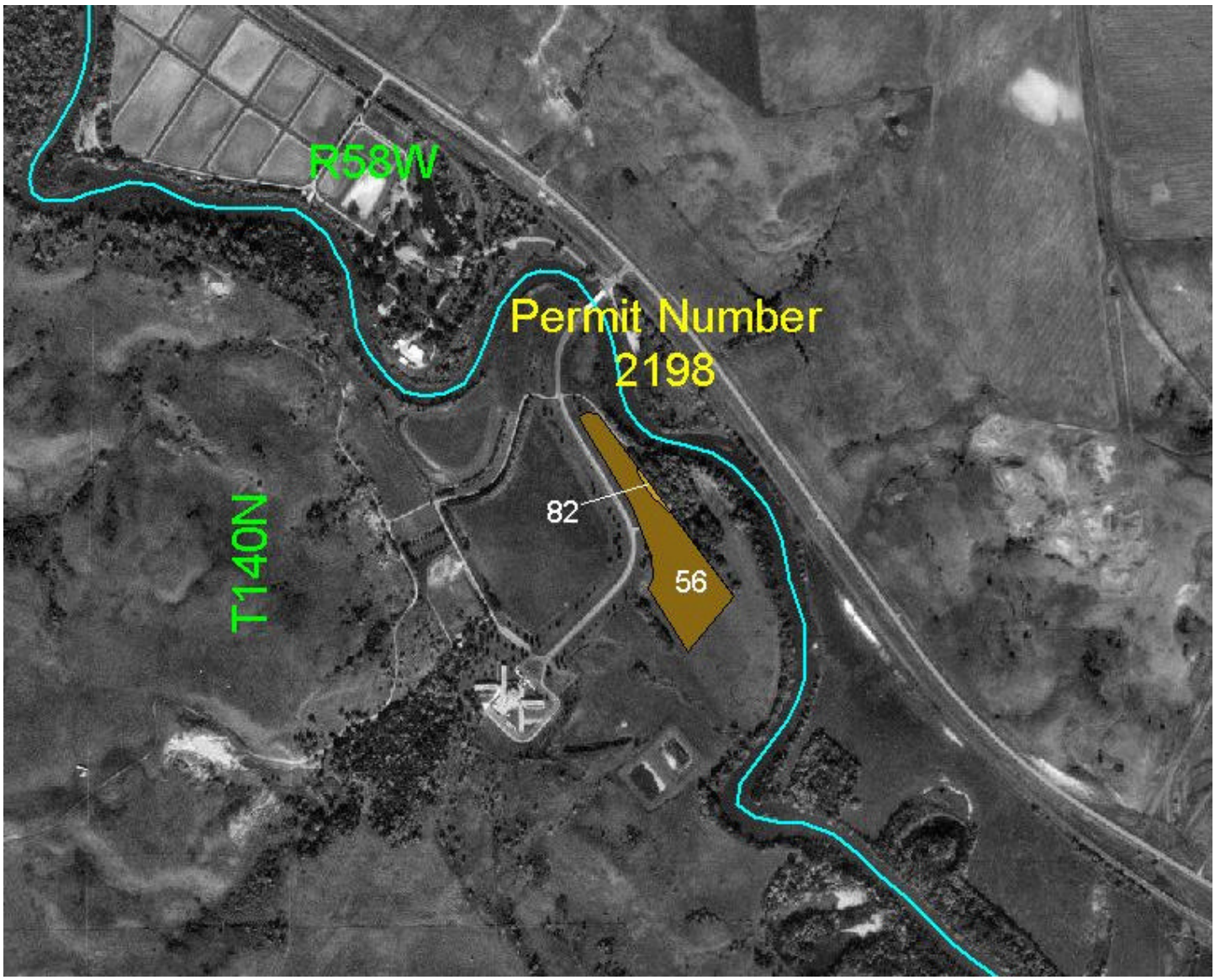
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-4

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

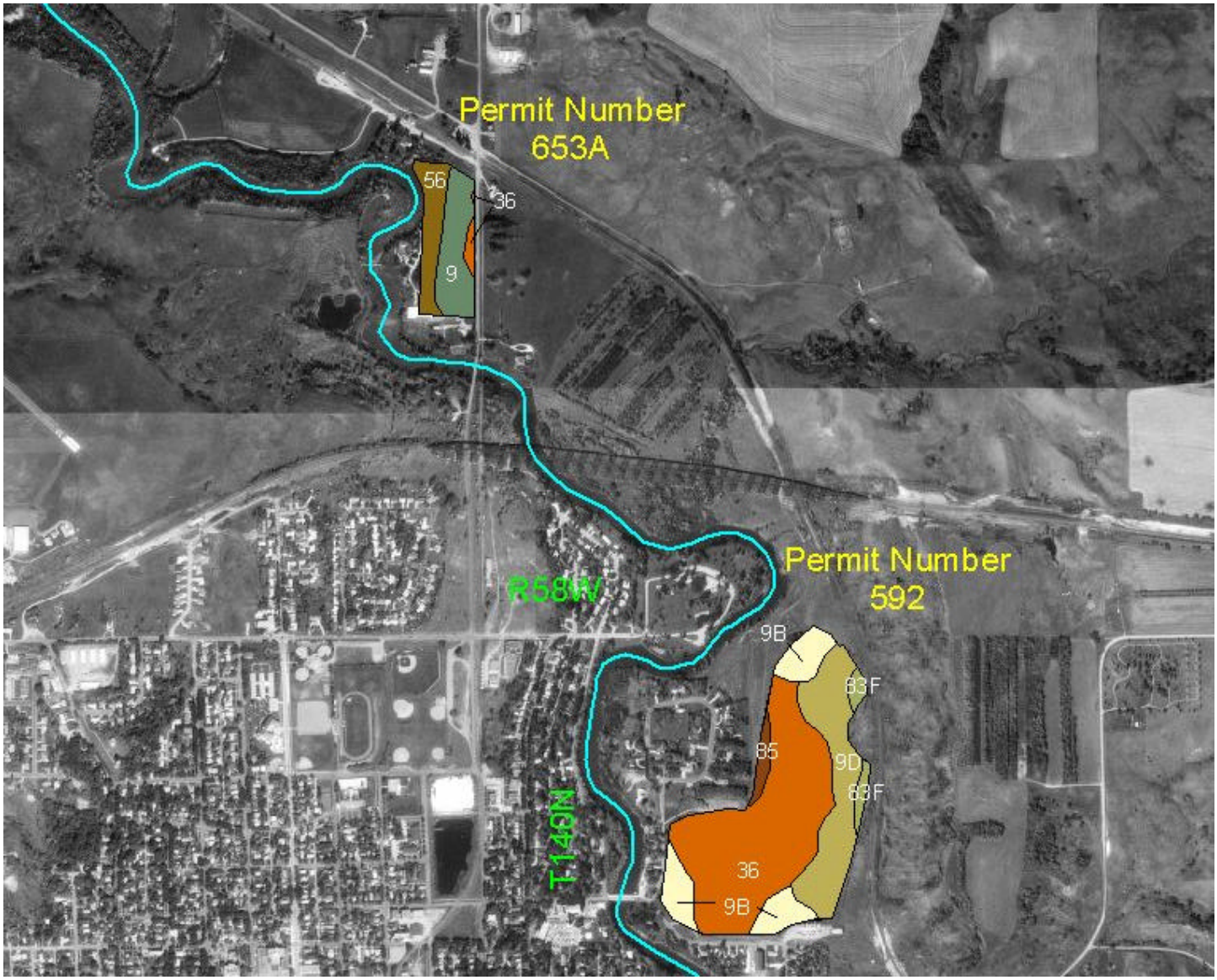
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-5

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

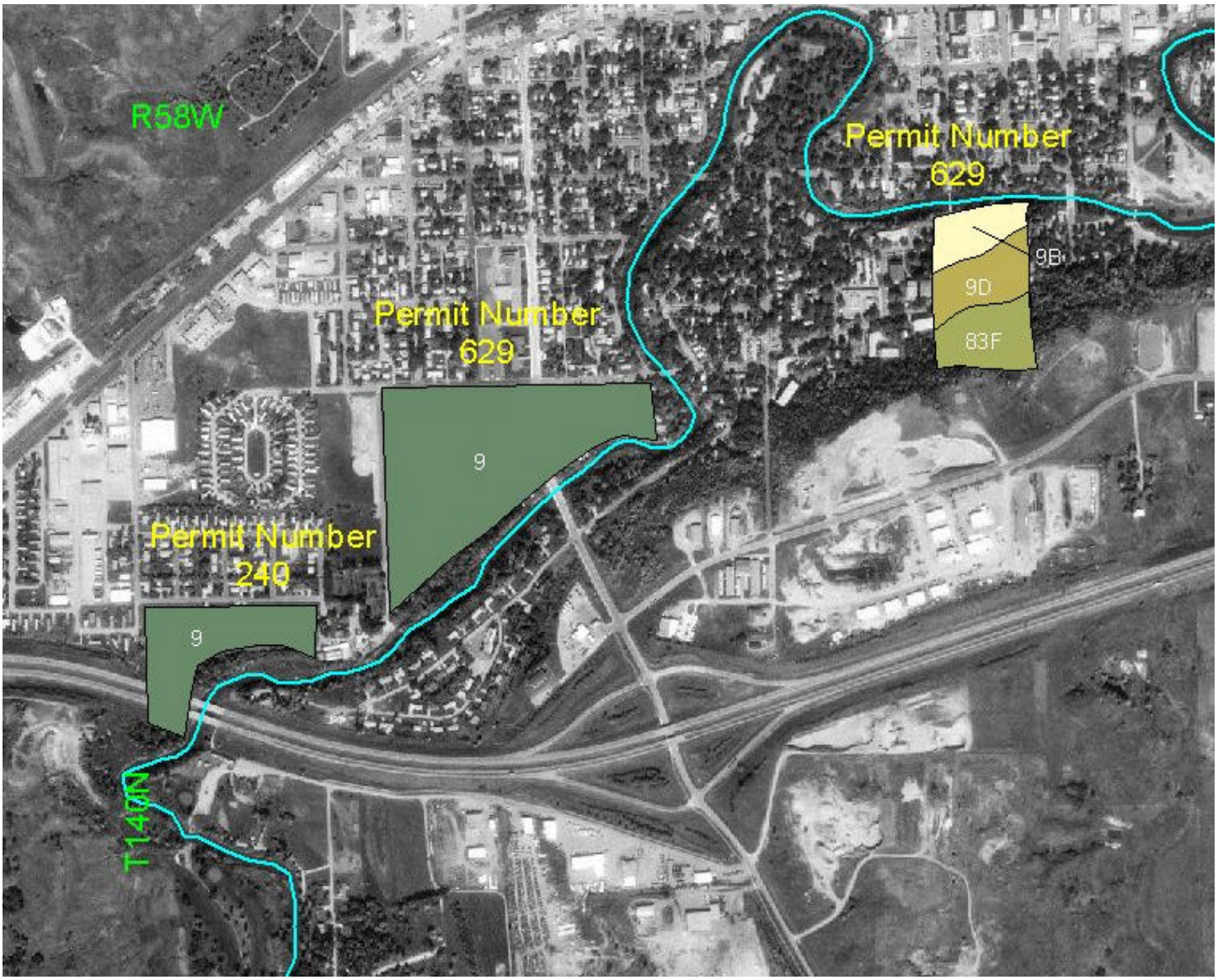
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-6

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

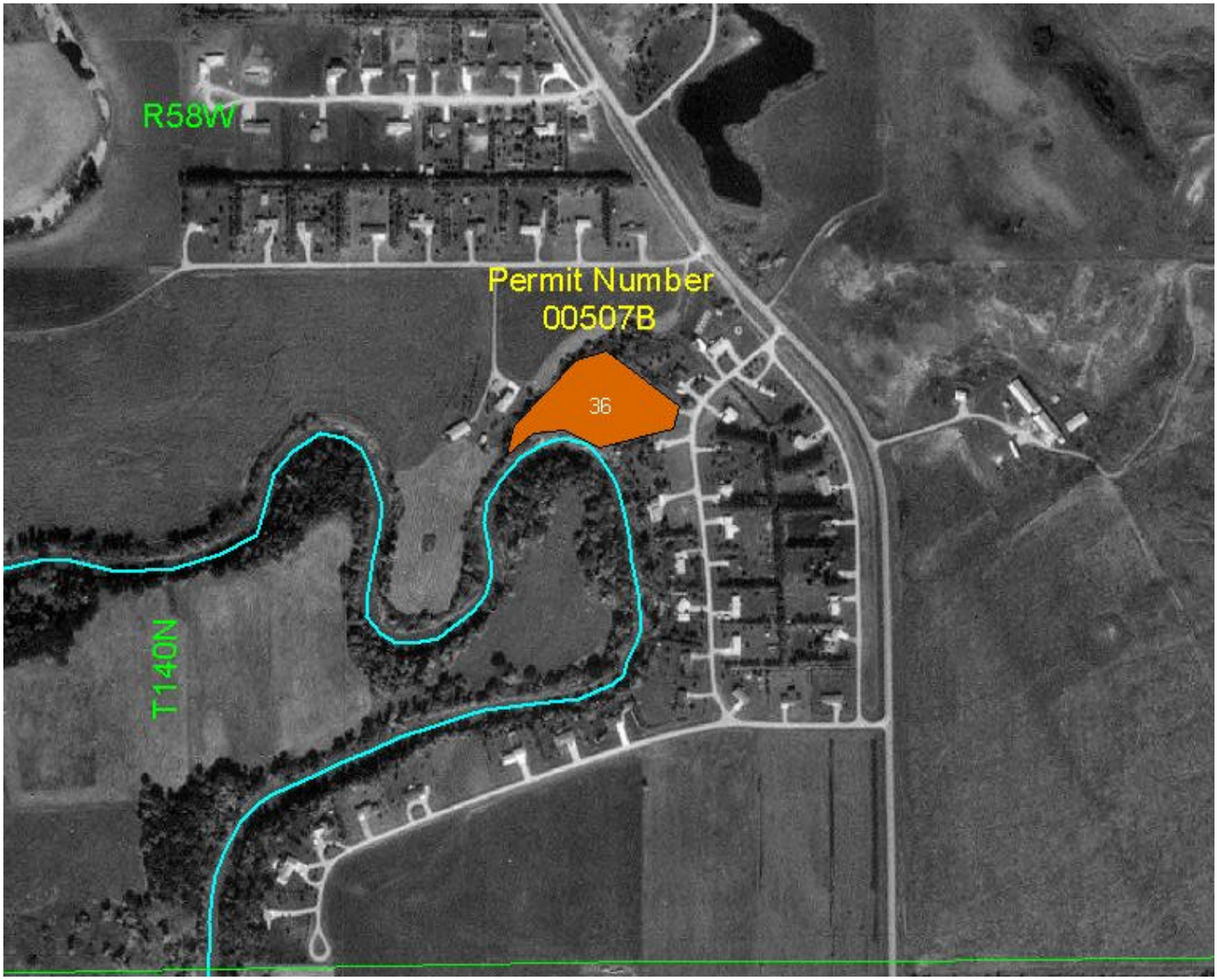
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-7

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-8

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026

Irrigation Permits

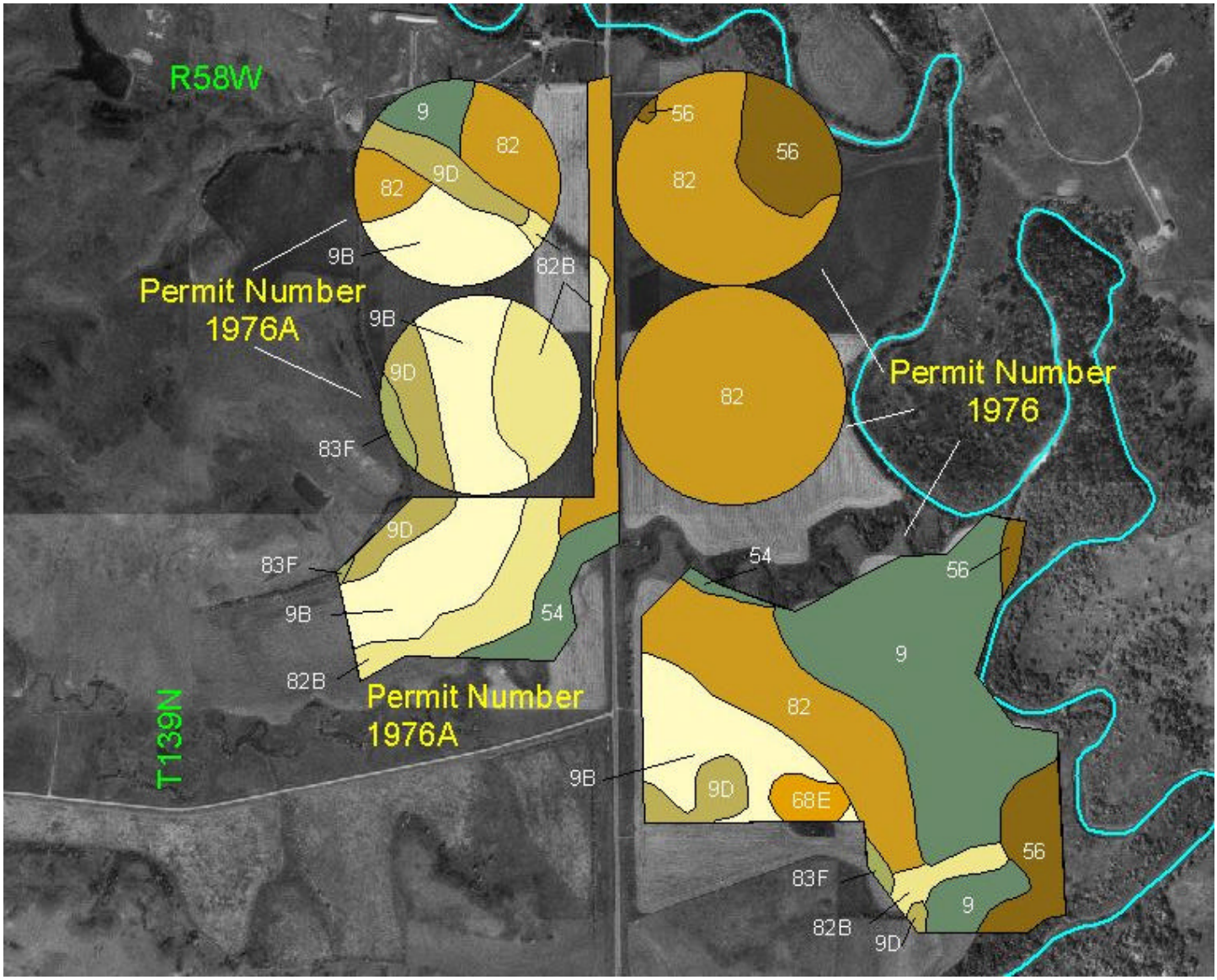
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-9

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

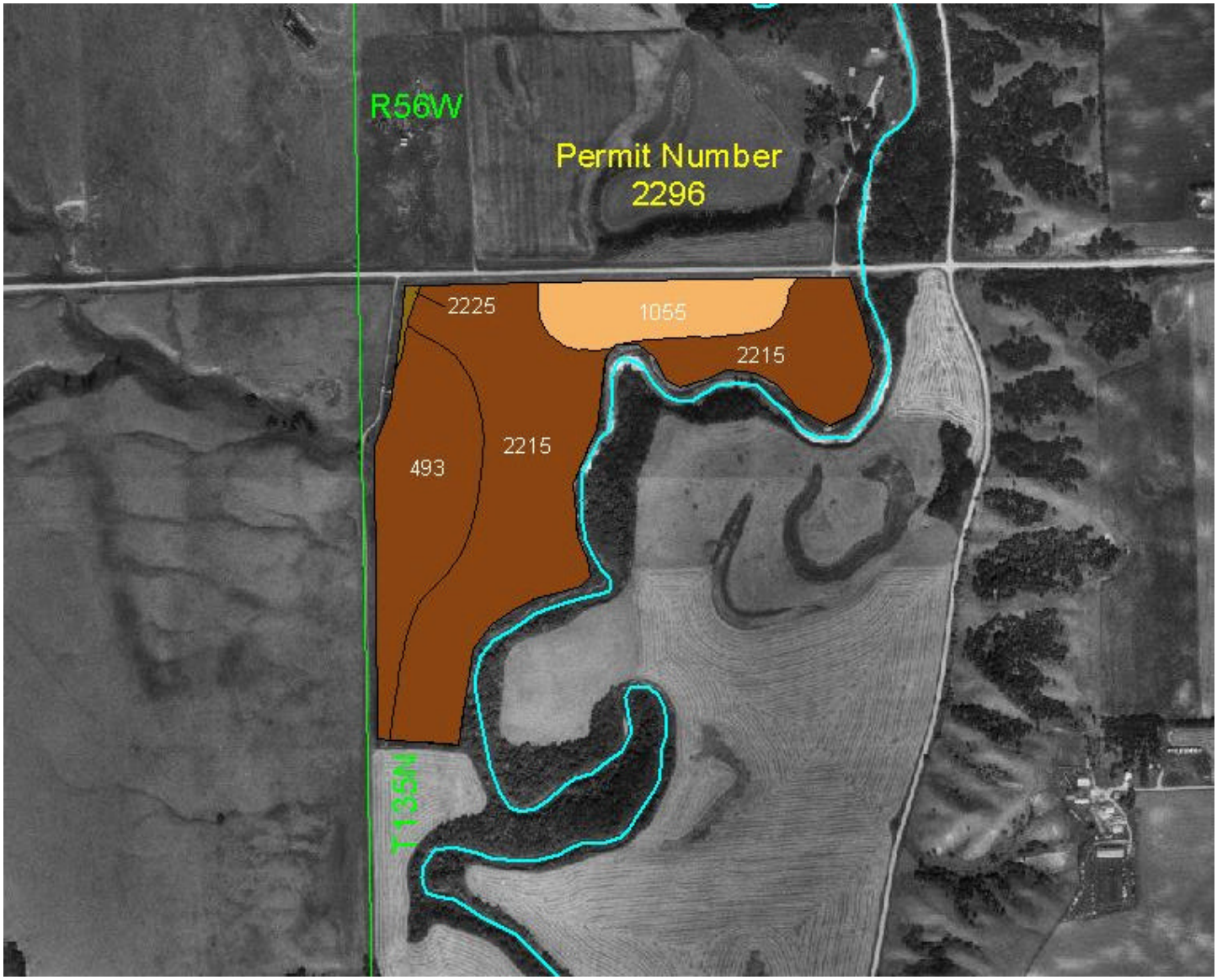
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-10

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

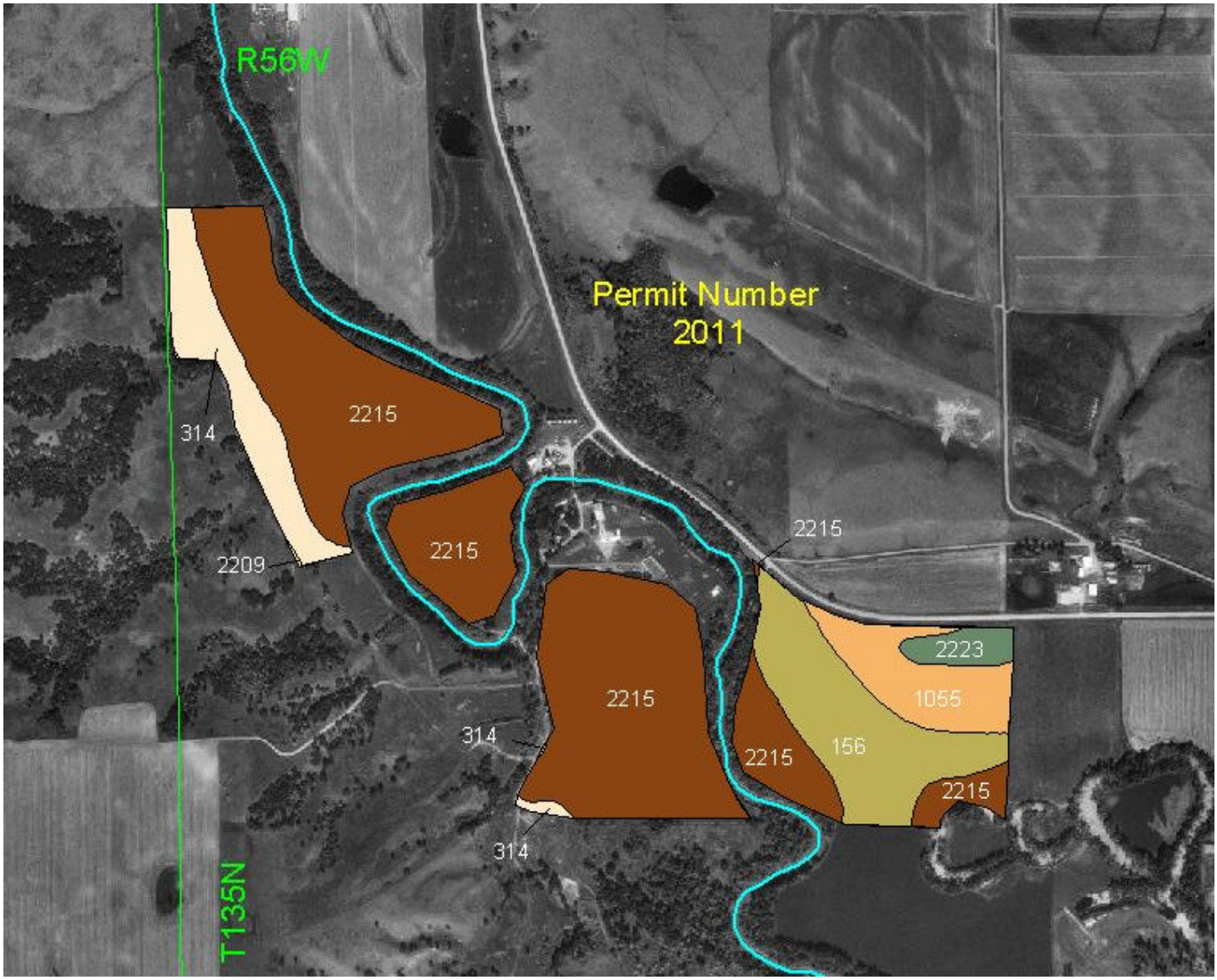
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-11

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

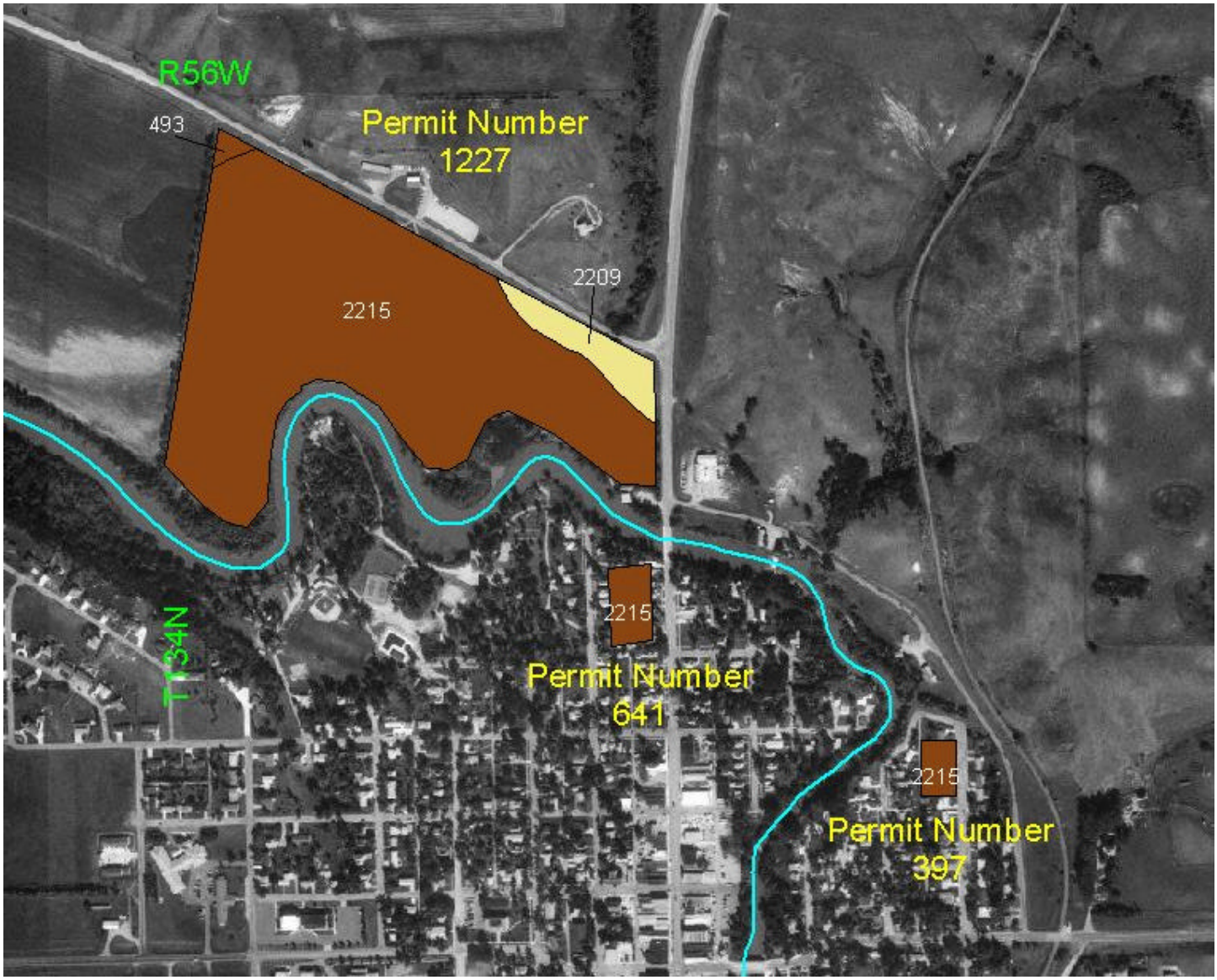
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-12

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

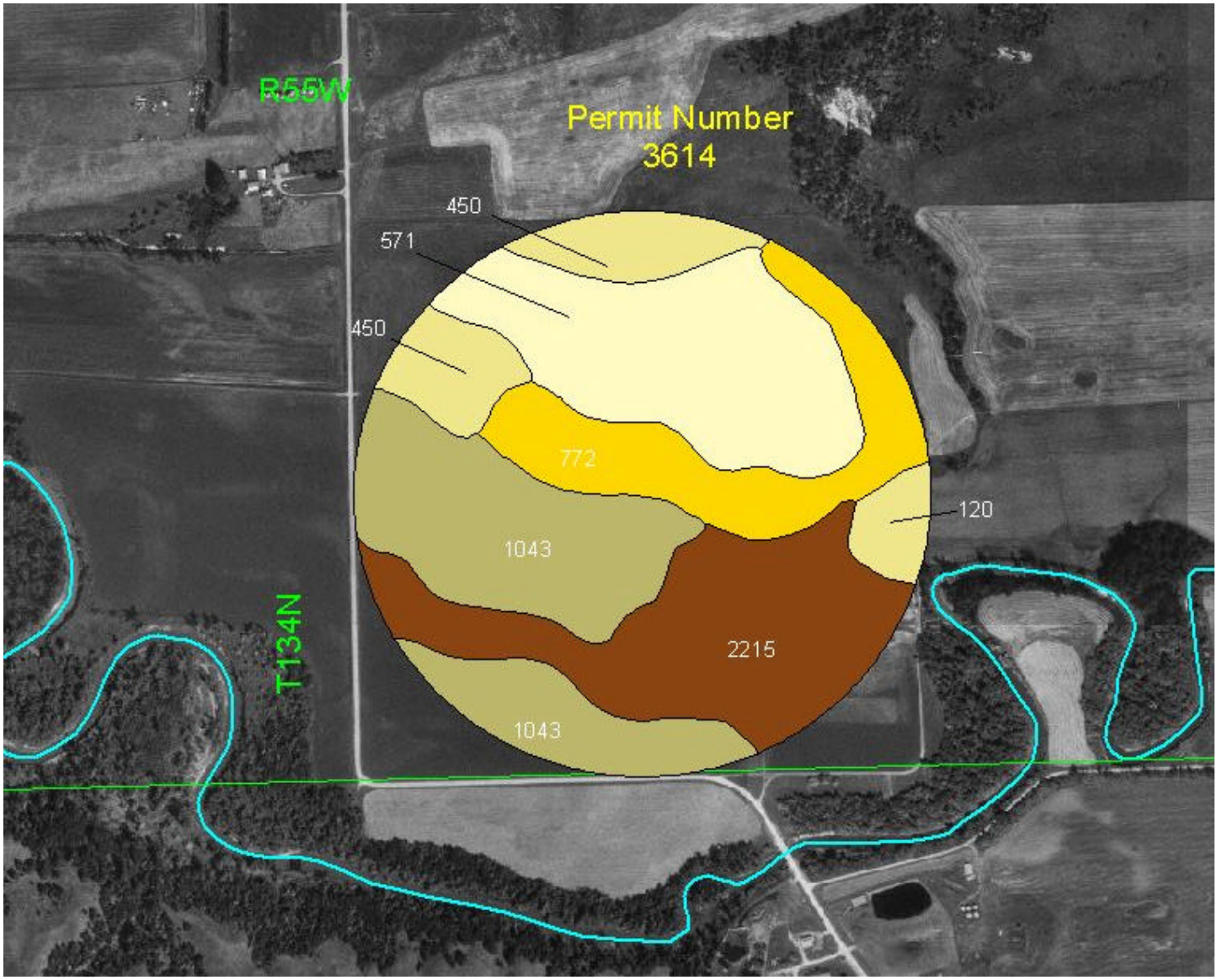
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-13

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

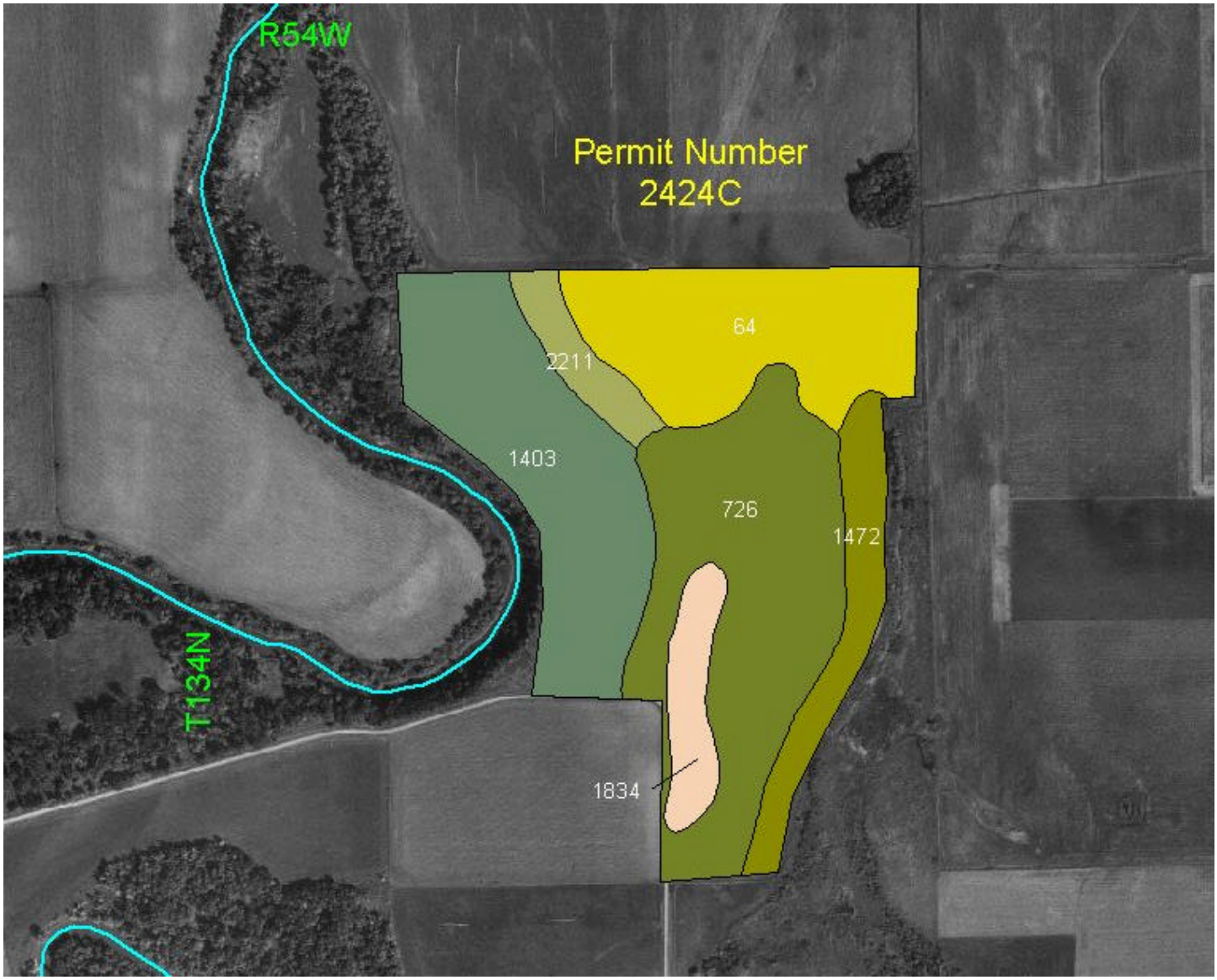
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-14

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

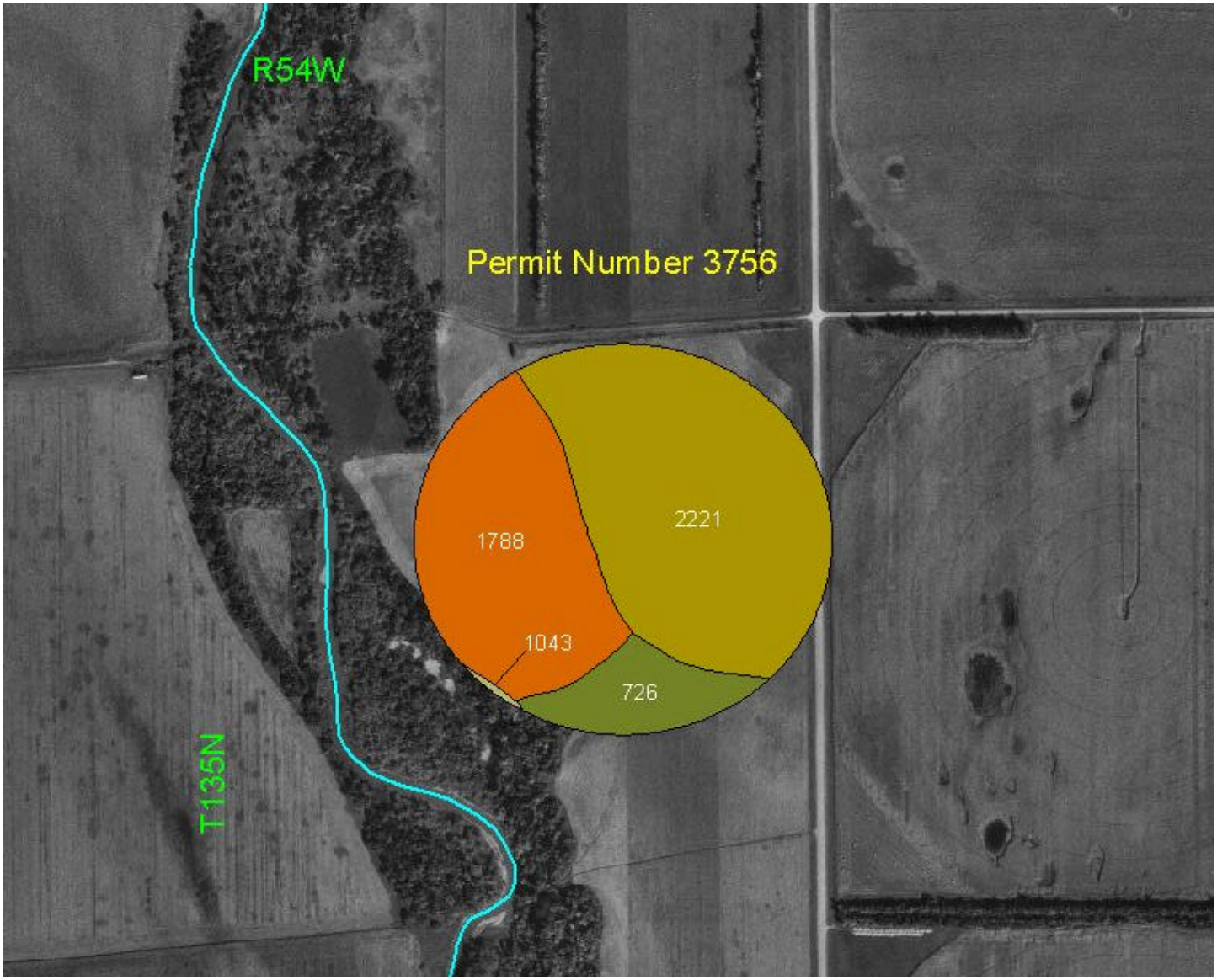
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-15

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

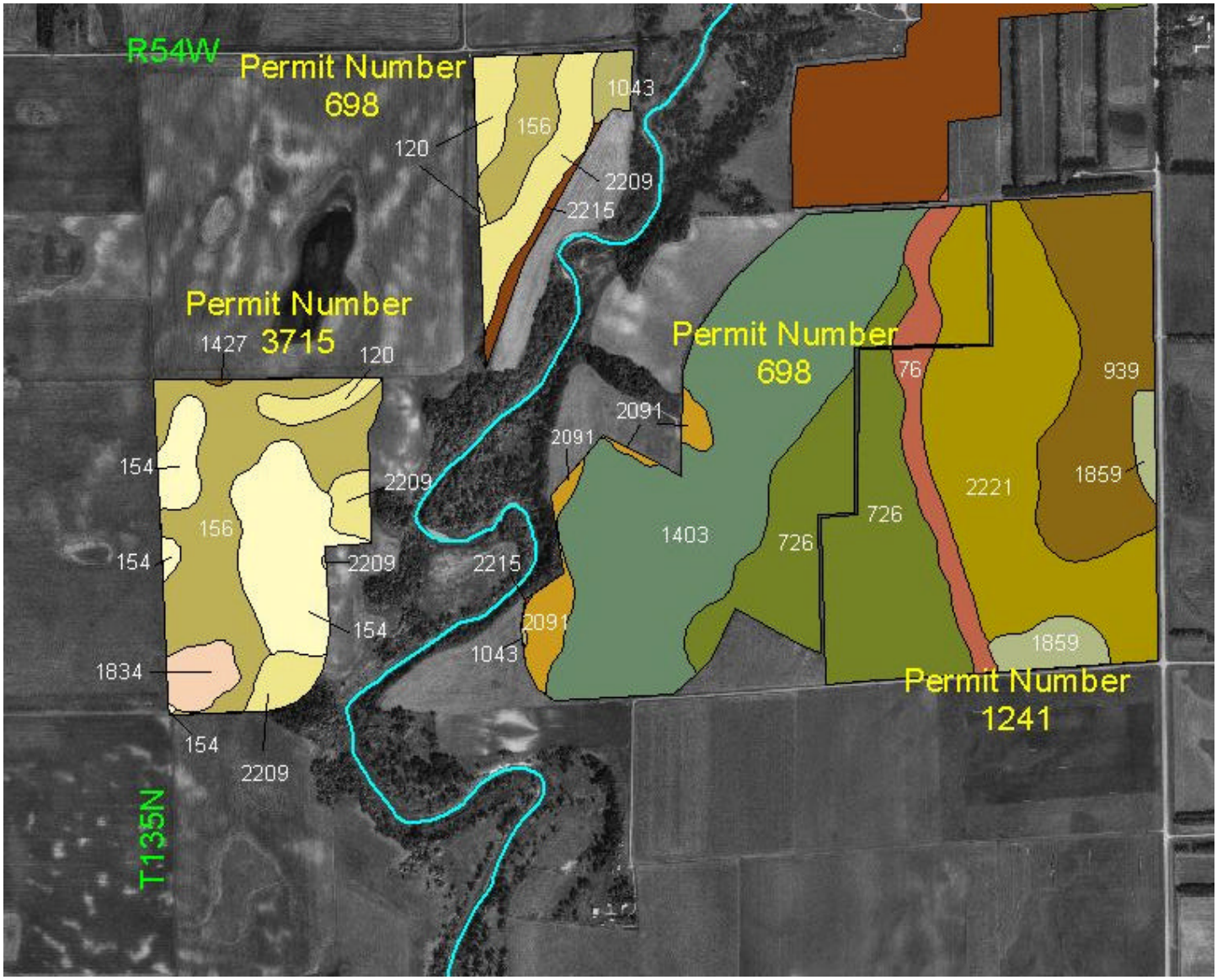
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-16

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

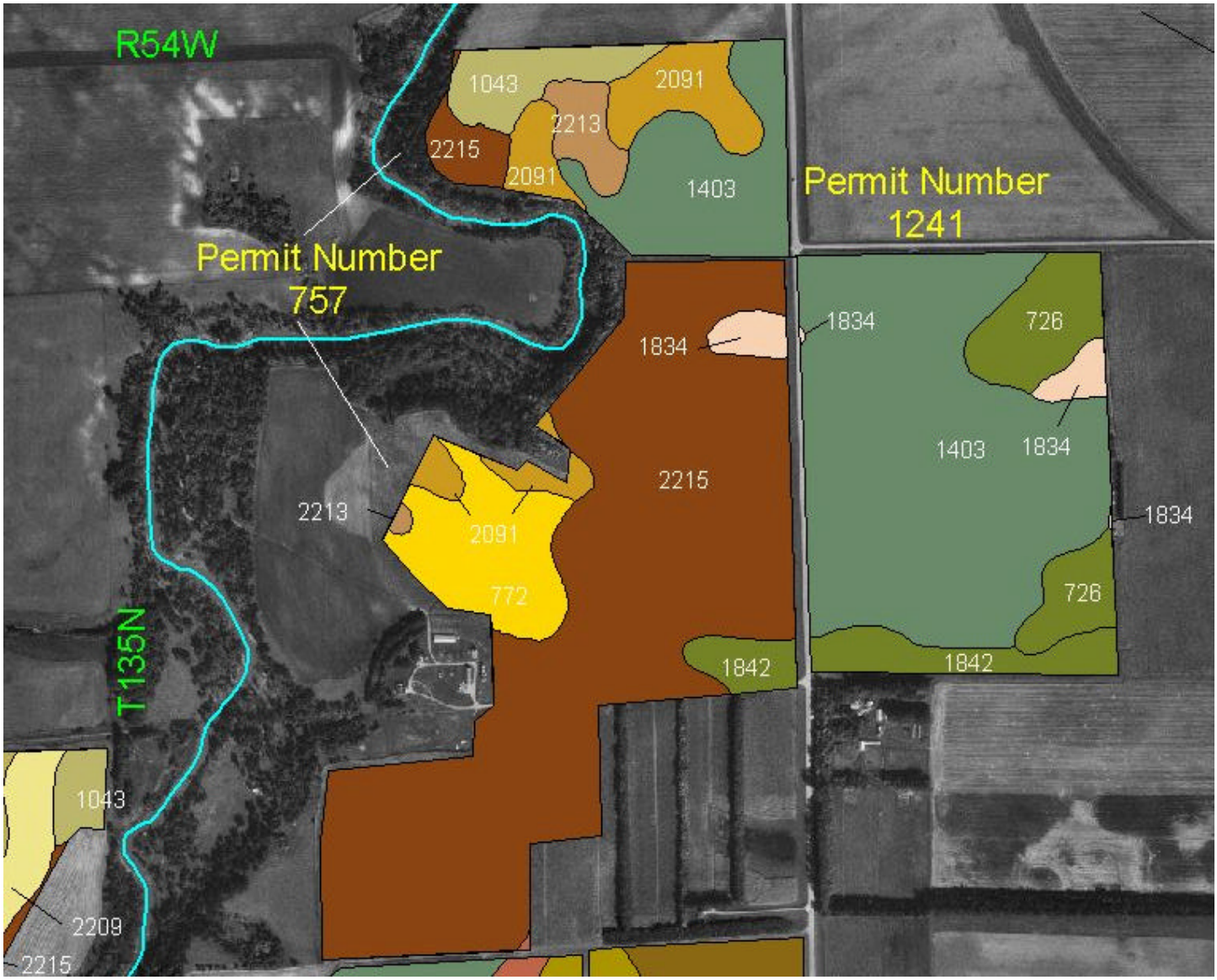
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-17

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

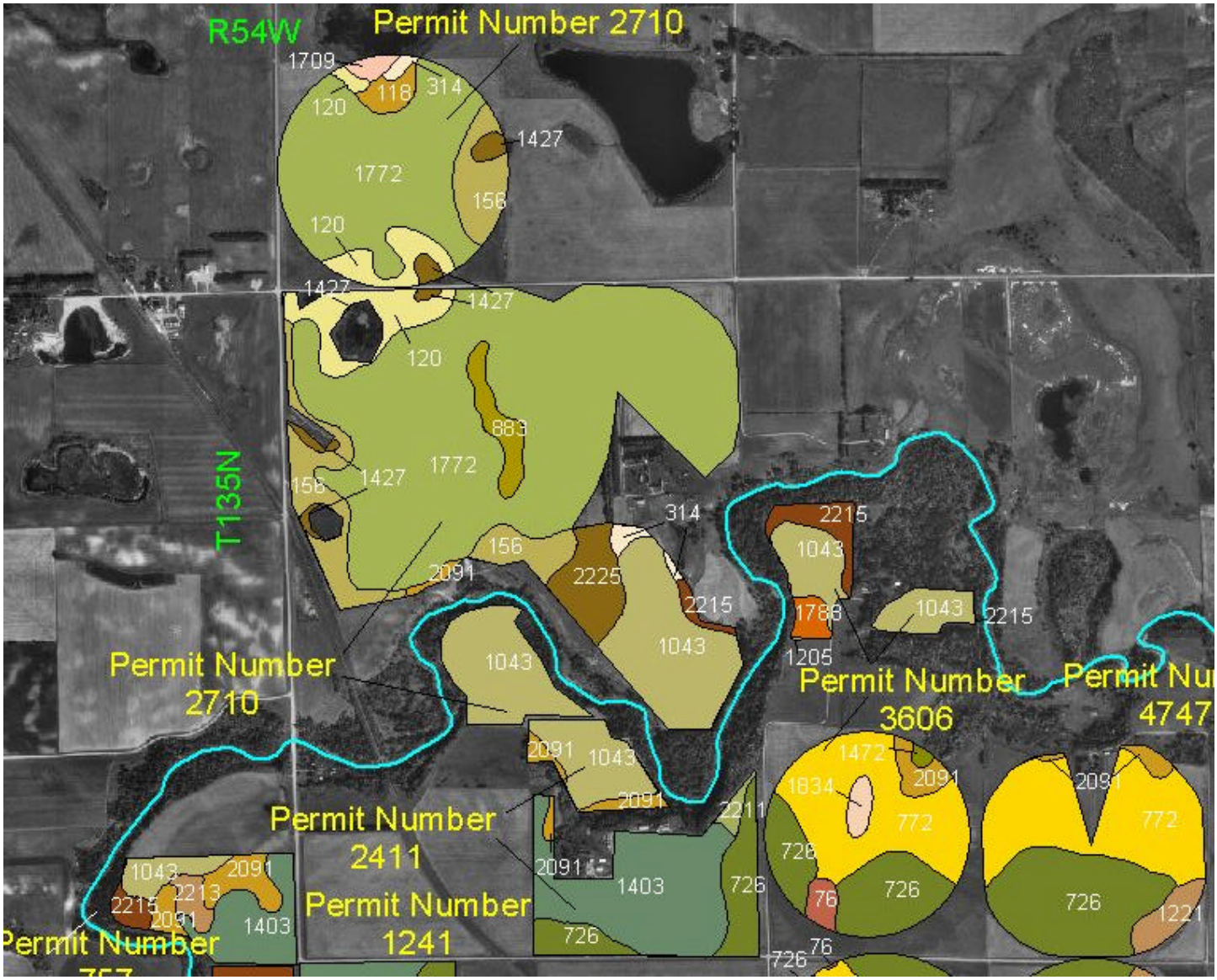
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-18

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-19

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026

Irrigation Permits

For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-20

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026

Irrigation Permits

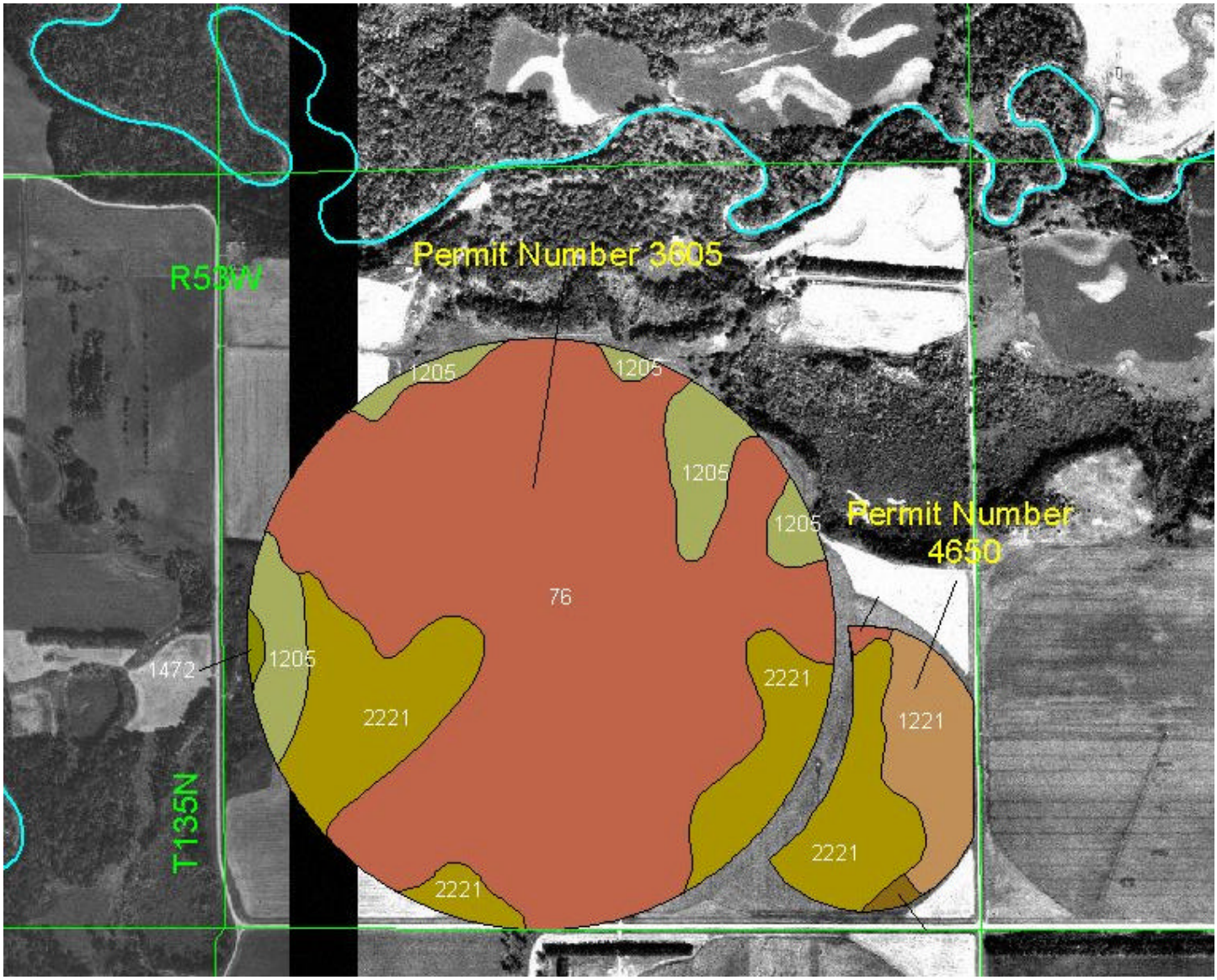
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-21

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

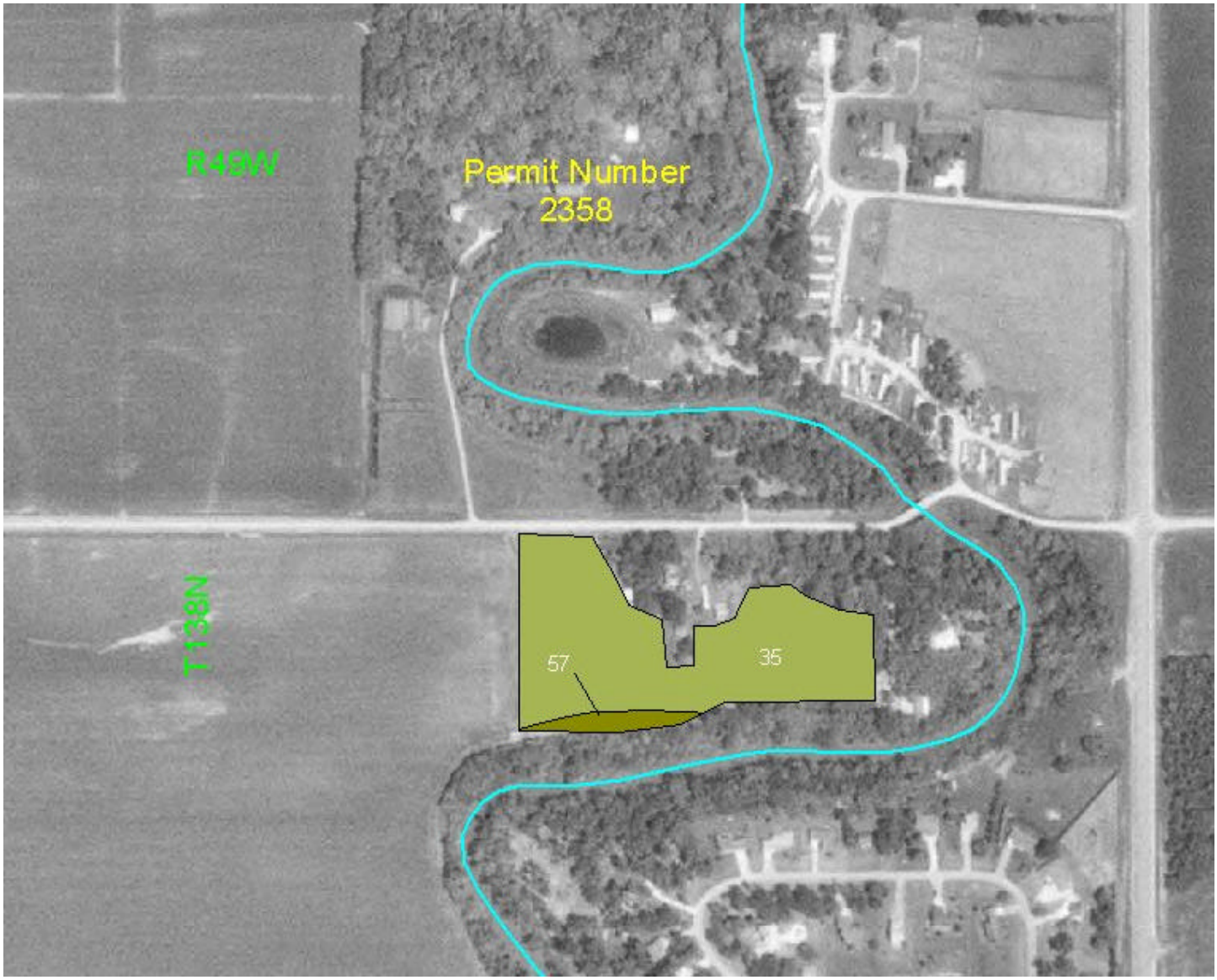
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-22

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

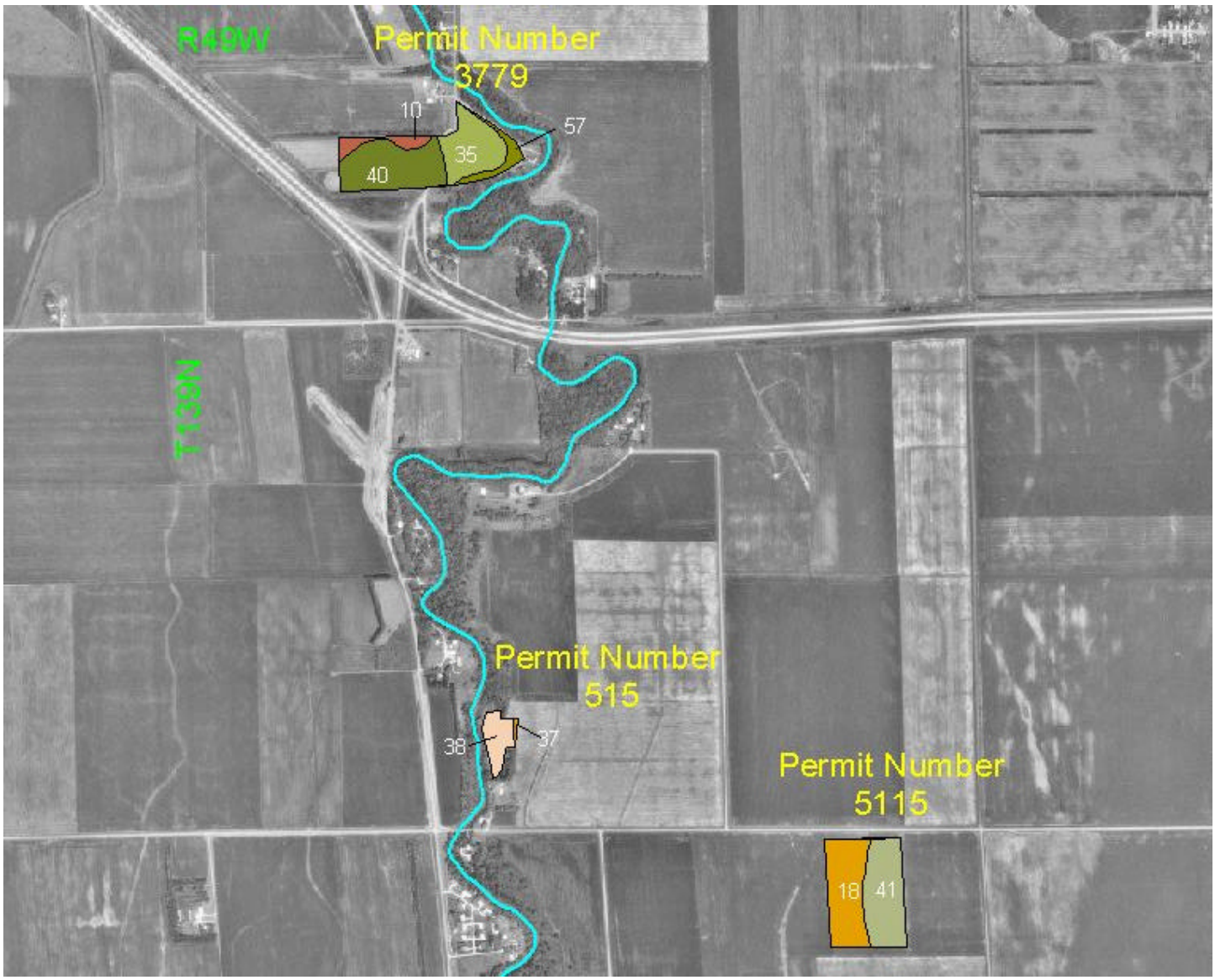
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-23

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-24

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026

Irrigation Permits

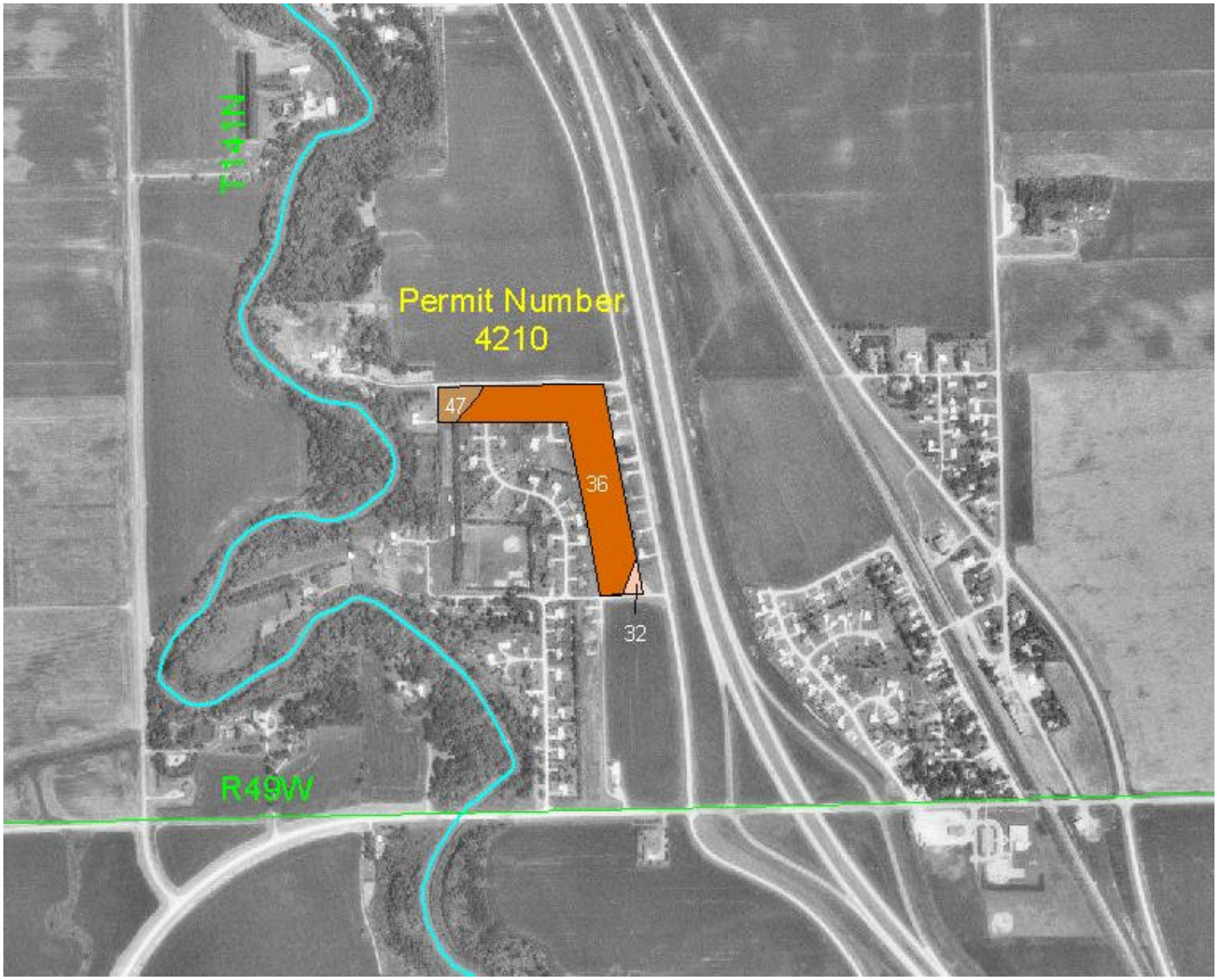
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-25

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

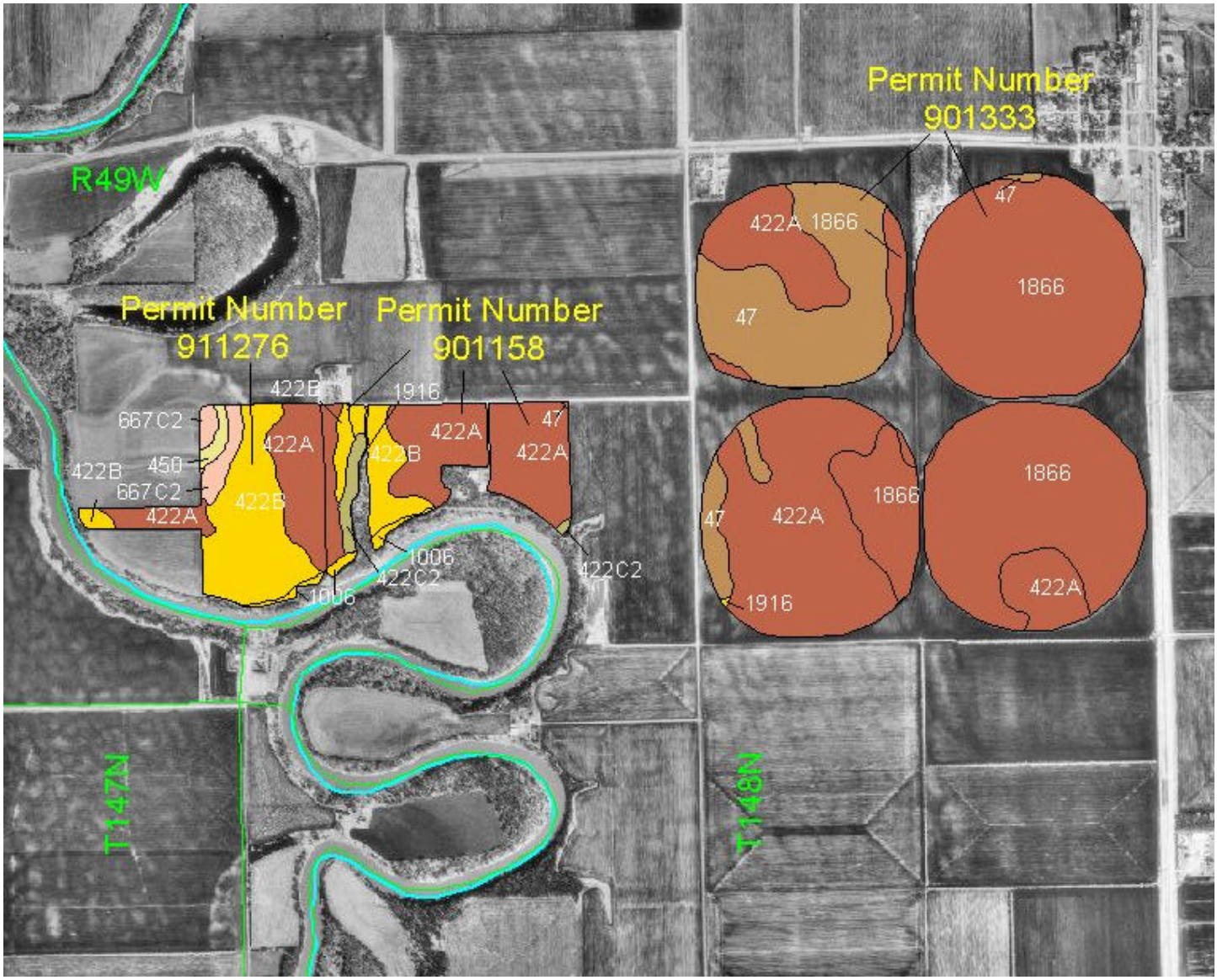
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-26

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

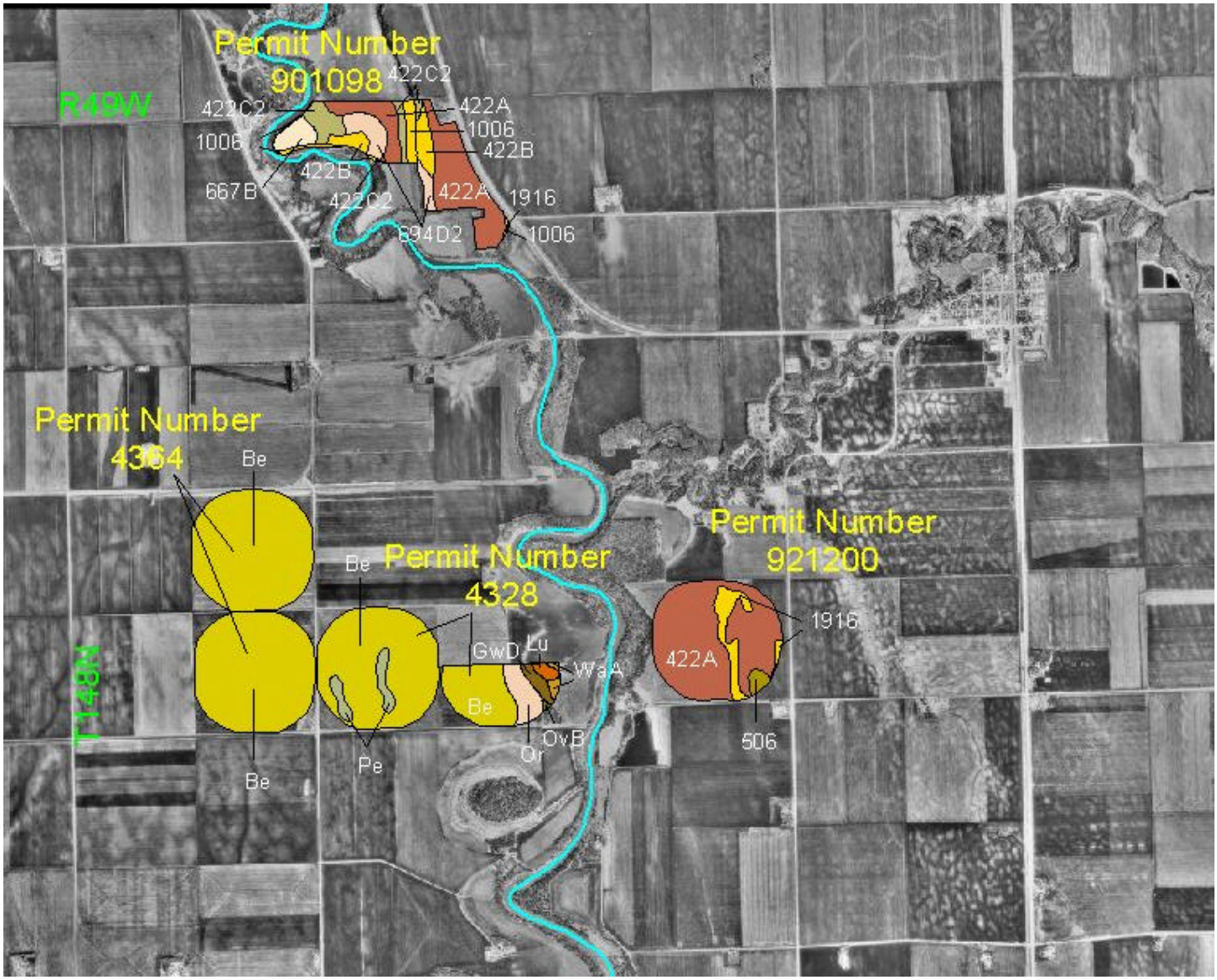
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-27

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

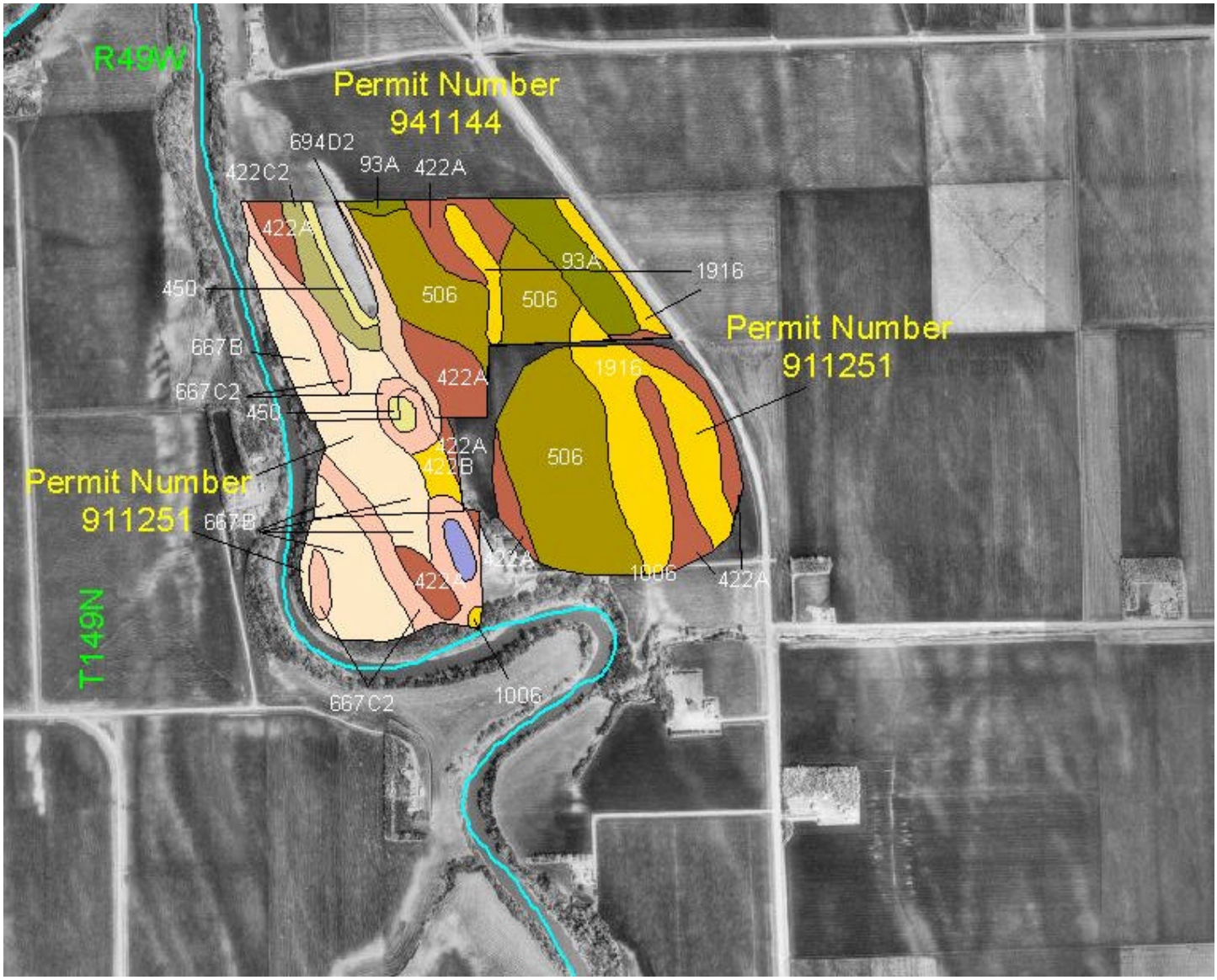
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-28

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

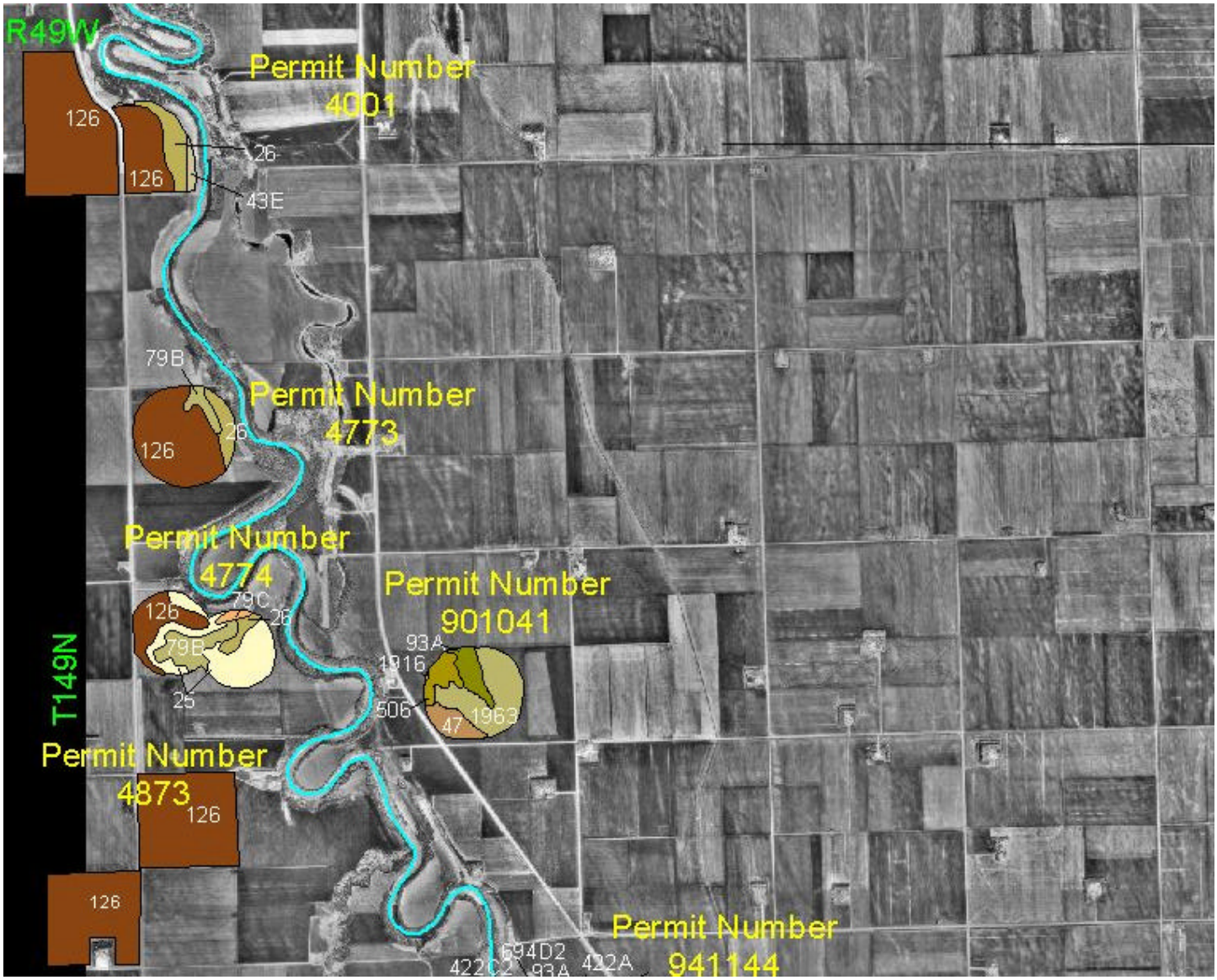
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-29

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

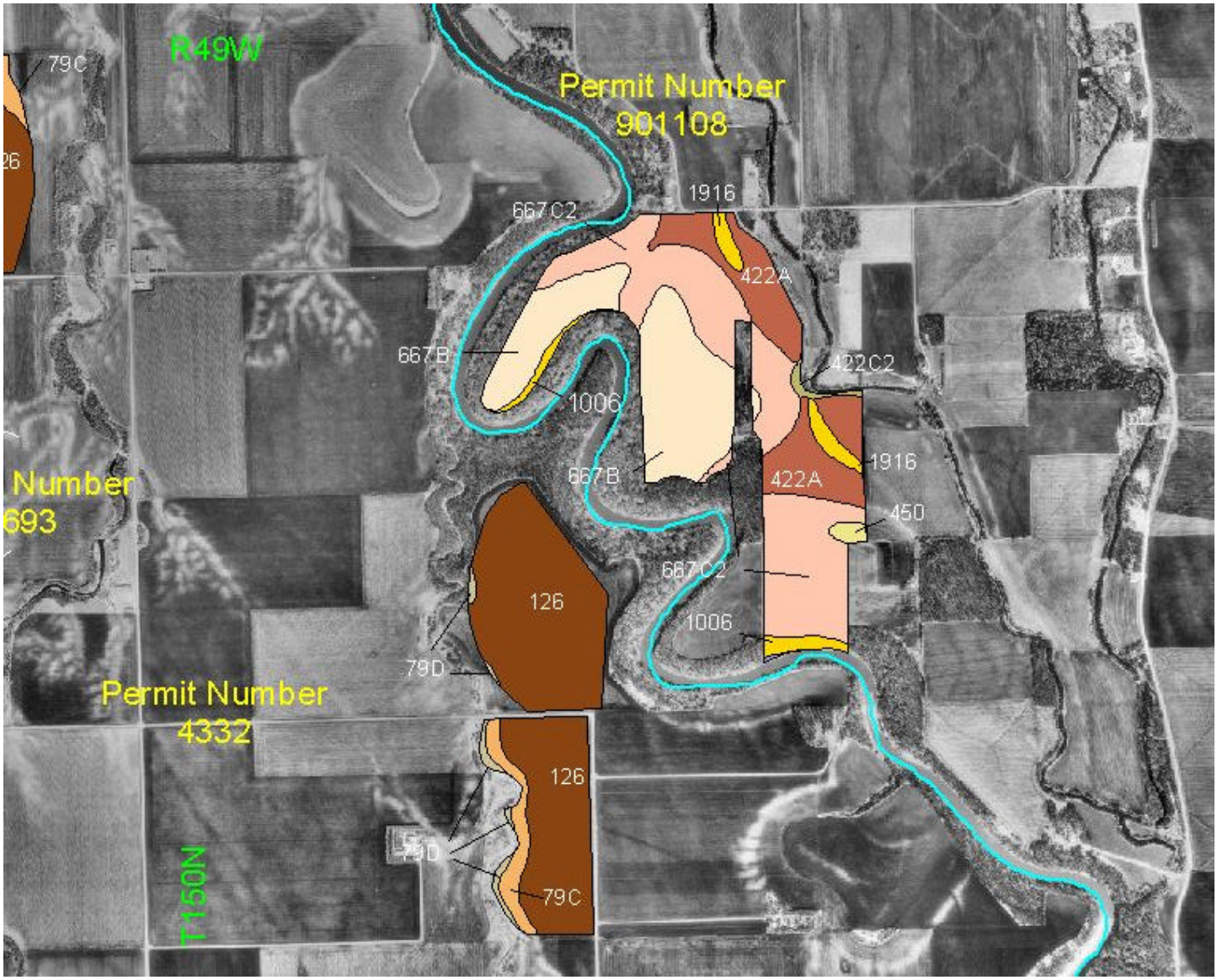
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-30

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

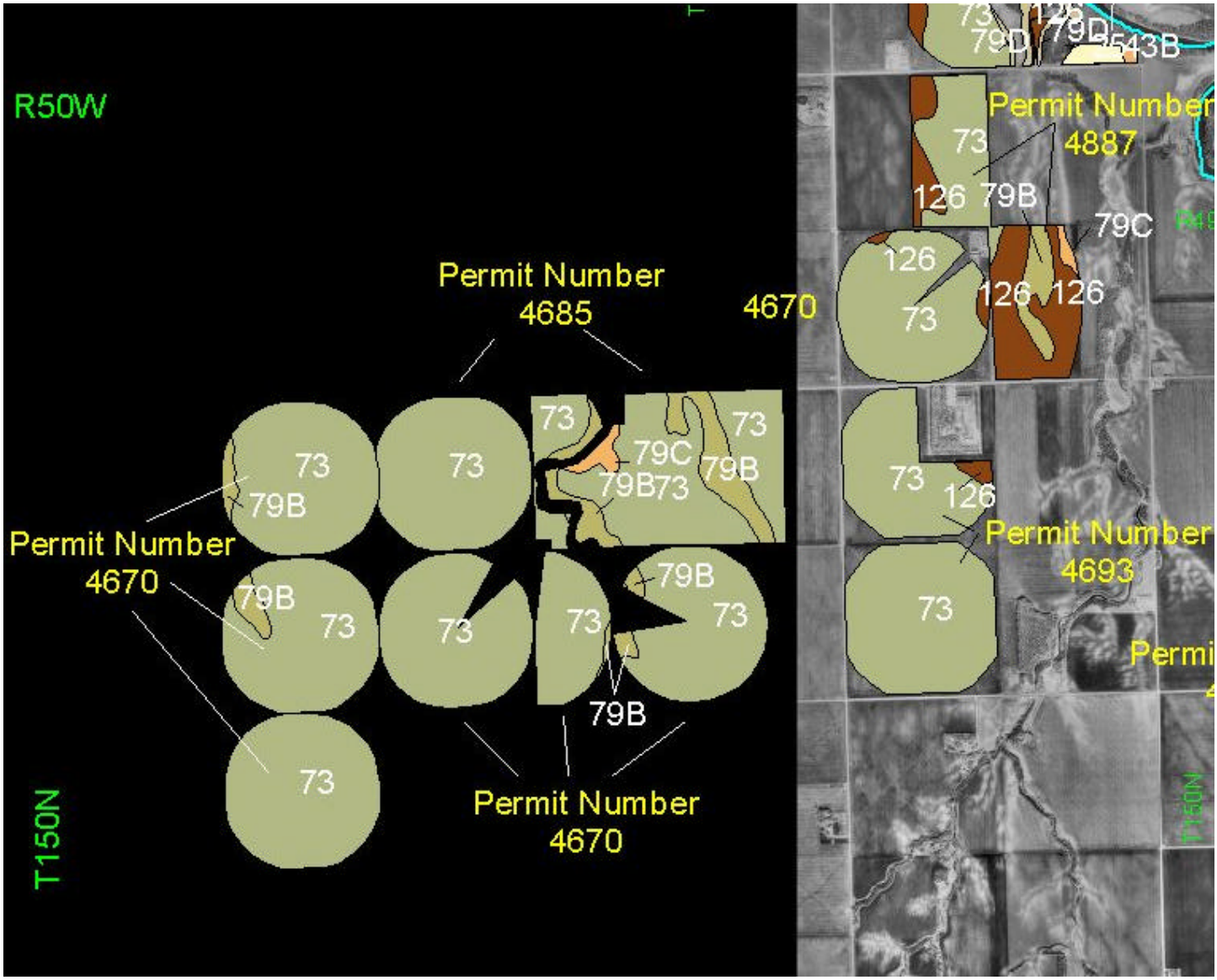
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-31

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

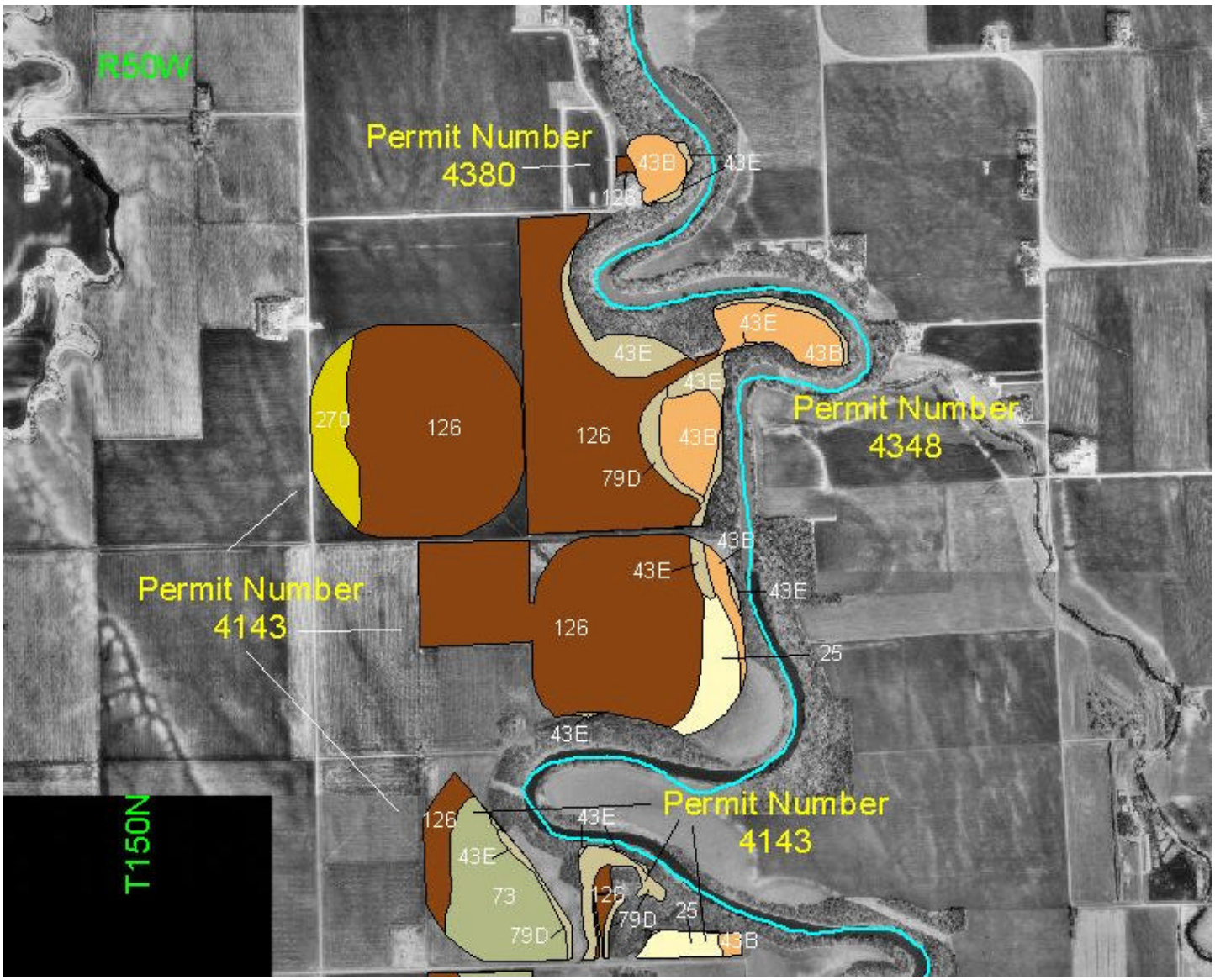
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-32

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

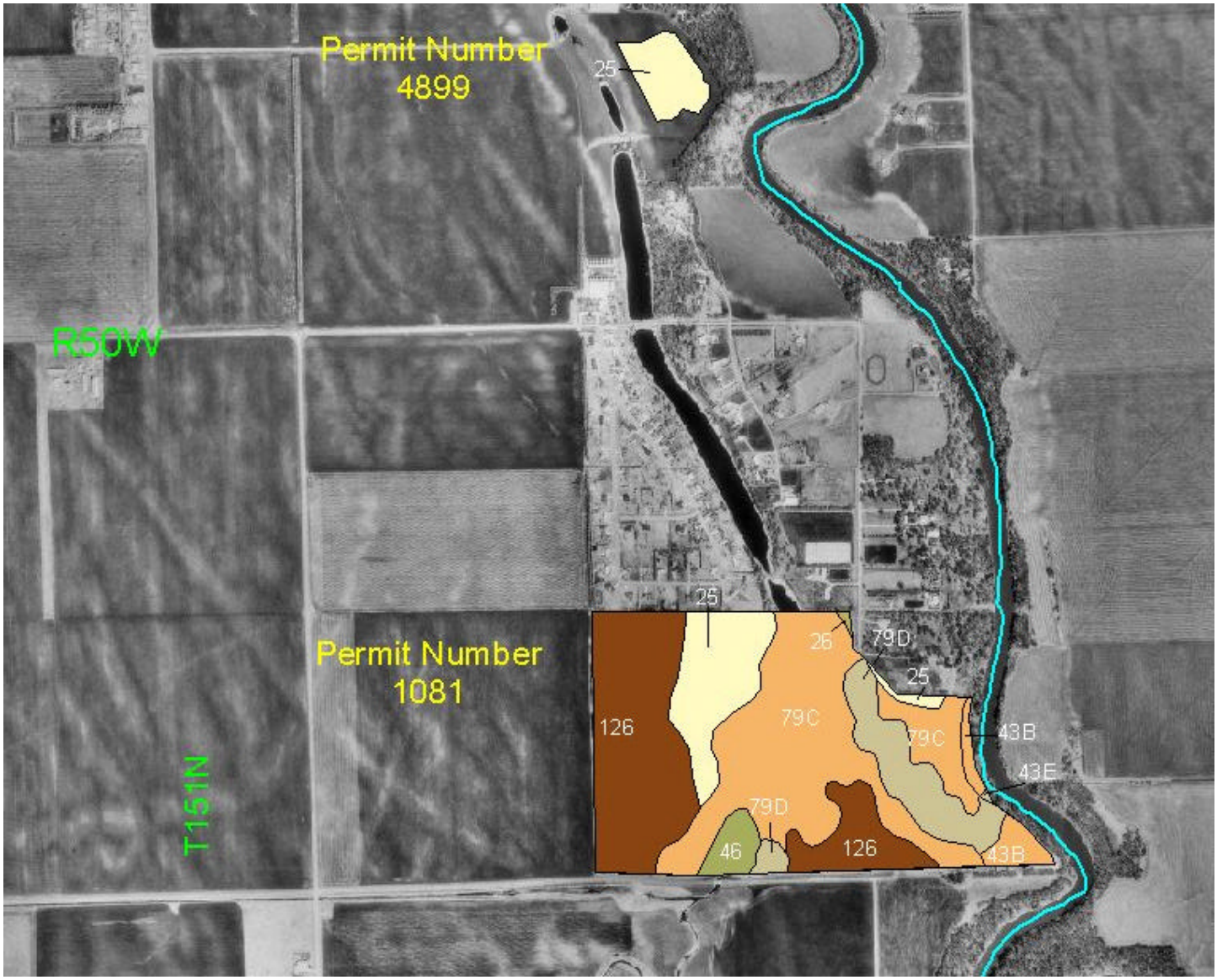
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-33

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

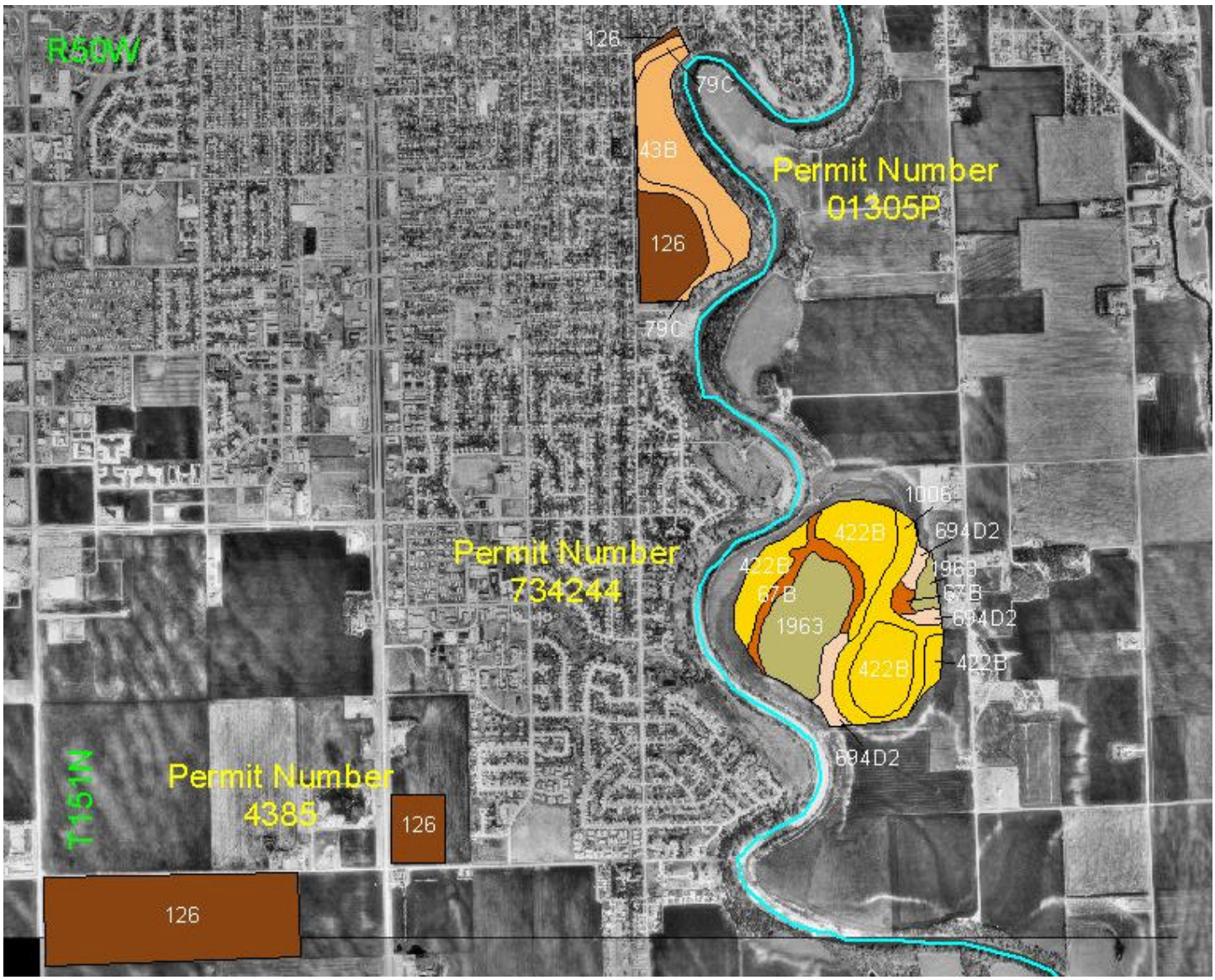
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-34

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

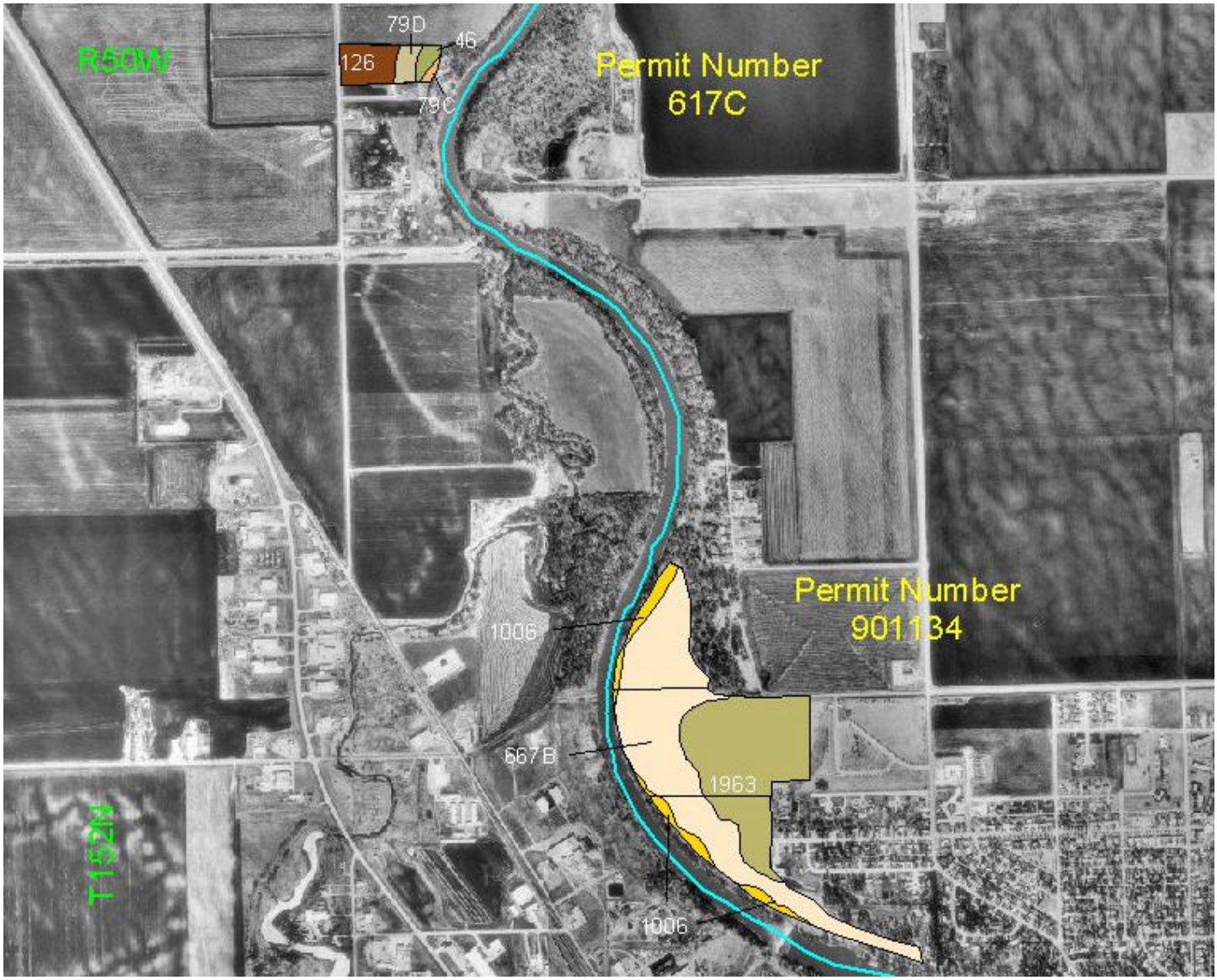
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-35

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

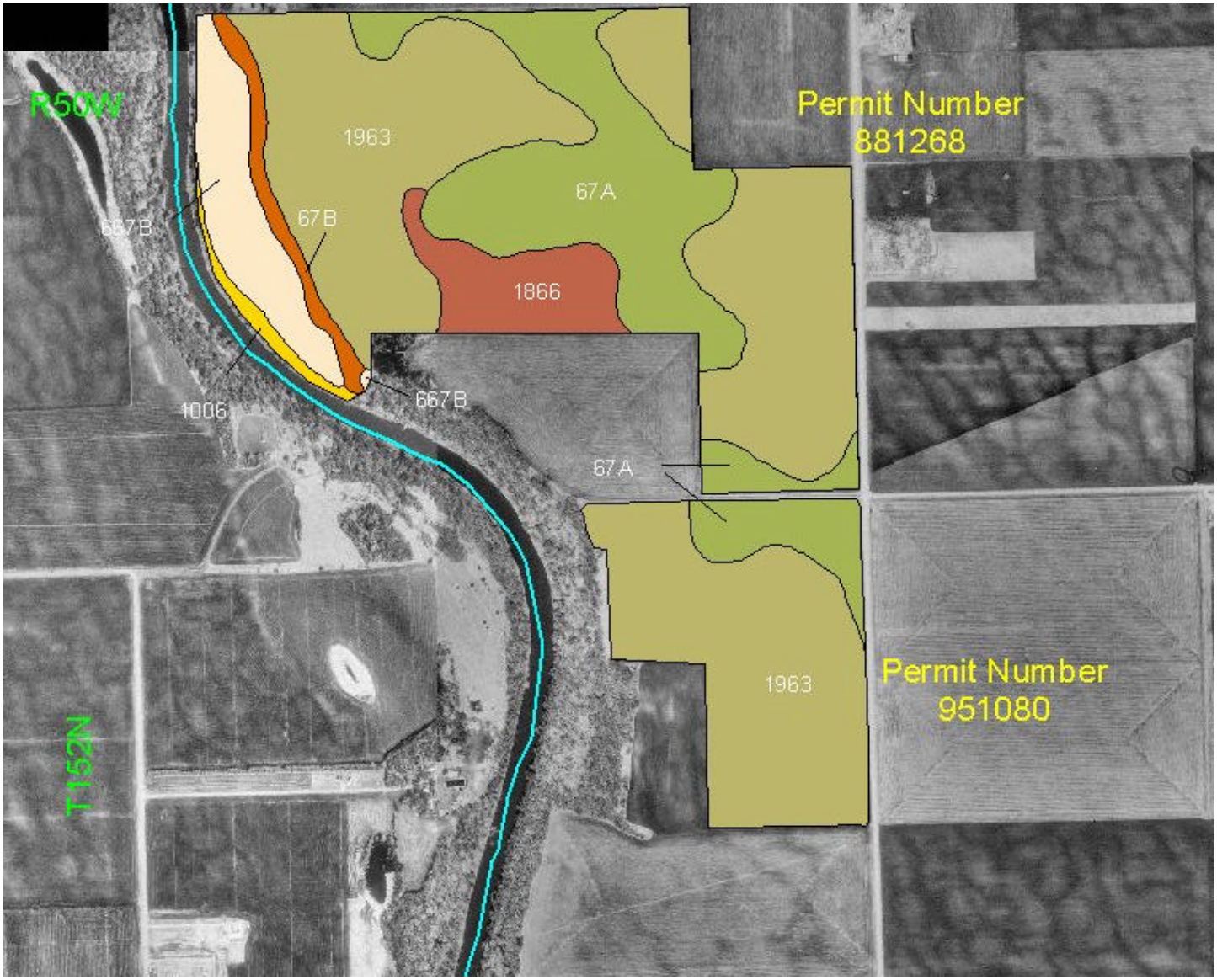
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-36

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

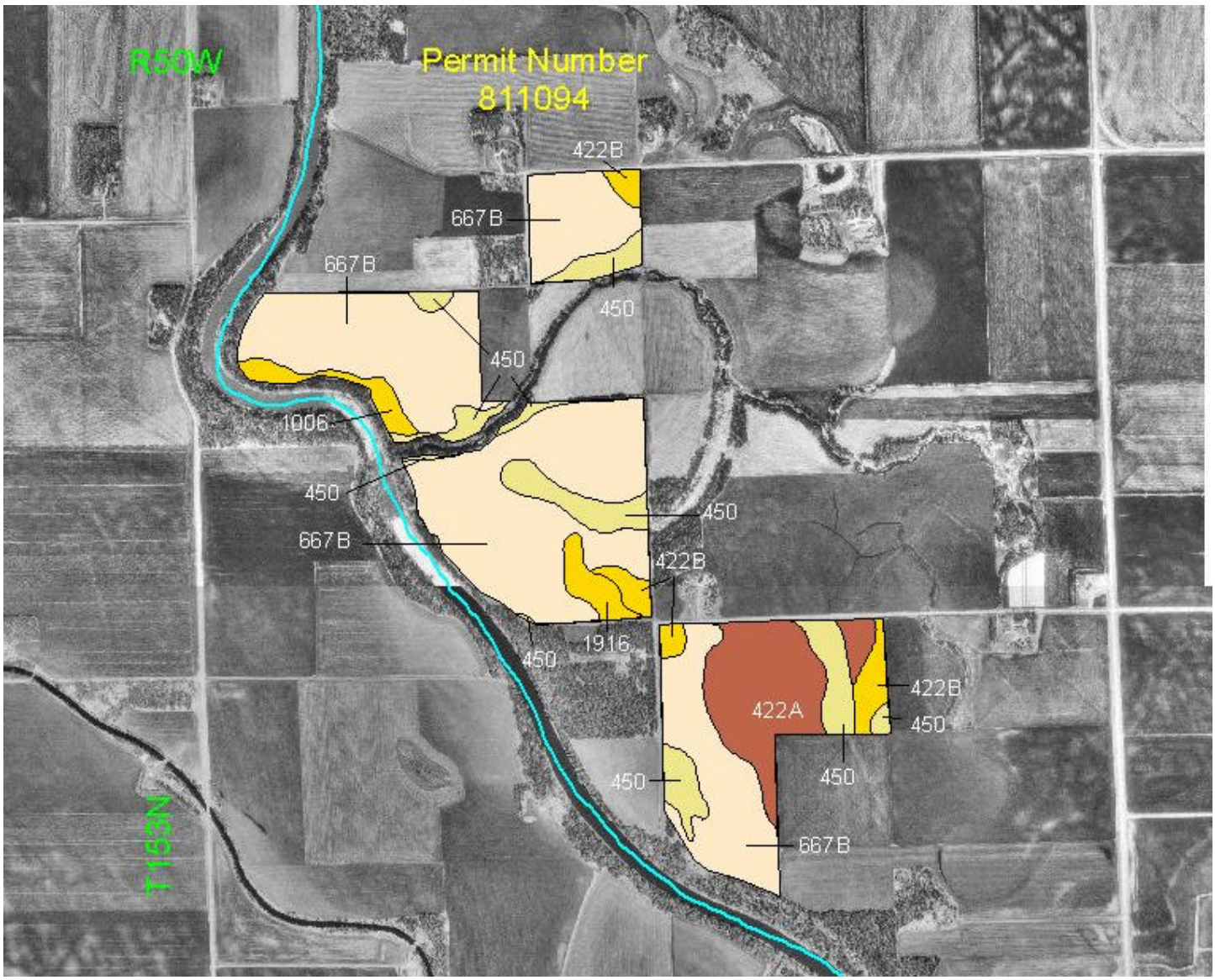
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-37

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

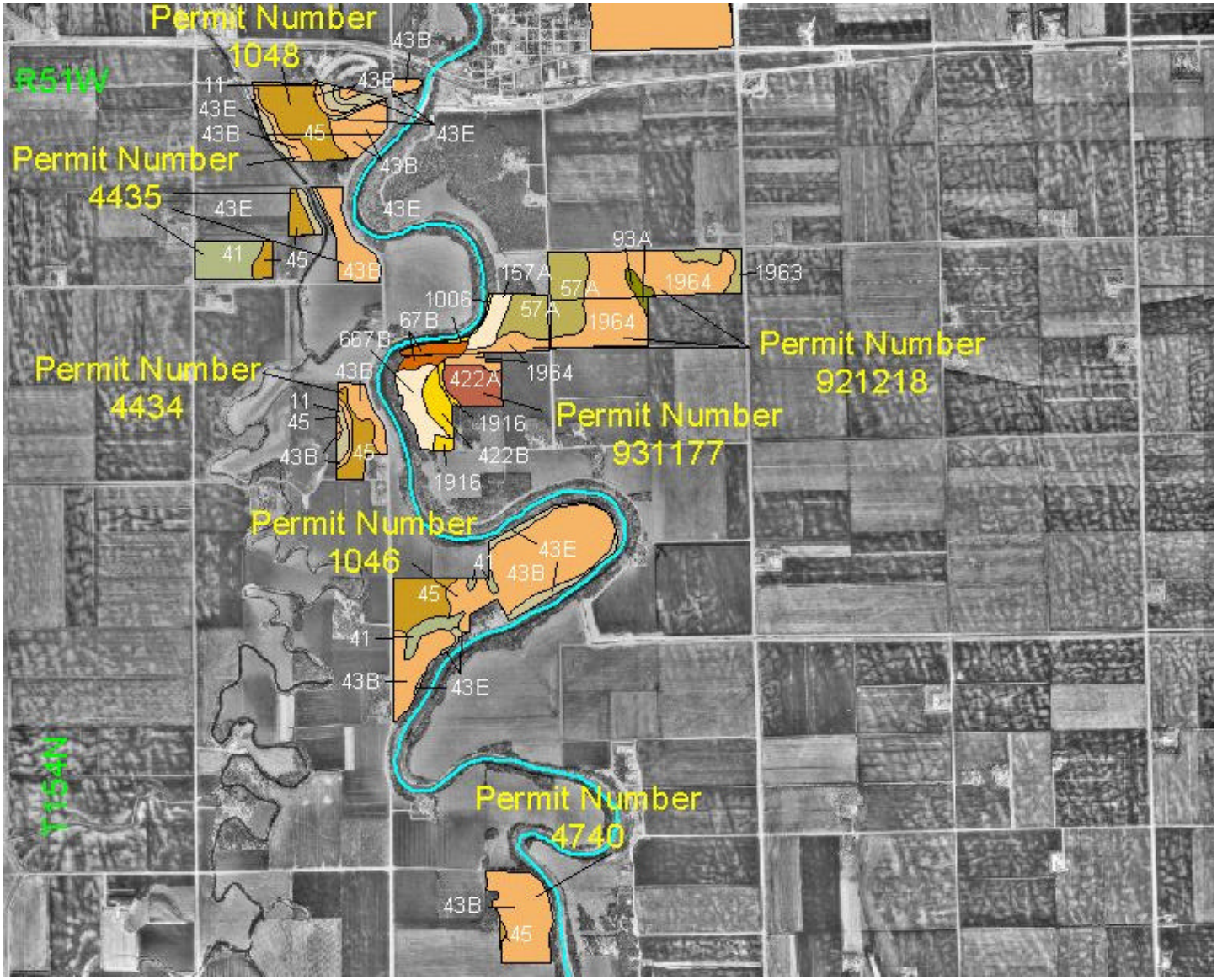
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-38

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

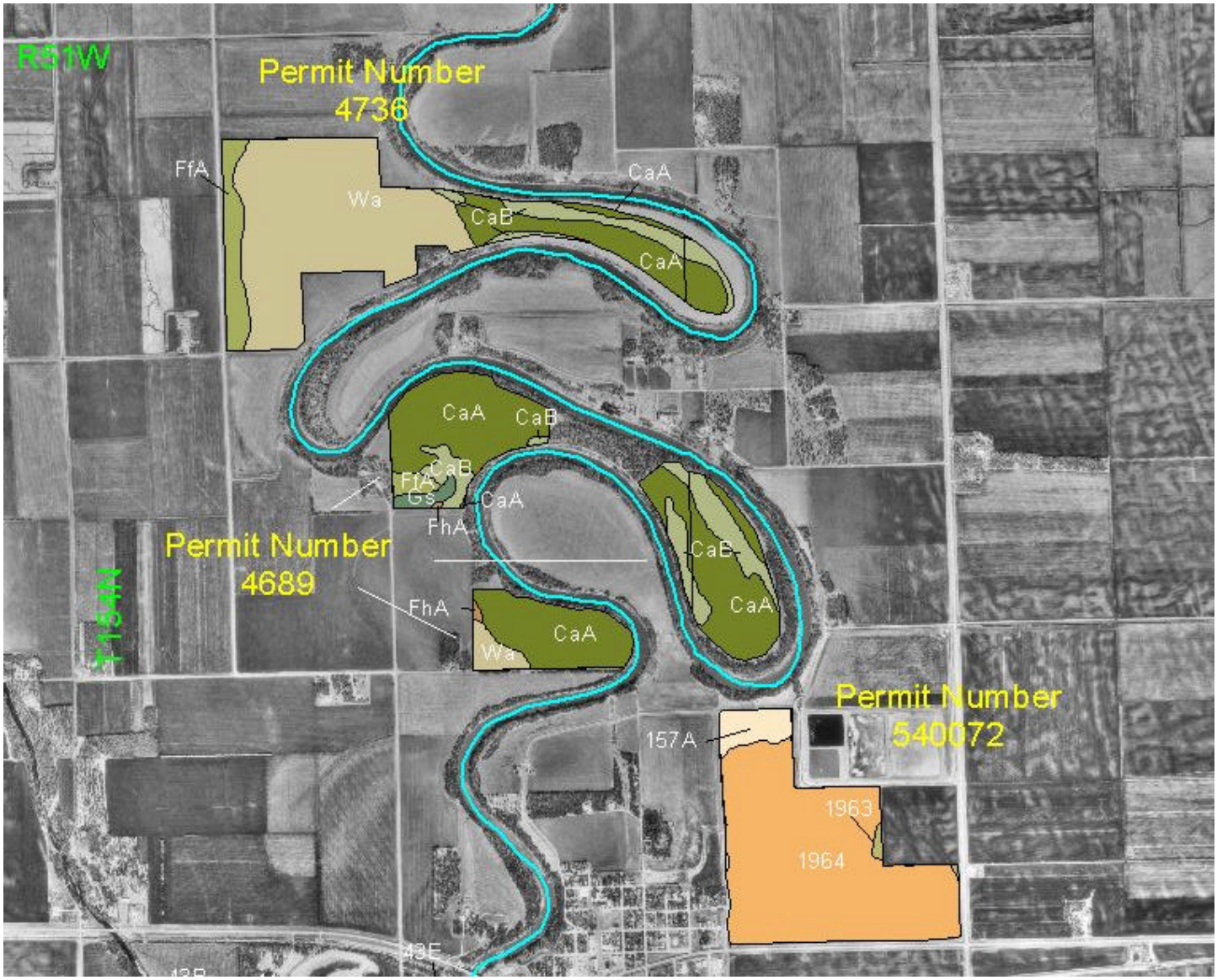
For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-39

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026



Irrigation Permits

For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-40

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026

Irrigation Permits

For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-41

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026

Irrigation Permits

For Project Location, see Figure B2-1
Soil Map Units shown. For explanation, see legend, Appendix B1, Table B1-1.
Devils Lake, North Dakota

N

FIGURE B2-42

PETERSON ENVIRONMENTAL CONSULTING, INC.

PEC Project No. 2001-026

Table B3-1. Acreage breakdown by hazard category for TDS irrigation water quality data, WET7 climatic scenario, using *Baseflow-plus-Blended Water* data. Numbers represent the categorical acreage summation of percentage exceedances by irrigation subgroup TDS maxima.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time TDS Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
MN	Red	Marshall	540072	2.7	222.2	-	-	-	222.2	-	-	-	222.2	-	-	-	222.2	-	-	-
			921218	4.3	302.3	-	-	-	302.3	-	-	-	302.3	-	-	-	302.3	-	-	-
		Marshall Total		7.0	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-
		Polk	734244	28.3	160.3	-	-	-	160.3	-	-	-	160.3	-	-	-	160.3	-	-	-
			811094	20.3	349.0	-	-	-	349.0	-	-	-	349.0	-	-	-	349.0	-	-	-
			881268	5.7	308.6	-	-	-	308.6	-	-	-	308.6	-	-	-	308.6	-	-	-
			901041	-	132.6	-	-	-	132.6	-	-	-	132.6	-	-	-	132.6	-	-	-
			901098	10.5	129.5	-	-	-	129.5	-	-	-	129.5	-	-	-	129.5	-	-	-
			901108	13.9	208.2	-	-	-	208.2	-	-	-	208.2	-	-	-	208.2	-	-	-
			901134	8.1	82.6	-	-	-	82.6	-	-	-	82.6	-	-	-	82.6	-	-	-
			901158	1.8	68.1	-	-	-	68.1	-	-	-	68.1	-	-	-	68.1	-	-	-
			901333	-	438.6	-	-	-	438.6	-	-	-	438.6	-	-	-	438.6	-	-	-
			911251	5.1	147.2	-	-	-	147.2	-	-	-	147.2	-	-	-	147.2	-	-	-
			911276	1.3	68.8	-	-	-	68.8	-	-	-	68.8	-	-	-	68.8	-	-	-
			921200	-	140.8	-	-	-	140.8	-	-	-	140.8	-	-	-	140.8	-	-	-
			931177	1.9	114.0	-	-	-	114.0	-	-	-	114.0	-	-	-	114.0	-	-	-
			941144	1.4	116.0	-	-	-	116.0	-	-	-	116.0	-	-	-	116.0	-	-	-
			951080	-	101.0	-	-	-	101.0	-	-	-	101.0	-	-	-	101.0	-	-	-
		Polk Total		98.4	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-
	Red Total			105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
MN Total				105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
ND	Red	Grand Forks	01305P	3.4	92.8	-	-	-	92.8	-	-	-	92.8	-	-	-	92.8	-	-	-
			1046	1.2	292.7	-	-	-	292.7	-	-	-	292.7	-	-	-	292.7	-	-	-
			1048	-	87.2	-	-	-	87.2	-	-	-	87.2	-	-	-	87.2	-	-	-
			1081	7.4	185.2	-	-	-	185.2	-	-	-	185.2	-	-	-	185.2	-	-	-
			4001	23.5	275.7	-	-	-	275.7	-	-	-	275.7	-	-	-	275.7	-	-	-
			4143	25.4	361.2	-	-	-	361.2	-	-	-	361.2	-	-	-	361.2	-	-	-
			4332	11.2	124.2	-	-	-	124.2	-	-	-	124.2	-	-	-	124.2	-	-	-
			4348	9.8	164.9	-	-	-	164.9	-	-	-	164.9	-	-	-	164.9	-	-	-
			4380	0.1	12.6	-	-	-	12.6	-	-	-	12.6	-	-	-	12.6	-	-	-
			4385	12.4	125.7	-	-	-	125.7	-	-	-	125.7	-	-	-	125.7	-	-	-
			4434	-	59.7	-	-	-	59.7	-	-	-	59.7	-	-	-	59.7	-	-	-
			4435	2.4	173.3	-	-	-	173.3	-	-	-	173.3	-	-	-	173.3	-	-	-
			4670	0.8	822.6	-	-	-	822.6	-	-	-	822.6	-	-	-	822.6	-	-	-
			4685	1.1	370.5	-	-	-	370.5	-	-	-	370.5	-	-	-	370.5	-	-	-
			4693	0.4	233.1	-	-	-	233.1	-	-	-	233.1	-	-	-	233.1	-	-	-
			4740	-	79.6	-	-	-	79.6	-	-	-	79.6	-	-	-	79.6	-	-	-
			4773	10.6	134.2	-	-	-	134.2	-	-	-	134.2	-	-	-	134.2	-	-	-

Table B3-1, Continued.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time TDS Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
			4774	4.3	163.9	-	-	-	163.9	-	-	-	163.9	-	-	-	163.9	-	-	-
			4873	26.8	270.7	-	-	-	270.7	-	-	-	270.7	-	-	-	270.7	-	-	-
			4887	7.6	155.4	-	-	-	155.4	-	-	-	155.4	-	-	-	155.4	-	-	-
			4899	-	10.5	-	-	-	10.5	-	-	-	10.5	-	-	-	10.5	-	-	-
			617C	0.5	8.8	-	-	-	8.8	-	-	-	8.8	-	-	-	8.8	-	-	-
		Grand Forks Total		149.0	4204.2	-	-	-	4204.2				4204.2				4204.2			
		Pembina	4403	0.1	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-
		Pembina Total		-	250.2	-	-	-	250.2	-	-	-	250.2				250.2			
		Traill	4328	-	200.8	-	-	-	200.8	-	-	-	200.8	-	-	-	200.8	-	-	-
			4364	-	134.0	-	-	-	134.0	-	-	-	134.0	-	-	-	134.0	-	-	-
		Traill Total		-	334.8				334.8				334.8				334.8			
		Walsh	4190	-	135.6	-	-	-	135.6	-	-	-	135.6	-	-	-	135.6	-	-	-
			4282	-	129.1	-	-	-	129.1	-	-	-	129.1	-	-	-	129.1	-	-	-
			4325	-	396.5	-	-	-	396.5	-	-	-	396.5	-	-	-	396.5	-	-	-
			4335	-	130.0	-	-	-	130.0	-	-	-	130.0	-	-	-	130.0	-	-	-
			4689	-	253.1	-	-	-	253.1	-	-	-	253.1	-	-	-	253.1	-	-	-
			4736	-	284.1	-	-	-	284.1	-	-	-	284.1	-	-	-	284.1	-	-	-
		Walsh Total			1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-
	Red Total				6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-
	Sheyenne	Barnes	00507B	0.1	3.1	-	-	-	0.1	-	3.0	-	0.1	-	-	3.0	-	3.1	-	-
			1573	0.4	4.8	-	-	-	0.4	-	4.4	-	0.4	-	-	4.4	0.0	4.8	-	-
			1976	1.7	170.1	-	-	-	23.5	-	146.6	-	23.5	-	-	146.6	2.7	167.4	-	-
			1976A	6.0	95.7	-	-	-	7.4	-	88.3	-	7.4	-	-	88.3	0.4	95.3	-	-
			2198	-	7.0	-	-	-	6.5	-	0.5	-	6.5	-	-	0.5	-	7.0	-	-
			240	-	9.9	-	-	-	-	-	9.9	-	-	-	-	9.9	-	9.9	-	-
			592	5.5	56.5	-	-	-	2.2	-	54.4	-	2.2	-	-	54.4	0.0	56.5	-	-
			629	4.0	39.3	-	-	-	2.0	-	37.4	-	2.0	-	-	37.4	0.1	39.2	-	-
			653A	0.0	13.1	-	-	-	5.0	-	8.1	-	5.0	-	-	8.1	-	13.1	-	-
		Barnes Total		17.7	399.5	-	-	-	47.0	-	352.5	-	47.0	-	-	352.5	3.3	396.2	-	-
		Cass	1089	0.3	5.8	16.0	-	-	5.8	-	16.0	-	5.8	-	-	16.0	4.5	1.3	16.0	-
			2358	-	6.6	0.3	-	-	6.6	-	0.3	-	6.6	-	-	0.3	6.2	0.4	0.3	-
			3779	1.4	9.7	12.9	-	-	9.7	-	12.9	-	9.7	-	-	12.9	9.0	0.6	12.9	-
			4189	6.6	15.1	14.4	-	-	15.1	-	14.4	-	15.1	-	-	14.4	0.9	14.2	14.4	-
			4210	0.4	0.9	21.0	-	-	0.9	-	21.0	-	0.9	-	-	21.0	-	-	21.0	-
			5115	0.5	9.5	10.6	-	-	9.5	-	10.6	-	9.5	-	-	10.6	-	-	10.6	-
			515	0.1	0.2	3.4	-	-	0.2	-	3.4	-	0.2	-	-	3.4	-	-	3.4	-
		Cass Total		9.4	47.6	78.5	-	-	47.6	-	78.5	-	47.6	-	-	78.5	20.6	27.0	78.5	-
		Eddy	2206	0.0	71.5	-	3.7	-	69.9	0.1	-	5.2	69.9	1.6	-	3.7	-	-	-	-
		Eddy Total		0.0	71.5	-	3.7	-	69.9	0.1	-	5.2	69.9	1.6	-	3.7	-	-	-	-
		Nelson	1889	0.1	30.0	1.0	-	-	29.6	1.4	-	-	29.6	0.4	-	1.0	-	30.0	1.0	-
			4999	45.7	125.7	3.7	-	-	116.3	9.4	-	3.7	116.3	9.4	-	3.7	-	125.7	3.7	-

Table B3-1, Continued.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time TDS Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
		Nelson Total		45.8	155.6	4.7			145.8	10.8		3.7	145.8	9.8		4.7		155.6	4.7	
		Ransom	1227	-	49.0	-	-	-	49.0	-	-	-	49.0	-	-	-	0.2	48.7	-	-
			1241	-	338.6	-	-	-	322.1	-	16.5	-	322.1	-	-	16.5	188.6	133.5	16.5	-
			2011	-	138.2	-	-	-	136.5	-	1.6	-	136.5	-	-	1.6	3.1	133.4	1.6	-
			2296	-	76.7	-	-	-	76.7	-	-	-	76.7	-	-	-	0.8	75.9	-	-
			2411	0.5	366.0	-	-	-	362.0	-	4.0	-	362.0	-	-	4.0	219.2	142.9	4.0	-
			2424C	0.4	93.0	-	-	-	88.4	-	4.5	-	88.4	-	-	4.5	48.4	40.0	4.5	-
			2710	10.4	539.9	-	-	-	523.5	-	16.5	-	523.5	-	-	16.5	44.5	479.0	16.5	-
			3605	-	304.5	-	-	-	304.5	-	-	-	304.5	-	-	-	301.9	2.7	-	-
			3606	-	140.7	-	-	-	137.5	-	3.1	-	137.5	-	-	3.1	38.8	98.8	3.1	-
			3614	-	129.2	-	-	-	128.8	-	0.4	-	128.8	-	-	0.4	31.5	97.3	0.4	-
			3715	-	90.1	-	-	-	80.3	-	9.8	-	80.3	-	-	9.8	0.6	79.7	9.8	-
			3756	-	59.4	-	-	-	59.4	-	-	-	59.4	-	-	-	40.4	19.0	-	-
			397	-	1.0	-	-	-	1.0	-	-	-	1.0	-	-	-	-	1.0	-	-
			4650	-	41.3	-	-	-	39.9	-	1.4	-	39.9	-	-	1.4	39.2	0.7	1.4	-
			4747	-	115.4	-	-	-	114.9	-	0.5	-	114.9	-	-	0.5	51.8	63.1	0.5	-
			4780	-	105.3	-	-	-	104.3	-	1.1	-	104.3	-	-	1.1	16.5	87.8	1.1	-
			641	-	1.6	-	-	-	1.6	-	-	-	1.6	-	-	-	-	1.6	-	-
			698	-	200.4	-	-	-	198.5	-	1.9	-	198.5	-	-	1.9	46.5	152.0	1.9	-
			757	-	143.4	-	-	-	141.1	-	2.2	-	141.1	-	-	2.2	1.8	139.3	2.2	-
		Ransom Total		11.3	2933.7	-	-	-	2870.1	-	63.6	-	2870.1	-	-	63.6	1073.7	1796.5	63.6	-
	Sheyenne Total			84.1	3608.0	83.2	3.7	-	3180.4	10.9	494.7	8.9	3180.4	11.4	-	503.0	1097.6	2375.3	146.8	-
ND Total				233.2	9725.6	83.2	3.7	-	9298.0	10.9	494.7	8.9	9298.0	11.4	-	503.0	7215.2	2375.3	146.8	-

Table B3-2. Acreage breakdown by hazard category for SAR irrigation water quality data, WET7 climatic scenario using *Baseflow-plus-Blended Water* data. Numbers represent the categorical acreage summation of percentage exceedances by irrigation subgroup SAR maxima.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time SAR Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
MN	Red	Marshall	540072	2.7	222.2	-	-	-	222.2	-	-	-	222.2	-	-	-	222.2	-	-	-
			921218	4.3	302.3	-	-	-	302.3	-	-	-	302.3	-	-	-	302.3	-	-	-
		Marshall Total		7.0	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-
		Polk	734244	28.3	160.3	-	-	-	160.3	-	-	-	160.3	-	-	-	160.3	-	-	-
			811094	20.3	349.0	-	-	-	349.0	-	-	-	349.0	-	-	-	349.0	-	-	-
			881268	5.7	308.6	-	-	-	308.6	-	-	-	308.6	-	-	-	308.6	-	-	-
			901041	-	132.6	-	-	-	132.6	-	-	-	132.6	-	-	-	132.6	-	-	-
			901098	10.5	129.5	-	-	-	129.5	-	-	-	129.5	-	-	-	129.5	-	-	-
			901108	13.9	208.2	-	-	-	208.2	-	-	-	208.2	-	-	-	208.2	-	-	-
			901134	8.1	82.6	-	-	-	82.6	-	-	-	82.6	-	-	-	82.6	-	-	-
			901158	1.8	68.1	-	-	-	68.1	-	-	-	68.1	-	-	-	68.1	-	-	-
			901333	-	438.6	-	-	-	438.6	-	-	-	438.6	-	-	-	438.6	-	-	-
			911251	5.1	147.2	-	-	-	147.2	-	-	-	147.2	-	-	-	147.2	-	-	-
			911276	1.3	68.8	-	-	-	68.8	-	-	-	68.8	-	-	-	68.8	-	-	-
			921200	-	140.8	-	-	-	140.8	-	-	-	140.8	-	-	-	140.8	-	-	-
			931177	1.9	114.0	-	-	-	114.0	-	-	-	114.0	-	-	-	114.0	-	-	-
			941144	1.4	116.0	-	-	-	116.0	-	-	-	116.0	-	-	-	116.0	-	-	-
			951080	-	101.0	-	-	-	101.0	-	-	-	101.0	-	-	-	101.0	-	-	-
		Polk Total		98.4	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-
	Red Total			105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
MN Total				105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
ND	Red	Grand Forks	01305P	3.4	92.8	-	-	-	92.8	-	-	-	92.8	-	-	-	92.8	-	-	-
			1046	1.2	292.7	-	-	-	292.7	-	-	-	292.7	-	-	-	292.7	-	-	-
			1048	-	87.2	-	-	-	87.2	-	-	-	87.2	-	-	-	87.2	-	-	-
			1081	7.4	185.2	-	-	-	185.2	-	-	-	185.2	-	-	-	185.2	-	-	-
			4001	23.5	275.7	-	-	-	275.7	-	-	-	275.7	-	-	-	275.7	-	-	-
			4143	25.4	361.2	-	-	-	361.2	-	-	-	361.2	-	-	-	361.2	-	-	-
			4332	11.2	124.2	-	-	-	124.2	-	-	-	124.2	-	-	-	124.2	-	-	-
			4348	9.8	164.9	-	-	-	164.9	-	-	-	164.9	-	-	-	164.9	-	-	-
			4380	0.1	12.6	-	-	-	12.6	-	-	-	12.6	-	-	-	12.6	-	-	-
			4385	12.4	125.7	-	-	-	125.7	-	-	-	125.7	-	-	-	125.7	-	-	-
			4434	-	59.7	-	-	-	59.7	-	-	-	59.7	-	-	-	59.7	-	-	-
			4435	2.4	173.3	-	-	-	173.3	-	-	-	173.3	-	-	-	173.3	-	-	-
			4670	0.8	822.6	-	-	-	822.6	-	-	-	822.6	-	-	-	822.6	-	-	-
			4685	1.1	370.5	-	-	-	370.5	-	-	-	370.5	-	-	-	370.5	-	-	-
			4693	0.4	233.1	-	-	-	233.1	-	-	-	233.1	-	-	-	233.1	-	-	-
			4740	-	79.6	-	-	-	79.6	-	-	-	79.6	-	-	-	79.6	-	-	-
			4773	10.6	134.2	-	-	-	134.2	-	-	-	134.2	-	-	-	134.2	-	-	-

Table B3-2, Continued.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time SAR Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
			4774	4.3	163.9	-	-	-	163.9	-	-	-	163.9	-	-	-	163.9	-	-	-
			4873	26.8	270.7	-	-	-	270.7	-	-	-	270.7	-	-	-	270.7	-	-	-
			4887	7.6	155.4	-	-	-	155.4	-	-	-	155.4	-	-	-	155.4	-	-	-
			4899	-	10.5	-	-	-	10.5	-	-	-	10.5	-	-	-	10.5	-	-	-
			617C	0.5	8.8	-	-	-	8.8	-	-	-	8.8	-	-	-	8.8	-	-	-
		Grand Forks Total		149.0	4204.2	-	-	-	4204.2				4204.2				4204.2			
		Pembina	4403	0.1	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-
		Pembina Total		-	-	-	-	-	250.2	-	-	-	250.2				250.2			
		Traill	4328	-	200.8	-	-	-	200.8	-	-	-	200.8	-	-	-	200.8	-	-	-
			4364	-	134.0	-	-	-	134.0	-	-	-	134.0	-	-	-	134.0	-	-	-
		Traill Total		-	334.8	-	-	-	334.8	-	-	-	334.8	-	-	-	334.8	-	-	-
		Walsh	4190	-	135.6	-	-	-	135.6	-	-	-	135.6	-	-	-	135.6	-	-	-
			4282	-	129.1	-	-	-	129.1	-	-	-	129.1	-	-	-	129.1	-	-	-
			4325	-	396.5	-	-	-	396.5	-	-	-	396.5	-	-	-	396.5	-	-	-
			4335	-	130.0	-	-	-	130.0	-	-	-	130.0	-	-	-	130.0	-	-	-
			4689	-	253.1	-	-	-	253.1	-	-	-	253.1	-	-	-	253.1	-	-	-
			4736	-	284.1	-	-	-	284.1	-	-	-	284.1	-	-	-	284.1	-	-	-
		Walsh Total			1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-
		Red Total			6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-
	Sheyenne	Barnes	00507B	0.1	3.1	-	-	-	3.1	-	-	-	3.1	-	-	-	-	3.1	-	-
			1573	0.4	4.8	-	-	-	4.8	-	-	-	4.8	-	-	-	0.0	4.8	-	-
			1976	1.7	170.1	-	-	-	170.1	-	-	-	170.1	-	-	-	2.7	167.4	-	-
			1976A	6.0	95.7	-	-	-	95.7	-	-	-	95.7	-	-	-	0.0	95.6	-	-
			2198	-	7.0	-	-	-	7.0	-	-	-	7.0	-	-	-	-	7.0	-	-
			240	-	9.9	-	-	-	9.9	-	-	-	9.9	-	-	-	-	9.9	-	-
			592	5.5	56.5	-	-	-	56.5	-	-	-	56.5	-	-	-	0.0	56.5	-	-
			629	4.0	39.3	-	-	-	39.3	-	-	-	39.3	-	-	-	0.1	39.2	-	-
			653A	0.0	13.1	-	-	-	13.1	-	-	-	13.1	-	-	-	-	13.1	-	-
		Barnes Total		17.7	399.5	-	-	-	399.5	-	-	-	399.5	-	-	-	2.9	396.7	-	-
		Cass	1089	0.3	21.9	-	-	-	21.9	-	-	-	21.9	-	-	-	-	21.9	-	-
			2358	-	6.9	-	-	-	6.9	-	-	-	6.9	-	-	-	-	6.9	-	-
			3779	1.4	22.5	-	-	-	22.5	-	-	-	22.5	-	-	-	-	22.5	-	-
			4189	6.6	29.4	-	-	-	29.4	-	-	-	29.4	-	-	-	-	29.4	-	-
			4210	0.4	21.9	-	-	-	21.9	-	-	-	21.9	-	-	-	-	21.9	-	-
			5115	0.5	20.0	-	-	-	20.0	-	-	-	20.0	-	-	-	-	20.0	-	-
			515	0.1	3.5	-	-	-	3.5	-	-	-	3.5	-	-	-	-	3.5	-	-
		Cass Total		9.4	126.2		-	-	126.2	-	-	-	126.2	-	-	-	-	126.2	-	-
		Eddy	2206	0.0	75.2	-	-	-	75.2	-	-	-	75.2	-	-	-	-	-	-	-
		Eddy Total		0.0	75.2	-	-	-	75.2	-	-	-	75.2	-	-	-	-	-	-	-
		Nelson	1889	0.1	31.0	-	-	-	31.0	-	-	-	31.0	-	-	-	23.7	7.2	-	-
			4999	45.7	129.3	-	-	-	129.3	-	-	-	129.3	-	-	-	32.6	96.7	-	-

Table B3-2, Continued.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time SAR Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
		Nelson Total		45.8	160.3	-	-	-	160.3	-	-	-	160.3	-	-	-	56.4	104.0	-	-
		Ransom	1227	-	49.0	-	-	-	49.0	-	-	-	49.0	-	-	-	0.2	48.7	-	-
			1241	-	338.6	-	-	-	338.6	-	-	-	338.6	-	-	-	196.9	141.6	-	-
			2011	-	138.2	-	-	-	138.2	-	-	-	138.2	-	-	-	4.0	134.1	-	-
			2296	-	76.7	-	-	-	76.7	-	-	-	76.7	-	-	-	1.3	75.4	-	-
			2411	0.5	366.0	-	-	-	366.0	-	-	-	366.0	-	-	-	240.0	126.0	-	-
			2424C	0.4	93.0	-	-	-	93.0	-	-	-	93.0	-	-	-	54.7	38.2	-	-
			2710	10.4	539.9	-	-	-	539.9	-	-	-	539.9	-	-	-	56.7	483.2	-	-
			3605	-	304.5	-	-	-	304.5	-	-	-	304.5	-	-	-	299.3	5.2	-	-
			3606	-	140.7	-	-	-	140.7	-	-	-	140.7	-	-	-	41.4	99.3	-	-
			3614	-	129.2	-	-	-	129.2	-	-	-	129.2	-	-	-	41.6	87.6	-	-
			3715	-	90.1	-	-	-	90.1	-	-	-	90.1	-	-	-	4.5	85.6	-	-
			3756	-	59.4	-	-	-	59.4	-	-	-	59.4	-	-	-	50.3	9.1	-	-
			397	-	1.0	-	-	-	1.0	-	-	-	1.0	-	-	-	-	1.0	-	-
			4650	-	41.3	-	-	-	41.3	-	-	-	41.3	-	-	-	39.5	1.8	-	-
			4747	-	115.4	-	-	-	115.4	-	-	-	115.4	-	-	-	50.5	64.8	-	-
			4780	-	105.3	-	-	-	105.3	-	-	-	105.3	-	-	-	45.0	60.3	-	-
			641	-	1.6	-	-	-	1.6	-	-	-	1.6	-	-	-	-	1.6	-	-
			698	-	200.4	-	-	-	200.4	-	-	-	200.4	-	-	-	51.2	149.3	-	-
			757	-	143.4	-	-	-	143.4	-	-	-	143.4	-	-	-	4.7	138.6	-	-
		Ransom Total		11.3	2933.7	-	-	-	2933.7	-	-	-	2933.7	-	-	-	1241.2	1751.7	-	-
	Sheyenne Total			84.1	3694.9	-	-	-	3694.9	-	-	-	3694.9	-	-	-	1241.2	2378.5	-	-
ND Total				233.2	9812.5	-	-	-	9812.5	-	-	-	9812.5	-	-	-	7358.8	2378.5	-	-

Table B3-3. Acreage breakdown by hazard category for irrigation water quality TDS data, WET7 climatic scenario, *Blended-Water-Only*. Numbers represent the categorical acreage summation of percentage exceedances by irrigation subgroup TDS maxima.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time TDS Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
MN	Red	Marshall	540072	2.7	222.2	-	-	-	222.2	-	-	-	222.2	-	-	-	222.2	-	-	-
			921218	4.3	302.3	-	-	-	302.3	-	-	-	302.3	-	-	-	302.3	-	-	-
		Marshall Total		7.0	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-
		Polk	734244	28.3	160.3	-	-	-	160.3	-	-	-	160.3	-	-	-	160.3	-	-	-
			811094	20.3	349.0	-	-	-	349.0	-	-	-	349.0	-	-	-	349.0	-	-	-
			881268	5.7	308.6	-	-	-	308.6	-	-	-	308.6	-	-	-	308.6	-	-	-
			901041	-	132.6	-	-	-	132.6	-	-	-	132.6	-	-	-	132.6	-	-	-
			901098	10.5	129.5	-	-	-	129.5	-	-	-	123.8	5.7	-	-	123.8	5.7	-	-
			901108	13.9	208.2	-	-	-	208.2	-	-	-	208.2		-	-	208.2	-	-	-
			901134	8.1	82.6	-	-	-	82.6	-	-	-	82.6		-	-	82.6	-	-	-
			901158	1.8	68.1	-	-	-	68.1	-	-	-	63.6	4.4	-	-	63.6	4.4	-	-
			901333	-	438.6	-	-	-	438.6	-	-	-	422.8	15.8	-	-	422.8	15.8	-	-
			911251	5.1	147.2	-	-	-	147.2	-	-	-	147.2		-	-	147.2	-	-	-
			911276	1.3	68.8	-	-	-	68.8	-	-	-	65.7	3.0	-	-	65.7	3.0	-	-
			921200	-	140.8	-	-	-	140.8	-	-	-	119.0	21.8	-	-	119.0	21.8	-	-
			931177	1.9	114.0	-	-	-	114.0	-	-	-	114.0	-	-	-	114.0	-	-	-
			941144	1.4	116.0	-	-	-	116.0	-	-	-	116.0	-	-	-	116.0	-	-	-
			951080	-	101.0	-	-	-	101.0	-	-	-	101.0	-	-	-	101.0	-	-	-
		Polk Total		98.4	2565.2	-	-	-	2565.2	-	-	-	2514.5	50.7	-	-	2514.5	50.7	-	-
	Red Total			105.5	3089.8	-	-	-	3089.8	-	-	-	3039.1	50.7	-	-	3039.1	50.7	-	-
MN Total				105.5	3089.8	-	-	-	3089.8	-	-	-	3039.1	50.7	-	-	3039.1	50.7	-	-
ND	Red	Grand Forks	01305P	3.4	92.8	-	-	-	92.8	-	-	-	92.8	-	-	-	92.8	-	-	-
			1046	1.2	292.7	-	-	-	292.7	-	-	-	292.7	-	-	-	292.7	-	-	-
			1048	-	87.2	-	-	-	87.2	-	-	-	87.2	-	-	-	87.2	-	-	-
			1081	7.4	185.2	-	-	-	185.2	-	-	-	185.2	-	-	-	185.2	-	-	-
			4001	23.5	275.7	-	-	-	275.7	-	-	-	275.7	-	-	-	275.7	-	-	-
			4143	25.4	361.2	-	-	-	361.2	-	-	-	361.2	-	-	-	361.2	-	-	-
			4332	11.2	124.2	-	-	-	124.2	-	-	-	124.2	-	-	-	124.2	-	-	-
			4348	9.8	164.9	-	-	-	164.9	-	-	-	164.9	-	-	-	164.9	-	-	-
			4380	0.1	12.6	-	-	-	12.6	-	-	-	12.6	-	-	-	12.6	-	-	-
			4385	12.4	125.7	-	-	-	125.7	-	-	-	125.7	-	-	-	125.7	-	-	-
			4434	-	59.7	-	-	-	59.7	-	-	-	59.7	-	-	-	59.7	-	-	-
			4435	2.4	173.3	-	-	-	173.3	-	-	-	173.3	-	-	-	173.3	-	-	-
			4670	0.8	822.6	-	-	-	822.6	-	-	-	822.6	-	-	-	822.6	-	-	-
			4685	1.1	370.5	-	-	-	370.5	-	-	-	370.5	-	-	-	370.5	-	-	-
			4693	0.4	233.1	-	-	-	233.1	-	-	-	233.1	-	-	-	233.1	-	-	-
			4740	-	79.6	-	-	-	79.6	-	-	-	79.6	-	-	-	79.6	-	-	-

Table B3-3, Continued.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time TDS Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
			4773	10.6	134.2	-	-	-	134.2	-	-	-	134.2	-	-	-	134.2	-	-	-
			4774	4.3	163.9	-	-	-	163.9	-	-	-	163.9	-	-	-	163.9	-	-	-
			4873	26.8	270.7	-	-	-	270.7	-	-	-	270.7	-	-	-	270.7	-	-	-
			4887	7.6	155.4	-	-	-	155.4	-	-	-	155.4	-	-	-	155.4	-	-	-
			4899	-	10.5	-	-	-	10.5	-	-	-	10.5	-	-	-	10.5	-	-	-
			617C	0.5	8.8	-	-	-	8.8	-	-	-	8.8	-	-	-	8.8	-	-	-
		Grand Forks Total		-	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-	4204.2		-	-
		Pembina	4403	0.1	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-	247.2	3.0	-	-
		Pembina Total			250.2	-	-	-	250.2	-	-	-	250.2	-	-	-	247.2	3.0	-	-
		Traill	4328	-	200.8	-	-	-	200.8	-	-	-	197.8	2.9	-	-	197.8	2.9	-	-
			4364	-	134.0	-	-	-	134.0	-	-	-	134.0		-	-	134.0	-	-	-
		Traill Total			334.8				334.8	-	-	-	331.8	2.9	-	-	331.8	2.9	-	-
		Walsh	4190	-	135.6	-	-	-	135.6	-	-	-	135.6	-	-	-	130.2	5.4	-	-
			4282	-	129.1	-	-	-	129.1	-	-	-	129.1	-	-	-	6.9	122.2	-	-
			4325	-	396.5	-	-	-	396.5	-	-	-	396.5	-	-	-	374.4	22.1	-	-
			4335	-	130.0	-	-	-	130.0	-	-	-	130.0	-	-	-	130.0	-	-	-
			4689	-	253.1	-	-	-	253.1	-	-	-	253.1	-	-	-	253.1	-	-	-
			4736	-	284.1	-	-	-	284.1	-	-	-	284.1	-	-	-	284.1	-	-	-
		Walsh Total		-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-	1178.7	149.7	-	-
		Red Total		-	6117.6	-	-	-	6117.6	-	-	-	6114.7	2.9	-	-	5961.9	155.7	-	-
Sheyenne		Barnes	00507B	0.1	3.1	-	-	-	0.1	-	3.0	-	0.1	-	-	3.0	-	-	0.1	3.0
			1573	0.4	4.8	-	-	-	0.4	-	4.4	-	0.4	-	-	4.4	0.0	-	0.4	4.4
			1976	1.7	170.1	-	-	-	23.5	-	146.6	-	23.5	-	-	146.6	2.7	-	19.6	147.8
			1976A	6.0	95.7	-	-	-	7.4	-	88.3	-	7.4	-	-	88.3	0.4	-	1.2	94.1
			2198	-	7.0	-	-	-	6.5	-	0.5	-	6.5	-	-	0.5	-	-	6.4	0.6
			240	-	9.9	-	-	-	-	-	9.9	-		-	-	9.9	-	-	-	9.9
			592	5.5	56.5	-	-	-	2.2	-	54.4	-	2.2	-	-	54.4	0.0	-	2.0	54.5
			629	4.0	39.3	-	-	-	2.0	-	37.4	-	2.0	-	-	37.4	0.1	-	1.8	37.4
			653A	0.0	13.1	-	-	-	5.0	-	8.1	-	5.0	-	-	8.1	-	-	4.9	8.2
		Barnes Total		17.7	399.5	-	-	-	47.0	-	352.5	-	47.0			352.5	3.3		36.3	359.9
		Cass	1089	0.3	5.8	16.0	-	-	5.8	-	16.0	-	5.8	-	-	16.0	-	4.5	1.3	16.0
			2358	-	6.6	0.3	-	-	6.6	-	0.3	-	6.6	-	-	0.3	-	6.2	0.4	0.3
			3779	1.4	9.7	12.9	-	-	9.7	-	12.9	-	9.7	-	-	12.9	-	9.0	0.6	12.9
			4189	6.6	15.1	14.4	-	-	15.1	-	14.4	-	15.1	-	-	14.4	-	0.9	14.2	14.4
			4210	0.4	0.9	21.0	-	-	0.9	-	21.0	-	0.9	-	-	21.0	-	-	0.9	21.0
			5115	0.5	9.5	10.6	-	-	9.5	-	10.6	-	9.5	-	-	10.6	-	-	9.5	10.6
			515	0.1	0.2	3.4	-	-	0.2	-	3.4	-	0.2	-	-	3.4	-	-	0.2	3.4
		Cass Total		9.4	47.6	78.5	-	-	47.6	-	78.5	-	47.6			78.5		20.6	27.0	78.5
		Eddy	2206	0.0	71.5	-	3.7	-	70.0	-	-	5.2	69.9	0.1	1.6	3.7	-	-	-	-
		Eddy Total		0.0	71.5	-	3.7	-	70.0	-	-	5.2	69.9	0.1	1.6	3.7				
		Nelson	1889	0.1	30.0	1.0	-	-	29.6	0.4	-	1.0	29.6	0.4	-	1.0	-	22.4	1.3	7.2

Table B3-3, Continued.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time TDS Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
			4999	45.7	125.7	3.7	-	-	116.3	9.4	-	3.7	116.3	9.4	-	3.7	-	84.5	0.5	44.4
		Nelson Total		45.8	155.6	4.7			145.8	9.8	-	4.7	145.8	9.8		4.7		106.9	1.7	51.7
		Ransom	1227	-	49.0	-	-	-	49.0	-	-	-	49.0	-	-	-	0.2	45.9	2.8	
			1241	-	338.6	-	-	-	322.1	-	16.5	-	322.1	-	-	16.5	188.6	55.4	78.1	16.5
			2011	-	138.2	-	-	-	136.5	-	1.6	-	136.5	-	-	1.6	3.1	100.8	32.6	1.6
			2296	-	76.7	-	-	-	76.7	-	-	-	76.7	-	-	-	0.8	72.0	3.9	
			2411	0.5	366.0	-	-	-	362.0	-	4.0	-	362.0	-	-	4.0	219.2	73.5	69.4	4.0
			2424C	0.4	93.0	-	-	-	88.4	-	4.5	-	88.4	-	-	4.5	48.4	12.0	28.0	4.5
			2710	10.4	539.9	-	-	-	523.5	-	16.5	-	523.5	-	-	16.5	44.5	178.7	300.3	16.5
			3605	-	304.5	-	-	-	304.5	-	-	-	304.5	-	-	-	301.9	1.2	1.5	
			3606	-	140.7	-	-	-	137.5	-	3.1	-	137.5	-	-	3.1	38.8	89.3	9.4	3.1
			3614	-	129.2	-	-	-	128.8	-	0.4	-	128.8	-	-	0.4	31.5	81.3	16.0	0.4
			3715	-	90.1	-	-	-	80.3	-	9.8	-	80.3	-	-	9.8	0.6	0.0	79.7	9.8
			3756	-	59.4	-	-	-	59.4	-	-	-	59.4	-	-	-	40.4	10.2	8.8	-
			397	-	1.0	-	-	-	1.0	-	-	-	1.0	-	-	-	-	1.0	-	-
			4650	-	41.3	-	-	-	39.9	-	1.4	-	39.9	-	-	1.4	39.2	0.4	0.4	1.4
			4747	-	115.4	-	-	-	114.9	-	0.5	-	114.9	-	-	0.5	51.8	56.7	6.5	0.5
			4780	-	105.3	-	-	-	104.3	-	1.1	-	104.3	-	-	1.1	16.5	73.9	13.9	1.1
			641	-	1.6	-	-	-	1.6	-	-	-	1.6	-	-	-	-	1.6	-	-
			698	-	200.4	-	-	-	198.5	-	1.9	-	198.5	-	-	1.9	46.5	40.6	111.4	1.9
			757	-	143.4	-	-	-	141.1	-	2.2	-	141.1	-	-	2.2	1.8	137.2	2.1	2.2
		Ransom Total		11.3	2933.7	-	-	-	2870.1		63.6		2870.1			63.6	1073.7	1031.6	764.9	63.6
	Sheyenne Total			84.1	3608.0	83.2	3.7	-	3180.5	9.8	494.7	9.9	3180.4	9.9	1.6	503.0	1076.9	1159.1	829.9	553.7
ND Total				233.2	9725.6	83.2	3.7	-	9298.1	9.8	494.7	9.9	9295.1	12.8	1.6	503.0	7038.9	1314.7	829.9	553.7

Table B3-4. Acreage breakdown by hazard category for SAR irrigation water quality data, WET7 climatic scenario, *Blended-Water-Only*. Numbers represent the categorical acreage summation of percentage exceedances by irrigation subgroup SAR maxima.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time SAR Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
MN	Red	Marshall	540072	2.7	222.2	-	-	-	222.2	-	-	-	222.2	-	-	-	222.2	-	-	-
			921218	4.3	302.3	-	-	-	302.3	-	-	-	302.3	-	-	-	302.3	-	-	-
		Marshall Total		7.0	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-	524.6	-	-	-
		Polk	734244	28.3	160.3	-	-	-	160.3	-	-	-	160.3	-	-	-	160.3	-	-	-
			811094	20.3	349.0	-	-	-	349.0	-	-	-	349.0	-	-	-	349.0	-	-	-
			881268	5.7	308.6	-	-	-	308.6	-	-	-	308.6	-	-	-	308.6	-	-	-
			901041	-	132.6	-	-	-	132.6	-	-	-	132.6	-	-	-	132.6	-	-	-
			901098	10.5	129.5	-	-	-	129.5	-	-	-	129.5	-	-	-	129.5	-	-	-
			901108	13.9	208.2	-	-	-	208.2	-	-	-	208.2	-	-	-	208.2	-	-	-
			901134	8.1	82.6	-	-	-	82.6	-	-	-	82.6	-	-	-	82.6	-	-	-
			901158	1.8	68.1	-	-	-	68.1	-	-	-	68.1	-	-	-	68.1	-	-	-
			901333	-	438.6	-	-	-	438.6	-	-	-	438.6	-	-	-	438.6	-	-	-
			911251	5.1	147.2	-	-	-	147.2	-	-	-	147.2	-	-	-	147.2	-	-	-
			911276	1.3	68.8	-	-	-	68.8	-	-	-	68.8	-	-	-	68.8	-	-	-
			921200	-	140.8	-	-	-	140.8	-	-	-	140.8	-	-	-	140.8	-	-	-
			931177	1.9	114.0	-	-	-	114.0	-	-	-	114.0	-	-	-	114.0	-	-	-
			941144	1.4	116.0	-	-	-	116.0	-	-	-	116.0	-	-	-	116.0	-	-	-
			951080	-	101.0	-	-	-	101.0	-	-	-	101.0	-	-	-	101.0	-	-	-
		Polk Total		98.4	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-	2565.2	-	-	-
	Red Total			105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
MN Total				105.5	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-	3089.8	-	-	-
ND	Red	Grand Forks	01305P	3.4	92.8	-	-	-	92.8	-	-	-	92.8	-	-	-	92.8	-	-	-
			1046	1.2	292.7	-	-	-	292.7	-	-	-	292.7	-	-	-	292.7	-	-	-
			1048	-	87.2	-	-	-	87.2	-	-	-	87.2	-	-	-	87.2	-	-	-
			1081	7.4	185.2	-	-	-	185.2	-	-	-	185.2	-	-	-	185.2	-	-	-
			4001	23.5	275.7	-	-	-	275.7	-	-	-	275.7	-	-	-	275.7	-	-	-
			4143	25.4	361.2	-	-	-	361.2	-	-	-	361.2	-	-	-	361.2	-	-	-
			4332	11.2	124.2	-	-	-	124.2	-	-	-	124.2	-	-	-	124.2	-	-	-
			4348	9.8	164.9	-	-	-	164.9	-	-	-	164.9	-	-	-	164.9	-	-	-
			4380	0.1	12.6	-	-	-	12.6	-	-	-	12.6	-	-	-	12.6	-	-	-
			4385	12.4	125.7	-	-	-	125.7	-	-	-	125.7	-	-	-	125.7	-	-	-
			4434	-	59.7	-	-	-	59.7	-	-	-	59.7	-	-	-	59.7	-	-	-
			4435	2.4	173.3	-	-	-	173.3	-	-	-	173.3	-	-	-	173.3	-	-	-
			4670	0.8	822.6	-	-	-	822.6	-	-	-	822.6	-	-	-	822.6	-	-	-
			4685	1.1	370.5	-	-	-	370.5	-	-	-	370.5	-	-	-	370.5	-	-	-
			4693	0.4	233.1	-	-	-	233.1	-	-	-	233.1	-	-	-	233.1	-	-	-
			4740	-	79.6	-	-	-	79.6	-	-	-	79.6	-	-	-	79.6	-	-	-
			4773	10.6	134.2	-	-	-	134.2	-	-	-	134.2	-	-	-	134.2	-	-	-

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time SAR Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
			4774	4.3	163.9	-	-	-	163.9	-	-	-	163.9	-	-	-	163.9	-	-	-
			4873	26.8	270.7	-	-	-	270.7	-	-	-	270.7	-	-	-	270.7	-	-	-
			4887	7.6	155.4	-	-	-	155.4	-	-	-	155.4	-	-	-	155.4	-	-	-
			4899	-	10.5	-	-	-	10.5	-	-	-	10.5	-	-	-	10.5	-	-	-
			617C	0.5	8.8	-	-	-	8.8	-	-	-	8.8	-	-	-	8.8	-	-	-
		Grand Forks Total		-	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-	4204.2	-	-	-
		Pembina	4403	0.1	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-
		Pembina Total		-		-	-	-	250.2	-	-	-	250.2	-	-	-	250.2	-	-	-
		Traill	4328	-	200.8	-	-	-	200.8	-	-	-	200.8	-	-	-	200.8	-	-	-
			4364	-	134.0	-	-	-	134.0	-	-	-	134.0	-	-	-	134.0	-	-	-
		Traill Total		-	334.8	-	-	-	334.8	-	-	-	334.8	-	-	-	334.8	-	-	-
		Walsh	4190	-	135.6	-	-	-	135.6	-	-	-	135.6	-	-	-	135.6	-	-	-
			4282	-	129.1	-	-	-	129.1	-	-	-	129.1	-	-	-	129.1	-	-	-
			4325	-	396.5	-	-	-	396.5	-	-	-	396.5	-	-	-	396.5	-	-	-
			4335	-	130.0	-	-	-	130.0	-	-	-	130.0	-	-	-	130.0	-	-	-
			4689	-	253.1	-	-	-	253.1	-	-	-	253.1	-	-	-	253.1	-	-	-
			4736	-	284.1	-	-	-	284.1	-	-	-	284.1	-	-	-	284.1	-	-	-
		Walsh Total			1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-	1328.4	-	-	-
		Red Total			6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-	6117.6	-	-	-
	Sheyenne	Barnes	00507B	0.1	3.1	-	-	-	3.1	-	-	-	3.1	-	-	-		-	-	3.1
			1573	0.4	4.8	-	-	-	4.8	-	-	-	4.8	-	-	-	0.0	-	-	4.8
			1976	1.7	170.1	-	-	-	170.1	-	-	-	170.1	-	-	-	2.7	-	-	167.4
			1976A	6.0	95.7	-	-	-	95.7	-	-	-	95.7	-	-	-	0.0	-	-	95.6
			2198	-	7.0	-	-	-	7.0	-	-	-	7.0	-	-	-	-	-	-	7.0
			240	-	9.9	-	-	-	9.9	-	-	-	9.9	-	-	-	-	-	-	9.9
			592	5.5	56.5	-	-	-	56.5	-	-	-	56.5	-	-	-	0.0	-	-	56.5
			629	4.0	39.3	-	-	-	39.3	-	-	-	39.3	-	-	-	0.1	-	-	39.2
			653A	0.0	13.1	-	-	-	13.1	-	-	-	13.1	-	-	-	-	-	-	13.1
		Barnes Total		17.7	399.5	-	-	-	399.5	-	-	-	399.5	-	-	-	2.9	-	-	396.7
		Cass	1089	0.3	21.9		-	-	21.9	-	-	-	21.9	-	-	-	-	21.9	-	-
			2358		6.9		-	-	6.9	-	-	-	6.9	-	-	-	-	6.9	-	-
			3779	1.4	22.5		-	-	22.5	-	-	-	22.5	-	-	-	-	22.5	-	-
			4189	6.6	29.4		-	-	29.4	-	-	-	29.4	-	-	-	-	29.4	-	-
			4210	0.4	21.9		-	-	21.9	-	-	-	21.9	-	-	-	-	21.9	-	-
			5115	0.5	20.0		-	-	20.0	-	-	-	20.0	-	-	-	-	20.0	-	-
			515	0.1	3.5		-	-	3.5	-	-	-	3.5	-	-	-	-	3.5	-	-
		Cass Total		9.4	126.2		-	-	126.2	-	-	-	126.2	-	-	-		126.2	-	-
		Eddy	2206	0.0	75.2	-		-	75.2	-	-	-	75.2		-	-	6.1			
		Eddy Total		0.0	75.2	-		-	75.2	-	-	-	75.2		-	-	6.1	-	-	-
		Nelson	1889	0.1	31.0		-	-	31.0	-	-	-	31.0		-	-	23.7	-	-	7.2
			4999	45.7	129.3		-	-	129.3	-	-	-	129.3		-	-	32.6	-	51.8	44.9

Table B3-4, Continued.

State	River	County	Permit Number	Non-Irrigible or No Group -Acres-	Acreage Breakdown by Hazard Category (percentage of time SAR Maxima were exceeded during the project period, May 1, 2005 - September 30, 2050).															
					Base Conditions				300 cfs Constrained Alternative				480 cfs Constrained Alternative				No Action, Natural Spill Alternative			
					None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High	None/Slight	Low	Moderate	High
					0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50	0-5	>5-25	>25-50	>50
		Nelson Total		45.8	160.3				160.3	-	-	-	160.3			-	56.4	-	51.8	52.1
		Ransom	1227	-	49.0	-	-	-	49.0	-	-	-	49.0	-	-	-	0.2	-	48.7	-
			1241	-	338.6	-	-	-	338.6	-	-	-	338.6	-	-	-	191.6	-	147.0	-
			2011	-	138.2	-	-	-	138.2	-	-	-	138.2	-	-	-	3.0	-	135.1	-
			2296	-	76.7	-	-	-	76.7	-	-	-	76.7	-	-	-	0.8	-	75.9	-
			2411	0.5	366.0	-	-	-	366.0	-	-	-	366.0	-	-	-	236.9	-	129.1	-
			2424C	0.4	93.0	-	-	-	93.0	-	-	-	93.0	-	-	-	45.5	-	47.4	-
			2710	10.4	539.9	-	-	-	539.9	-	-	-	539.9	-	-	-	44.5	-	495.5	-
			3605	-	304.5	-	-	-	304.5	-	-	-	304.5	-	-	-	298.4	-	6.1	-
			3606	-	140.7	-	-	-	140.7	-	-	-	140.7	-	-	-	39.6	-	101.0	-
			3614	-	129.2	-	-	-	129.2	-	-	-	129.2	-	-	-	30.7	-	98.5	-
			3715	-	90.1	-	-	-	90.1	-	-	-	90.1	-	-	-	0.6	-	89.6	-
			3756	-	59.4	-	-	-	59.4	-	-	-	59.4	-	-	-	50.3	-	9.1	-
			397	-	1.0	-	-	-	1.0	-	-	-	1.0	-	-	-	-	-	1.0	-
			4650	-	41.3	-	-	-	41.3	-	-	-	41.3	-	-	-	39.5	-	1.8	-
			4747	-	115.4	-	-	-	115.4	-	-	-	115.4	-	-	-	50.5	-	64.8	-
			4780	-	105.3	-	-	-	105.3	-	-	-	105.3	-	-	-	43.4	-	62.0	-
			641	-	1.6	-	-	-	1.6	-	-	-	1.6	-	-	-	-	-	1.6	-
			698	-	200.4	-	-	-	200.4	-	-	-	200.4	-	-	-	45.5	-	154.9	-
			757	-	143.4	-	-	-	143.4	-	-	-	143.4	-	-	-	4.3	-	139.0	-
		Ransom Total		11.3	2933.7	-	-	-	2933.7	-	-	-	2933.7	-	-	-	1125.5	-	1808.2	-
	Sheyenne Total			84.1	3694.9	-	-	-	3694.9	-	-	-	3694.9	-	-	-	1184.7	126.2	1860.1	448.8
ND Total				233.2	9812.5	-	-	-	9812.5	-	-	-	9812.5	-	-	-	7302.3	126.2	1860.1	448.8