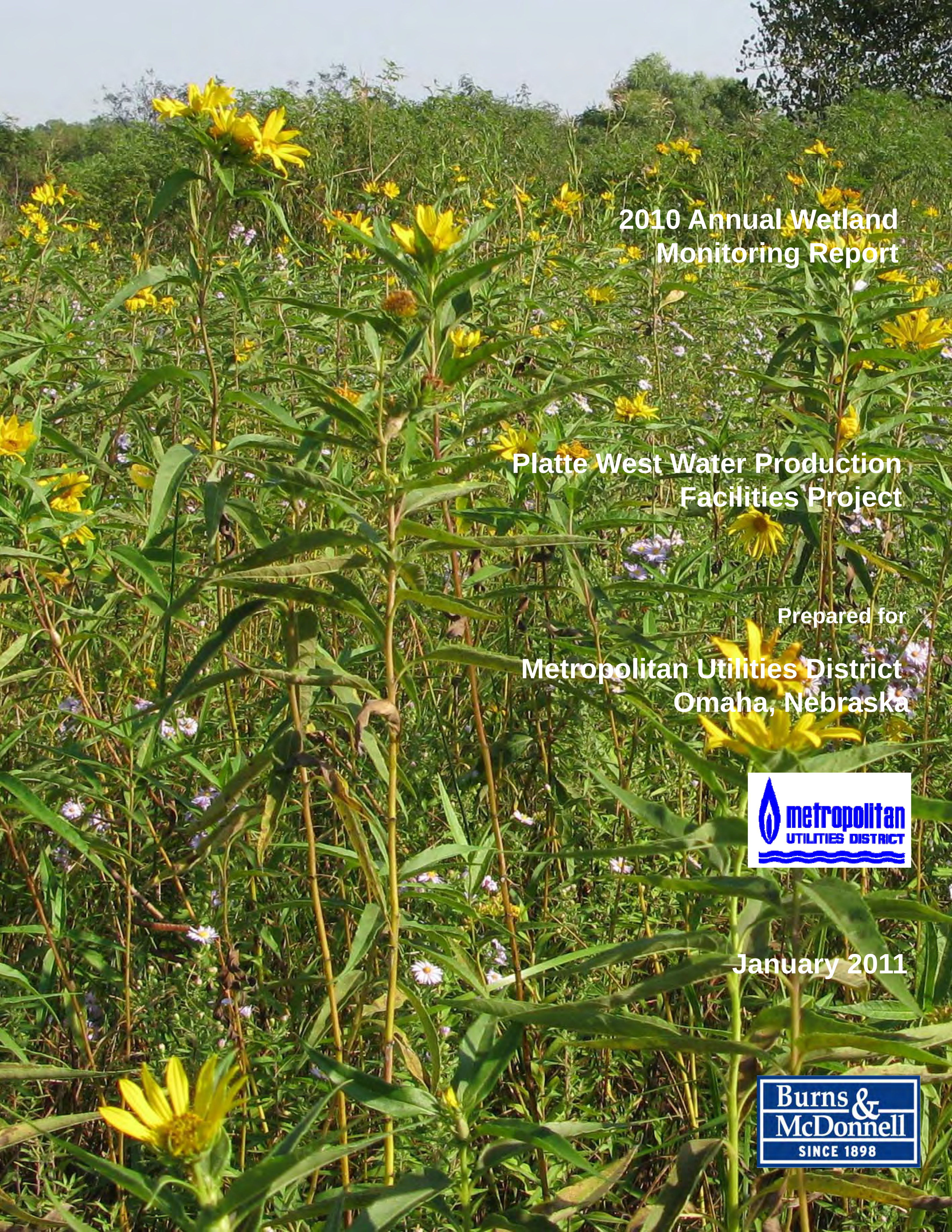

2010 Annual Wetland Monitoring Report

Platte West Water Production Facilities Project

Prepared for

Metropolitan Utilities District
Omaha, Nebraska

metropolitan UTILITIES DISTRICT

January 2011

Burns & McDonnell SINCE 1898

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for the

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Prepared for:
Metropolitan Utilities District
Omaha, Nebraska

Prepared by:
Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

Project Number: 56799

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TABLE OF CONTENTS

Page

APPENDICES

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

The Metropolitan Utilities District (District), Omaha, Nebraska, received a Section 404 Individual Permit (Permit) on May 16, 2003 from the U.S. Army Corps of Engineers, Omaha District (Corps), for the Platte West Water Production Facilities Project (Project) (U.S. Army Corps of Engineers 2003). As part of the terms and conditions included in the Corps Section 404 Permit, the wetlands located in the well fields and projected cones of depression must be monitored to determine the extent of any impacts to wetlands that may take place as a result of Project operation. To comply with this condition, a Wetland Monitoring Plan was approved in 2005 and is now being implemented (Burns & McDonnell 2005a).

As stated in Permit Condition 37: “The purpose of the monitoring is to identify any changes in the existing or future wetlands or aquatic sites impacted as a result of project development and operation.” Both temporary and permanent impacts to wetlands are expected to result from the construction and operation of the Project, which is located in Douglas and Saunders Counties, Nebraska. The 2005 Wetland Monitoring Plan presents a systematic, multi-tiered approach to monitor wetlands within the Douglas County and Saunders County well fields and their associated cones of depression to evaluate any impact due to the operation of the Project.

Wetlands selected for monitoring were chosen from those identified during the delineations conducted in the well fields (Burns & McDonnell 2004) and in the cones of depression (Burns & McDonnell 2005b). Monitoring of wetlands, in accordance with the Wetland Monitoring Plan, was initiated in June 2005. Annual monitoring reports, characterizing each year’s monitoring effort (2005 through 2007) and culminating in the *Baseline Wetland Monitoring Report*, were submitted for each year of baseline monitoring (Burns & McDonnell 2006a, 2007a, 2008, 2009). Monitoring through spring of 2008 was conducted to characterize the baseline conditions of the wetlands prior to initiation of Project activities. The Project began producing water for municipal use during the summer of 2008; therefore, the monitoring efforts starting in fall 2008 are considered post-operational.

This report summarizes the 2010 monitoring efforts and provides some comparisons to the pre- and post-operation conditions.

2.0 SAMPLING METHODOLOGY

The goal of monitoring wetlands within the Douglas County and Saunders County well fields and associated cones of depression is to evaluate the impact that operation of the Project may have on the existing wetlands. To accomplish this goal, a wetland monitoring approach consisting of a systematic, multi-tiered vegetation sampling procedure has been developed, approved, and implemented. In developing this vegetation sampling procedure, numerous literature sources and references were reviewed. Several discussions with personnel from the Corps and the District occurred during the preparation of this plan and the synthesis of the approach. Key references and sources used included:

- 1987 Corps and 1989 Federal wetland delineation manuals (Environmental Laboratory 1987 and Federal Interagency Committee for Wetland Delineation 1989)
- performance standards for wetland creation and restoration (Streever 1999 and Environmental Law Institute 2004)
- vegetation sampling and analysis methodologies (U.S. Environmental Protection Agency 2002 and Tiner 1999)
- wetland mitigation guidelines (Taylor and Krueger 1997)

Wetland monitoring, as stated above and described in the following paragraphs, began during Project construction in 2005, prior to initiation of Project operation. Monitoring will continue until the Corps determines that any impacts to wetlands as a result of Project operation are either completely mitigated for or are not likely to occur. If the results of the monitoring program indicate that no wetland impacts are occurring, long-term monitoring can either be decreased or stopped. If the results of the monitoring indicate that wetlands in excess of those identified in the Section 404 Permit are being affected by Project operation, discussions with the Corps will be initiated to determine what additional mitigation may be required.

2.1 WETLAND MONITORING IN THE WELL FIELDS

The types of data that were collected, the methods used, and the analyses completed during the wetland monitoring process in the well fields are described in the paragraphs that follow.

2.1.1 Vegetation Sampling

Vegetation was sampled in selected wetlands in the two well fields to characterize the major wetland and adjacent upland plant communities and the variation between them. Wetlands where vegetative change will most likely be detected first were selected for vegetation sampling; these wetlands are referred to as "primary" wetlands. Vegetation sampling in these primary wetlands will occur twice each year, in mid-June and in late September.

If Project operation-induced impacts to wetland vegetation are observed and documented in any of the primary wetlands, the monitoring of nearby secondary wetlands will be initiated. The monitoring of the secondary wetlands, in addition to the primary wetlands, will help determine if the observed impact is localized and confined to the primary wetland, or is spreading to the adjacent or surrounding wetlands. The primary and secondary wetlands that are being or will be monitored in the Douglas County and Saunders County well fields are shown in Figures 2-1 and 2-2. The wetlands in the Saunders County well field will be initially monitored more extensively than wetlands in the Douglas County well field due to the presence of the 95-acre Wet Meadow in Saunders County. However, the proposed monitoring plan is flexible and can be adjusted to meet specific identified needs for monitoring if they develop.

Vegetation sampling methods to be used vary depending on the type of wetland vegetation being sampled. These differences in methodologies are described in the following sections.

2.1.1.1 Palustrine Emergent Wetlands

The vegetation in a palustrine emergent (PEM) wetland is normally comprised of herbaceous plant species. However, seedlings of woody plants less than one meter tall may also be included in the PEM wetland vegetation. Herbaceous plant species were sampled using gradient-oriented transects, or "gradsects". A gradsect is defined as a transect that is placed perpendicular to the baseline transect along the ecotone gradient. The ecotone is the distinct area where one plant community changes or intergrades into another separate, distinct plant community. Sampling units are located in the center of each vegetation community and at each ecotone. The sampling unit consists of five, 3-foot-diameter circular sample plots placed along the gradsect. Three baseline transects with between two and seven gradsects have been placed in each PEM wetland.

Vegetation and wetland monitoring in the PEM wetlands began in 2005. During the first sampling period in June 2005, each permanent transect, gradsect, and sample plot was located and recorded using a global positioning system (GPS; Trimble® Pro XRS sub-meter GPS unit). The beginning and end of each transect and gradsect were permanently marked in each wetland using 2-foot sections of 3/8-inch re-bar, painted orange and flagged. These permanent markers also serve as photograph stations. A photographic record is being maintained for each sampling period at each gradsect and transect. This photographic record will provide a repetitive visual record of the wetland vegetation monitoring during seasons and over years.

Vegetation and plant species data that were collected during the annual PEM wetland vegetation monitoring effort include the identification, to species when possible, of each plant located within the 3-foot diameter sample plot. The percent cover for each plant species occurring in a sample plot was estimated using a modified Daubenmire cover-class method. In this methodology, percent canopy cover is visually estimated for each plant species either rooted within or extending into each 3-foot diameter plot. The plant species is placed into one of a series of cover classes using the estimated percent canopy cover. These classes are based on the mid-point of canopy coverage per the modified Daubenmire canopy cover method shown in Table 2-1 (Daubenmire 1959; Bailey and Poulton 1968).

Table 2-1 Modified Daubenmire Cover Class Scale

Cover Class	1	2	3	4	5	6	7
Range (%)	0-1	1-5	5-25	25-50	50-75	75-95	95-100
Midpoint (%)	0.5	3.0	15.0	37.5	62.5	85.0	97.5

A cover class was also estimated for the non-vegetated area in the 3-foot diameter plot because sample plots are often not completely vegetated. Non-vegetated areas can include bare soil, rocky surface, open water, or litter. Quantifying the bare area provides an indication of the potential for additional vegetation in the sample plot. Even with bare area in a plot, the total cover of vegetation may be greater than 100 percent, because plants often overlap in a plot.

If standing water is present within the sample plot, the water depth (in inches) at the center of each plot will be recorded. The percentage of the plot that is inundated will also be estimated and assigned a cover class value that is recorded on the data entry forms.

2.1.1.2 Palustrine Scrub-Shrub Wetlands

The vegetation of a palustrine scrub-shrub (PSS) wetland is characteristically made up of herbaceous plant species, seedlings of woody plants less than one meter tall, and shrubs. For this monitoring effort, shrubs have been defined as woody plants with stems less than three inches in diameter at breast height (dbh). Due to the addition of a shrub layer, the methodology selected for sampling a PSS wetland is different than what was described above in Section 2.1.1.1 for use in an herbaceous PEM wetland. A series of nested plots were used to estimate the aerial coverage of the scrub-shrub vegetation normally found in PSS wetlands. Three, 15-foot diameter macroplots were evenly spaced within each wetland to monitor the PSS wetlands. Three, 3-foot diameter sample plots were placed in each macroplot to sample the herbaceous vegetation. These sample plots were placed at locations representative of the PSS macroplot as a whole.

The 15-foot diameter macroplot is used to measure the canopy diameter of each individual shrub in the shrub layer of a PSS wetland. Total canopy cover for each species of shrub in the plot is obtained by measuring the canopy cover diameter of each individual plant that is located within the sample plot (Tiner 1999). As shown in Table 2-2, each individual shrub is placed in a canopy diameter class which in turn provides the conversion to an estimated percent cover for the shrub in the macroplot. The percent covers of each individual shrub in the 15-foot diameter sample plot were combined together as a whole and by species to calculate the total percent cover of the shrub layer in the sample plot.

Table 2-2 Estimating Cover Based on Canopy Diameter Within a 15- and 30-foot Diameter Macroplot (modified from Tiner 1999)

Canopy Diameter (Feet)	3-5	6-10	11-15	16-20	21-25	26-30
Approximate Cover for 30-ft Diameter Macroplot	2%	7%	19%	36%	59%	87%
Approximate Cover for 15-ft Diameter Macroplot	8%	25%	73%			

Herbaceous vegetation in the PSS wetland was sampled using three, 3-foot diameter circular plots. These sample plots were placed at locations representative of each 15-foot diameter macroplot as a whole according to methodology described by Tiner (1999). Percent cover for herbaceous species were estimated using the modified Daubenmire cover-class method as described above (Section 2.1.1.1).

Vegetation monitoring in the PSS wetland began in 2005. Only one PSS wetland (W-55) is being monitored in the well fields; this PSS wetland is located in Douglas County. There was only one PSS wetland and one PSS/PEM wetland identified in the Saunders County well field. Upon revisiting the PSS wetland in the field for monitoring, it became quickly apparent that the PSS wetland was actually a PFO wetland according to the monitoring criteria. The PSS/PEM wetland in Saunders County was too small to allow for adequate sampling. Therefore, no PSS wetland is being monitored in the Saunders County well field.

In June 2005, three macroplots with three sample plots each were placed in the PSS wetland in Douglas County and recorded using GPS. The center point of each macroplot was permanently marked using a 6-foot section of 3/8-inch re-bar, painted orange and flagged; the center point of each sample plot was similarly marked using 2-foot sections of re-bar. As described for PEM wetlands, a record is being maintained for each sampling period that photographically documents the condition of the PSS wetland vegetation at each sampling period. Photographs were taken from the southern edge of each macroplot looking north. This photographic record will provide a repetitive visual record of the PSS wetland vegetation monitoring during seasons and over years.

2.1.1.3 Palustrine Forested Wetlands

The vegetation of a palustrine forested (PFO) wetland is composed of herbaceous plant species, shrubs, and trees. For the purposes of this monitoring effort, trees are defined as all woody plants with stems greater than three inches dbh. The vegetation sampling for PFO wetlands is similar to the sampling methods used for the PSS wetland described in Section 2.1.1.2. Each PFO wetland was sampled using three macroplots evenly spaced within the wetland.

A 30-foot diameter macroplot was used to sample the tree layer in the PFO wetlands. A single, 15-foot diameter macroplot will be placed in the center of each 30-foot diameter macroplot to sample the shrub layer as described above for the PSS wetland. Total aerial cover for each tree and shrub species occurring in their respective macroplots was calculated based on measuring the diameter of the tree canopy located within the sample plot (Tiner 1999). Table 2-2 provides the conversion that was used to transform tree and shrub canopy diameters to an estimated percent cover in a 30- and 15-foot diameter macroplot.

Herbaceous vegetation was sampled using three, 3-foot diameter circular sample plots, as described above for PEM and PSS wetlands. These herbaceous sample plots were placed at locations representative of each 30-foot diameter PFO plot as a whole according to methodology described by Tiner (1999). Percent cover for herbaceous species was again estimated using the modified Daubenmire cover class method described above for PEM wetlands (Section 2.1.1.1).

In June 2005, three nested macroplots with three sample plots each were placed in the PFO wetlands and recorded using GPS. The center point of each nested macroplot and sample plot was permanently marked using 2-foot sections of 3/8-inch re-bar, painted orange and flagged. As described for PEM and PSS wetlands, a photographic record is being maintained for each sampling period. This photographic record will provide a repetitive visual record of the PFO wetland vegetation monitoring during seasons and over years. Photographs were taken from the southern edge of the PFO macroplot looking north.

2.1.2 False-color Infrared (CIR) Aerial Photography

False-color infrared (CIR) aerial photography was initially taken in 2005 and was obtained annually through 2009. The CIR photographic coverage typically includes both well fields and the associated cones of depression in Douglas and Saunders Counties. The annual CIR aerial photography is used to monitor the overall size, shape and condition of the wetlands and different types of vegetation occurring in the well fields over time. In accordance with the reduced monitoring intensity level, as described in Section 4.0 Thresholds, new CIR aerial photography was not obtained in 2010. CIR aerial photography will again be obtained in 2011.

2.2 WETLAND MONITORING IN THE CONES OF DEPRESSION

The Douglas County and Saunders County well fields are owned in fee title by the District. As a result, access to the well fields for vegetation and groundwater monitoring is available at all times. The land surrounding or adjacent to the well fields is projected to potentially experience some groundwater drawdown during Project operation. Groundwater modeling is conducted annually to incorporate data collected from the monitoring and production wells (HDR 2011). The groundwater model is able to predict the area of land surrounding the well fields that is expected to experience a 1-foot drawdown of local groundwater during project operation. These areas are designated as “cones of depression” and are larger than the well fields. The 2010 projected cones of depression are included in Figures 2-3 and 2-4.

The land outside the well fields but within the cones of depression is not owned by the District. As such, seasonal and annual access to that portion of the cones of depression for consistent wetland monitoring cannot be assured. Therefore, the monitoring methodology for the wetlands within the cones of depression but outside of the District-owned well fields is based on the interpretation and comparison of the annual CIR aerial photography. The CIR aerial photography for the cones of depression will be obtained per the methods described in Section 2.1.2 above for the wetland monitoring in the well fields.

A total of eight wetlands in the cones of depression have been selected from those that were delineated (Burns & McDonnell 2005b; Figures 2-3 and 2-4). Six of these eight wetlands are emergent wetlands (W-9, W-514, and W-519 in Douglas County and W-306, W-321, and W-700 in Saunders County), one is a PFO/PEM wetland complex (W-5 in Douglas County), and one is a PFO wetland (W-8 in Douglas County). More emergent wetlands are being monitored than other types of wetlands due to the fact that more emergent wetlands were delineated in the cones of depression than any other type of wetland.

2.3 HYDROLOGICAL MONITORING

Several different types of hydrological data are being collected and analyzed. This hydrological data is being used to document the effect the existing water table has on wetlands in the two well fields and the potential effect Project operation may have.

2.3.1 Groundwater Monitoring Wells

Permanent monitoring wells designed to measure groundwater levels before and during Project operation have been installed at specific locations in and around the Douglas County and Saunders County well fields and cones of depression (Figures 2-1 through 2-4). The location of these groundwater monitoring wells was recorded using GPS. Data loggers have been installed at the monitoring wells so that groundwater levels can be measured and recorded on a daily basis. Groundwater data from the monitoring wells will be correlated with the other hydrological data that is being collected to evaluate if any Project-induced groundwater system changes are occurring.

2.3.2 Production Wells

The Project production wells that will be pumped to provide raw water to the new water treatment facility during Project operation are located in the Douglas County and Saunders County well fields (Figures 2-1 and 2-2). These water production wells have also been fitted with data loggers that measure and record the depth to the water table at each well head whether or not the well is actively being pumped. In addition, the rate at which each well is being pumped is measured in millions of gallons per day (MGD). The location of these water production wells was recorded using GPS. Groundwater data from the water production wells (production rate, drawdown, cone of depression, etc.) during Project operation will be correlated with the other hydrological data that is being collected to evaluate if Project-induced changes to wetlands are occurring.

2.3.3 Piezometers

A total of 18 piezometers have been installed in five wetlands in the Saunders County well field (Figure 2-2). Twelve piezometers were installed in three existing wetlands (four piezometers per wetland) being monitored as part of the Wetland Monitoring Plan (Burns & McDonnell 2005a). Four piezometers were installed in the Phase I Mitigation Site located adjacent to the Wet Meadow and described in the Phase I Wetland Mitigation Plan (Burns & McDonnell 2005d). The remaining two piezometers were installed in the Phase II Wet Meadow Mitigation Site (Burns & McDonnell 2007c). In July 2010, eight of the existing piezometers were replaced by installing a new piezometer adjacent to the old ones. The replacement of some piezometers was necessary due to the undermining of existing piezometers due to frost heave, erosion, or animal activity. A modified installation approach was implemented during the replacement of the eight piezometers. Additional re-bar was driven into the ground at divergent angles before the concrete base was poured. This additional rebar should help stabilize the piezometers against frost heave. The locations of the installed piezometers have been recorded using GPS.

In each of the five wetlands being monitored with piezometers, one of the piezometers was located near the center or low point of the individual wetland being monitored. Since subsurface groundwater flow is generally from north to south in these wetlands, one piezometer was installed at the northern edge of each wetland; the remaining two piezometers were installed along the southern edge of each wetland.

The piezometers installed in two existing wetlands in the Wet Meadow (W-5 and W-25) and the created Phase I Wet Meadow Mitigation Site wetland adjacent to the Wet Meadow are designed to monitor the shallow, perched water table between the soil surface and the clay layer before and after Project operation begins. Piezometers were also installed in a PEM wetland (W-100) in the southern portion of the Saunders County well field that is outside of the Wet Meadow boundary (and also outside of the perched water table located above the shallow clay layer) to monitor the shallow groundwater prior to and during Project operation. All piezometers are being monitored on an approximately monthly basis during the growing season to assess the seasonal and annual fluctuation in the shallow water table, and the variation between years. For additional information on the installation and monitoring of the piezometers, please refer to Burns & McDonnell's Wetland Monitoring Plan (2005a).

2.3.4 Bathymetric Monitoring of Ponds

Bathymetric monitoring of ponds located in the Douglas County and Saunders County well fields and associated cones of depression was initiated in 2004 (Burns & McDonnell 2005c). Using GPS and a boat-mounted sonar recorder, bathymetric maps were developed for each of the 45 ponds initially being monitored. These maps established baseline conditions by depicting each pond's water surface area and water depth contours. To help establish baseline conditions prior to initiation of Project operations, water surface elevations are being monitored four times (March, August, September, and October) each year. The pond surface water elevation data collected will provide the basis for comparing the seasonal pre-project changes with the changes that may occur with operation of the Project.

Permanent benchmarks and elevations were established near each pond above the high water mark during the early summer of 2005. The location and elevation of each permanent benchmark was established using a survey-grade GPS. Water surface elevations were measured from the established permanent benchmark using a surveyor's level. The 2005 bathymetric monitoring also included the contour mapping of a pond that was overlooked during the 2004 mapping effort (Burns & McDonnell 2006b). During the 2006 bathymetric monitoring effort, an additional pond was surveyed at the request of the landowner (Burns & McDonnell 2007b). In 2008, two ponds were added and two ponds were removed, leaving a total of 45 ponds being monitored. DG-11 was added by request of the landowner in 2009 and is being monitored by photographic documentation only at this time. Therefore, a total of 46 ponds are currently being monitored.

The seasonal variation in surface water elevation of the 46 ponds under baseline and operational conditions will be evaluated in concert with the other hydrologic data that are being collected.

The bathymetric data collected from the ponds will be used to indicate if Project operation is resulting in water level fluctuations for a specific pond or ponds and if these fluctuations are different than would normally occur under baseline conditions.

2.3.5 Other Hydrological Data

Additional hydrological data is also collected during the annual monitoring effort each year. This additional data includes monthly total precipitation, monthly average ambient air temperature, and stream gauge data for the Platte and Elkhorn Rivers.

3.0 DATA ANALYSIS

The following sections provide a brief discussion of the data analysis and the results of the 2010 annual wetland monitoring efforts in the well fields and cones of depression.

3.1 WETLAND MONITORING IN THE WELL FIELDS

The spring and fall 2010 monitoring efforts in the well fields consisted of the systematic sampling and analysis of wetland and nearby upland vegetation, the collection and comparison of various types of hydrological data, and the review and comparison of natural color aerial photography for the monitored wetlands.

3.1.1 Vegetation Data

Vegetation monitoring of the wetlands in the well fields was conducted in June and September 2010 to characterize major wetland and upland plant communities and the variation between them. These sampling efforts represent the second full year of monitoring after Project start-up and initial operation of the water treatment plant. Vegetation sampling took place in sample plots established along permanent transects and gradsects established in each wetland ecosystem as described previously. Data obtained during 2010 has been analyzed and compared to baseline data and the results are discussed below and included in Appendix I. Additionally, some comparisons of vegetation data collected each sampling period during Project operation have also been included.

All of the wetland vegetation data obtained during monitoring was input into a Microsoft Access database that has been designed specifically to accommodate seasons and years of data. The database was also designed for the rapid comparative assessment of selected vegetative characteristics within and among wetlands and wetland types in general. Current nomenclature and plant characteristics were obtained from the USDA PLANTS Database (USDA 2010). A complete list of plant species that have been identified in each of the monitored wetlands has been compiled and is included in Appendix II. The vegetative characteristics that were analyzed are described below.

In the initial data collection process in the field, the percent cover for each plant species observed in each sample plot and macroplot was estimated. As explained in the following paragraphs, these collected vegetative data were used to calculate a weighted average for each sampling unit in addition to calculating the species richness; species diversity; percent native species; percent invasive species; the percentage of perennial, biennial, and annual species; the mean coefficient of conservatism (c-value); and the Floristic Quality Index (FQI).

3.1.1.1 Change in Wetness

Species abundance and the wetland indicator status for each species can be used to calculate a measure of how wet an area is. This measure of wetness is referred to as the weighted average (Tiner 1999). For the current year's data, the average or mean weighted average (WA_M) was calculated for each wetland as a whole and for each gradsect located in the emergent wetlands. The WA_M is calculated using the following formula:

$$\text{Mean Weighted Average}(WA_M) = \frac{\sum I\,E}{\sum I}$$

where I = importance value for the species (e.g., percent cover)
E = ecological index for the species

The importance value used for this evaluation is the percent cover for the species in the sample plot. The ecological index is a value between 1 and 5 that corresponds to the wetland indicator status for the given species. An ecological index value of 1 corresponds to an obligate or wetland plant and a value of 5 corresponds to an upland plant. The calculated WA_M should be equal to or less than 3.0 in order for a specific site to be considered a wetland if hydric soils and sufficient hydrology are present. In transitional areas, a WA_M should approach 3.5, depending on landscape position, hydrology, and other related features.

When multiple years of data are available after the start of Project operation, a non-parametric statistical analysis will be used to determine if any changes in WA_M observed are statistically significant. If the WA_M for a wetland exhibits a significant change, then a recommendation for monitoring to be expanded to additional surrounding wetlands to determine the extent of the impact may be made. Adjustments to the monitoring intensity, in response to the data analysis will occur according to the guidelines outlined in Section 4.0 – Thresholds.

3.1.1.2 Change in Species Composition

Change in species composition over time will be analyzed by comparing the various vegetative indices that are being calculated each year. These indices were calculated from the collected data to assist in interpreting any changes observed in the vegetation communities. These additional calculations are explained in the following paragraphs and include:

- Species richness
- Species diversity
- Percent of native vegetation
- Percent of invasive species
- Percent of perennial/annual/biennial vegetation
- Floristic Quality Index (FQI)
- Mean c-value

Species richness is the count of the number of different species identified in a plant community. This parameter is used to help characterize the plant community being examined, and is often used in concert with species diversity indices (Greig-Smith 1983). In most cases, a higher species richness value is obtained from a better quality or more diverse plant community.

Species diversity is an index that combines species richness and equitability (the evenness of the contribution of different species to the community) in order to investigate the heterogeneity of a plant community that is more a measure of the functional or apparent number of species rather than the absolute number of species as in species richness (Greig-Smith 1983). Species diversity in this study is the number of different species in an area weighted by some measure of abundance. Here, the measure of abundance used is the number of occurrences of each species in each wetland out of the total number of plots. The formula for species diversity follows Simpson (1949) and is included below:

$$\text{Species Diversity}(D) = \frac{N(N-1)}{\sum n(n-1)}$$

where $N = \text{total number of occurences for all species in all plots}$

$n = \text{number of occurences for each individual species}$

Simpson's Reciprocal Index (1/D) is calculated and included in the data analysis. In general, diversity increases with increasing heterogeneity; so, the higher the diversity value, the more diverse the plant community.

Assessing the abundance of native and invasive species provides an indication of the quality of the plant community and, when used long-term, provides an indication of whether there is a shift in quality over time. For this study, the percent of native vegetation is the percent of plant species out of the total species occurring in the wetland that are considered to be native to the United

States. The percent of invasive vegetation is the percent of plant species out of the total species occurring in the wetland that are considered to be invasive in the United States or have the potential to dominate a community to the exclusion of more desirable species. Invasive species can be both native and non-native plants.

Additionally, the percentages of the total plant species that are annual, biennial, and perennial are also indicated. This parameter shows the contribution of the different types of plants, and provides, in part, an indication of the diversity of the plant community in question.

A Floristic Quality Analysis (FQA) will also be conducted on the vegetation data. The FQA is typically conducted on vegetation data collected during a pedestrian survey of the whole site. However, because the sampling of these wetlands is so extensive, the FQA calculations will be based on data collected from the sample plots rather than a separate survey. The mean c-value and FQI are calculated using c-values that were assigned for the Nebraska region by Rolfsmeier and Steinauer (2003). The c-value is a number between 0 and 10 that is assigned to each plant species in a region. The c-value assigned is an indication of whether the plant is native to the area and how tolerant to disturbances the species is. For example, a native plant that is found only in intact natural communities would be assigned a value of 10, while an invasive or non-native species commonly found on roadsides, for example, would be assigned a value of 0. The mean c-value is the average of the c-values from the plant species identified in the site.

While the mean c-value provides a measure of the botanical quality of a site that can be compared from year to year, it does not take into account the size of the site or the quality of the surrounding area. Therefore, the FQI is calculated to combine the mean c-value with the total number of species identified in the site. The FQI is calculated using the following formula:

$$\text{Floristic Quality Index (FQI)} = \bar{c}\sqrt{n}$$

where $\bar{c} = \textit{mean}\ \text{coefficient of conservatism}$

$n = \text{number of native species}$

With this calculation, higher FQI numbers correspond to more natural sites that have a higher diversity. Lower FQI values imply a more disturbed or lower quality site.

3.1.1.3 Statistical Analysis

The 2010 Annual Wetland Monitoring Report is the first annual report that includes statistical analysis of the vegetation data. Upon the completion of the 2010 monitoring efforts, a sufficient number of sampling efforts have taken place since operation began to allow for an evaluation of the vegetative characteristics using statistical analysis. To determine whether any observed changes in the vegetative indices that are calculated each year are significant, a statistical analysis is conducted to compare the baseline data, which captured some of the natural variation in the wetlands, to the operational data to determine if project operation is having any significant effect on the wetlands.

Through discussions with the District, Corps, and Burns & McDonnell, the Repeated Measures ANOVA was selected as the statistical test appropriate for this analysis. The statistical add-on package to Microsoft Excel that was utilized for this analysis is the EZAnalyze program (www.ezanalyze.com). The Repeated Measures ANOVA is able to compare multiple sampling seasons of data against the baseline average for a given vegetative index. A post-hoc analysis is also included when a significant difference is detected to determine which sampling efforts were significantly different. A Bonferroni correction is then applied to the p-values to decrease the error that may occur when comparing multiple data sets amongst each other. The final P-Bonferroni values are reviewed to determine if any of the sampling efforts are significantly different from the baseline average value. This indication of significance is the analysis used when triggering thresholds for monitoring intensity or identifying possible impacts to the wetland due to project operation.

The Repeated Measures ANOVA test is conducted on each of the vegetative indices that are calculated for each sampling effort: WA_M, FQI, c-Value, Species Richness, and Species Diversity.

3.1.2 False-color Infrared (CIR) Aerial Photography

The CIR aerial photography was not obtained in 2010. CIR aerial photography will be obtained again and analyzed in the 2011 monitoring report.

3.2 WETLAND MONITORING IN THE CONES OF DEPRESSION

In accordance with the reduced monitoring intensity level, as described in Section 4.0 Thresholds, new CIR aerial photography was not obtained in 2010. CIR aerial photography will again be obtained in 2011. Therefore, wetland monitoring of the wetlands in the cones of depression based on CIR aerial photography did not occur in 2010. Monitoring of these wetlands will occur again according to the monitoring requirements as described in Section 4.0 Thresholds.

3.3 HYDROLOGICAL MONITORING

Several different types of hydrological data were collected during the 2010 monitoring efforts. These collected data have been analyzed and the results are discussed below and included in Appendix III.

3.3.1 Groundwater Monitoring Wells

Permanent monitoring wells designed to measure groundwater levels before and during Project operation have been monitored using the installed data loggers. A total of 23 monitoring wells were monitored during 2010. Water level readings were measured and recorded on a daily basis using an electronic datalogger. The collected data in 2010 have been graphed over time and are presented for each monitoring well in Section A of Appendix III. Readings from these monitoring wells will be analyzed and summarized in the future to provide corroborating evidence should any changes be detected in the wetland vegetation data.

3.3.2 Production Wells

The Project production wells that are pumped to provide raw water to the new water treatment facility during Project operation are monitored using installed data loggers. The data collected from the production wells will be evaluated and analyzed to possibly provide corroborating evidence should any changes be detected in the other monitoring data.

3.3.3 Piezometers

Sixteen piezometers were installed in four wetlands in the Saunders County well field in 2005. Twelve of the piezometers were installed in May and the remaining four piezometers (located in the Phase I Wet Meadow Mitigation Site, WM-1, adjacent to the Wet Meadow) were installed in late October. In May of 2009, two additional piezometers were installed in the Phase I Wet Meadow Expansion Mitigation Site, WM-2. As described in Section 2.3.3, eight of the piezometers were reinstalled adjacent to their original position in July of 2010. The collected data from the 2010 monitoring efforts have been graphed over time and are presented in Section B, Appendix III.

The piezometers installed in PEM W-25 (PZ-01 through PZ-04), PFO W-5 (PZ-05 through PZ-08), PEM WM-1 (PZ-13 through PZ-16), and PEM WM-2 (PZ-17 and PZ-18) are all located above the shallow clay layer associated with the Wet Meadow (Figures 1, 3, and 4; Section B, Appendix III). Piezometers installed in PEM W-100 (PZ-09 through PZ-12) are outside of both the Wet Meadow boundary and the perched water table located above the shallow clay layer (Figure 2, Section B, Appendix III). These readings will be used in the future to provide corroborating hydrological evidence should any changes be detected in the wetland vegetation data.

3.3.4 Bathymetric Monitoring of Ponds

The post-operation bathymetric monitoring of ponds located in the Douglas County and Saunders County well fields and associated cones of depression was completed during 2010 as planned. The data collected from these monitoring efforts is presented in a separate report entitled the *2010 Annual Bathymetric Monitoring Report for the Ponds within the Well Fields and Cones of Depression* (Burns & McDonnell 2011). Pond monitoring is being conducted to evaluate any deviation in a given pond's seasonal water surface elevation that may occur due to Project operation. The data presented in the bathymetric monitoring report will be used in the future to provide corroborating hydrological evidence should any changes be detected in the wetland vegetation data.

3.3.5 Other Hydrological Data

Additional hydrological data collected during the 2010 monitoring efforts included monthly total precipitation, monthly average ambient air temperature, and stream gauge data. The monthly total precipitation and monthly average ambient air temperature were both obtained from the weather station at Fremont Municipal Airport in Fremont, Nebraska. The 2010 precipitation and temperature data and the historical average monthly precipitation and temperature have been graphed over time; the graphs are included in Figures 1 and 2 (Section C, Appendix III).

Stream gauge data was obtained from the USGS stream gauge stations on the Platte and Elkhorn rivers. Platte River data was obtained from the recently installed stream gauge near Venice, Nebraska (USGS Stream Gauge No. 06796550). The installation of this stream gauge took place at the request of and through funding by the District. Data collected from this stream gauge is represented in Figure 3 (Section C, Appendix III). The Elkhorn River data was obtained from the stream gauge near Waterloo, Nebraska (USGS Stream Gauge No. 06800500). Data collected from this stream gauge is represented in Figure 4 (Section C, Appendix III).

4.0 THRESHOLDS

According to the Section 404 Permit conditions, the monitoring of wetlands in the well fields and cones of depression will take place during Project operation. To determine whether an impact is taking place at a given wetland, thresholds have been established in accordance with the baseline data that was collected. As thresholds are met, or after several sampling efforts where the thresholds are not met, the intensity of monitoring may be increased or decreased. The wetland monitoring intensity levels and the process for determining whether a wetland has met the thresholds used to identify potential changes in the wetlands is described below. A wetland-specific thresholds analysis for each of the wetlands monitored in 2010 is also included.

4.1 LEVELS OF WETLAND MONITORING INTENSITY

A Wetland Monitoring Plan was developed and implemented in 2005 (Burns & McDonnell 2005a). This Monitoring Plan describes in detail the standard annual monitoring approach. During the years of baseline monitoring and the first several seasons of operational monitoring, the standard approach was considered an appropriate protocol. However, as monitoring continued, it became apparent that it may be beneficial to adjust the amount of data being collected based on whether impacts were being observed or not. If impacts have been documented ("yellow flags"), the intensity of monitoring increases. If no impacts have been documented ("green flags"), then the intensity of monitoring decreases. To clarify this approach, Figure 4-1 was developed to outline the different levels of wetland monitoring that are available, beyond the standard annual monitoring approach described in the 2005 Wetland Monitoring Plan. Each of the five levels of monitoring is described in detail in Figure 4-1.

4.2 METHOD FOR DETERMINING WETLAND IMPACTS

A series of evaluations and comparisons to the baseline data will be conducted after each sampling effort during Project operation to determine whether wetland impacts are occurring. The process for these evaluations is outlined in a flowchart included in Figure 4-2. A "green flag" on the chart indicated that no thresholds have been triggered that would indicate an impact to wetlands due to Project operation. A "yellow flag" on the chart indicates that a change or an anomaly has been detected in either a vegetative index, the aerial photography, or in the hydrological monitoring. This possible anomaly may be due to an effect of Project operation on the wetland or it may be due to one of many naturally-occurring environmental or climatic factors. A “red flag” indicates that a threshold has been triggered that may indicate an impact to wetlands due to Project operation.

5.0 RESULTS

The following sections provide the results of the data analysis for each of the wetlands sampled during the 2010 monitoring efforts. The complete set of data (figures, summary tables, ground photographs, and raw data sheets) for each monitored wetland in the well fields is available in Appendix I.

The various vegetative indices, aerial photography, and other supporting hydrological data that are collected annually have been analyzed above to compare 2010 data to baseline averages. To determine whether any differences from baseline averages are significant, further analysis is required to identify if an observed change to a wetland has taken place and if it would be indicative of a Project-induced impact. A discussion of the threshold analysis that was conducted for each wetland is included below.

Table 5-1 Summary of 2010 Wetland Vegetation Data Analysis

Wetland ID	Mean Weighted Average (WA_M)		Species Richness		Species Diversity		FQI		Mean C Value	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
W-68	2.42	2.59	59	53	24.89	20.35	27.36	24.28	3.72	3.40
W-25	2.30	2.59	53	54	30.06	26.12	21.27	17.50	3.10	2.64
W-100	2.07	2.81	44	27	20.63	13.98	17.82	11.82	2.97	2.41

5.1 PEM WETLAND 68 – DOUGLAS COUNTY

Wetland 68 is a PEM wetland located in Douglas County, Nebraska (Figure 1, Section A-1, Appendix I). The vegetation in this wetland was sampled using 3 transects, 12 gradsects, and 60 sample plots. Dominant species observed in this wetland during the 2010 monitoring efforts included prairie cordgrass (*Spartina pectinata*), sedge (*Carex* sp.), Kentucky bluegrass (*Poa pratensis*), redtop (*Agrostis gigantea*), and field horsetail (*Equisetum arvense*). Wetland 68 (excluding the upland gradsects) had a WA_M of 2.42 in the spring of 2010, and 2.59 in the fall of 2010 (Table 5-2), indicating that it continues to be dominated by wetland vegetation. The baseline threshold mean weighted average for W-68 is 2.78. The WA_M for spring and fall 2010 remained below the baseline threshold as illustrated in Figure 2 in Section A-1 in Appendix I. This wetland contained an average of 94 percent native species and 31 percent invasive species in 2010. The average FQI for this wetland during the same time period was 24.59, implying a relatively high ecological value. Tables 1, 2, and 3 in Section A-2 of Appendix I contain a summary of the monitoring data, the WA_M by gradsect for W-68, and the complete species list from the 2010 monitoring efforts.

Table 5-2 Wetland 68 Comparison of 2010 Vegetation Data to Baseline Averages

	Spring 2010	Fall 2010	Baseline Mean	Baseline Low	Baseline High
Mean Weighted Average	2.42	2.59	2.55	2.33	2.78
Species Richness	59	53	56.14	46.00	70.00
Species Diversity	24.89	20.35	20.43	16.63	24.29
Mean C Value	3.72	3.40	3.58	3.22	3.83
FQI	27.36	24.28	24.62	22.50	28.89

The WA_M for the 2010 sampling seasons did not increase by 0.5 or more from the baseline WA_M of 2.55 as shown above in Table 5-2 and in Figure 2 in Appendix I, Section A-1. The calculated values for FQI, mean c-value, species diversity, and species richness remain very close to the mean baseline values (Table 5-2). The statistical analysis, using the repeated measures ANOVA, indicated two statistically significant changes from baseline averages in 2010. The species diversity and species richness in June 2010 were significantly higher than the baseline average. That means that more species are present in W-68. This could indicate colonization by transition species; therefore, this wetland and these data will be closely monitored in June 2011. However, as June 2010 was also a significantly wetter season than baseline averages; it may be that more wetland species were present. Aerial photography for W-68 shows no significant visible change from baseline photography (Appendix I, Section A-1). The data gathered during the post-operational monitoring efforts did not trigger a yellow or red flag as outlined in Figure 4-2 or illustrated in Table 5-3. It is recommended that monitoring at W-68 continue consistent with the current methodology for the next monitoring effort.

5.2 PEM WETLAND 25 – SAUNDERS COUNTY

Wetland 25 is a PEM wetland located in Saunders County, Nebraska (Figure 1, Section B-1, Appendix I). The vegetation in this wetland was sampled using 3 transects, 15 gradsects, and 75 sample plots. Dominant species observed in this wetland during the 2010 monitoring efforts included fox sedge (*Carex vulpinoidea*), reed canarygrass (*Phalaris arundinacea*), sawtooth sunflower (*Helianthus grosseserratus*), and sedge. Wetland 25 (excluding the upland gradsects) had a WA_M of 2.30 in the spring of 2010 and 2.59 in the fall of

Table 5-3 Record of Thresholds Evaluation by Sampling Season for Wetland 68

Sampling Season	Increase in WA_M by more than 0.5?	A *significant difference* in three or more of the following indices?				Change visible on aerial photos?	Flag?	Monitoring Intensity Change?
		FQI	mean c-value	species diversity	species richness			
Sept. 2008	No	No	No	No	No	No		No
June 2009	No	No	No	Yes	Yes	No		No
Sept. 2009	No	No	No	No	No	No		Yes - Decrease to Level 1
June 2010	No*	No	No	Yes	Yes	No		No - Remain at Level 1
Sept. 2010	No	No	No	No	No	No		No - Remain at Level 1

* = A significant decrease in WAM occurred, indicating that the wetland was wetter than baseline average.

2010 (Table 5-4), indicating that it continues to be dominated by wetland vegetation. The baseline threshold mean WA_M prior to Project operation for W-25 is 2.60. Mean weighted averages for 2010 remained below the baseline threshold as illustrated in Figure 2 in Section B-1 in Appendix I. This wetland contained an average of 85 percent native species and 39 percent invasive species in 2010. The average FQI for this wetland during the same time period was 19.38, implying a relatively high ecological value. Tables 1, 2, and 3 in Section B-2 of Appendix I contain a summary of the monitoring data, the WA_M by gradsect for W-25, and the complete species list from the 2010 monitoring efforts.

Table 5-4 Wetland 25 Comparison of 2010 Vegetation Data to Baseline Averages

	Spring 2010	Fall 2010	Baseline Mean	Baseline Low	Baseline High
Weighted Average	2.30	2.59	2.24	1.93	2.78
Species Richness	53	54	49.86	39.00	55.00
Species Diversity	30.06	26.12	23.12	17.19	28.00
Mean C Value	3.10	2.64	3.19	2.83	3.65
FQI	21.27	17.50	20.46	17.66	24.48

The WA_M for the 2010 sampling seasons did not increase by 0.5 or more from the baseline WA_M of 2.24 as shown in Table 5-4 and in Figure 2 in Appendix I, Section B-1. The statistical analysis, using the repeated measures ANOVA, indicated two statistically significant changes from baseline averages in Spring 2010and Fall 2010 (Table 5-5). The species diversity and species richness in June 2010 were significantly higher than the baseline average. This could indicate colonization by transition species; therefore, this wetland and these data will be closely monitored in June 2011. In fall 2010, the FQI and mean c-value were both significantly higher than baseline averages. That means that more species are present in W-25 and possibly higher quality species are becoming more dominant. Aerial photography for W-25 is located in Section B-1 of Appendix I and shows no significant visible change from baseline photography. The data gathered during the 2010 monitoring efforts do not trigger a yellow or red flag as outlined in Figure 4-2. It is recommended that monitoring at W-25 continue consistent with the current methodology for the next monitoring effort.

Table 5-5 Record of Thresholds Evaluation by Sampling Season for Wetland 25

Sampling Season	Increase in WA_M by more than 0.5?	A *significant difference* in three or more of the following indices?				Change visible on aerial photos?	Flag?	Monitoring Intensity Change?
		FQI	mean c-value	species diversity	species richness			
Sept. 2008	No	No	No	No	No	No		No
June 2009	No	No	No	No	No	No		No
Sept. 2009	No	No	Yes	No	No	No		Yes - Decrease to Level 1
June 2010	No	No	No	Yes	Yes	No		No - Remain at Level 1
Sept. 2010	No	Yes	Yes	No	No	No		No - Remain at Level 1

5.3 PEM WETLAND 100 – SAUNDERS COUNTY

Wetland 100 is a PEM wetland located in Saunders County, Nebraska (Figure 1, Section C-1, Appendix I). The vegetation in this wetland was sampled using 3 transects, 11 gradsects, and 55 sample plots. Dominant species observed in this wetland during the 2010 monitoring efforts included annual marshelder (*Iva annua*), unknown sedge species, wooly sedge (*Carex pellita*), and bluntleaf bedstraw (*Gallium obtusum*). Wetland 100 (excluding the upland gradsects) had a WA_M of 2.07 in the spring of 2010 and 2.81 in the fall (Table 3-1), indicating that it continues to be dominated by wetland vegetation. The baseline threshold mean weighted average prior to Project operation for W-100 is 2.96. The WA_M for spring and fall 2010 remained below the baseline threshold as illustrated in Figure 2 in Section C-1 in Appendix I. This wetland contained an average of 86 percent native species and 42 percent invasive species in 2010. The average

FQI for this wetland during the same time period was 14.82, implying a moderate ecological value. Tables 1, 2, and 3 in Section C-2 of Appendix I contain a summary of the monitoring data, the WA_M by gradsect for W-100, and the complete species list from both of the 2010 monitoring efforts.

Table 5-6 Wetland 100 Comparison of 2010 Vegetation Data to Baseline Averages

	Spring 2010	Fall 2010	Baseline Mean	Baseline Low	Baseline High
Weighted Average	2.07	2.81	2.40	1.71	2.96
Species Richness	44	27	28.71	23.00	33.00
Species Diversity	20.63	13.98	14.13	11.34	17.09
Mean C Value	2.97	2.41	3.41	3.00	3.72
FQI	17.82	11.82	16.42	14.70	18.33

The WA_M for the 2010 sampling seasons did not increase by 0.5 or more from the baseline WA_M of 2.40 as shown in Table 5-6 and in Figure 2 in Appendix I, Section C-1. The statistical analysis, using the repeated measures ANOVA, indicated two statistically significant changes from baseline averages in fall 2010 (Table 5-7). The FQI and mean c-value were significantly lower than the baseline average. That means that lower quality species are more dominant in W-100. This could indicate colonization by transition species; therefore, this wetland and these data will be closely monitored in June 2011. Aerial photography for W-100 is located in Section C-1 of Appendix I and shows no significant visible change from baseline photography. The data gathered during the 2010 monitoring efforts do not trigger a yellow or red flag as outlined in Figure 4-2. It is recommended that monitoring at W-100 continue consistent with the current methodology for the next monitoring effort.

Table 5-7 Record of Thresholds Evaluation by Sampling Season for Wetland 100

Sampling Season	Increase in WA_M by more than 0.5?	A *significant difference* in three or more of the following indices?				Change visible on aerial photos?	Flag?	Monitoring Intensity Change?
		FQI	mean c-value	species diversity	species richness			
Sept. 2008	No*	No	No	No	No	No		No
June 2009	No*	No	No	No	No	No		No
Sept. 2009	No	No	No	No	No	No		Yes - Decrease to Level 1
June 2010	No	No	No	No	No	No		No - Remain at Level 1
Sept. 2010	No	Yes	Yes	No	No	No		No - Remain at Level 1

* = A significant decrease in WAM occurred, indicating that the wetland was wetter than baseline average.

6.0 DISCUSSION AND RECOMMENDATIONS

The goal of monitoring wetlands within the Douglas County and Saunders County well fields and associated cones of depression is to evaluate the impact that operation of the Project may have on the existing wetlands. To accomplish this goal, a monitoring approach consisting of a systematic, multi-tiered vegetation sampling procedure has been developed and implemented. Monitoring data that was collected between 2005 and the spring monitoring effort of 2008 represents the baseline conditions prior to Project operation. Data collected since the fall of 2008 is considered post-operation and will be evaluated as it compares to the ranges and values established when analyzing the baseline data.

6.1 DISCUSSION

The following sections discuss the results of the 2010 wetland monitoring efforts.

6.1.1 Wetland Monitoring in the Well Fields

Data obtained during the spring and fall 2010 sampling seasons have been analyzed and the results are included in Appendix I. Additionally, a comparison of the data collected during the 2010 sampling seasons to the baseline data is also included for each wetland in Tables 5-2, 5-4, and 5-6. The calculated values for the WA_M were generally within the expected ranges established from the baseline data. The mean weighted averages for the 2010 data have been graphed and compared with the baseline averages and ranges. These graphs are provided as Figure 2 in the respective appendix for each wetland.

Per the results of the statistical analysis, most of the wetlands remain within baseline variation with only one or two indices falling outside of statistical normality. These indices will be closely monitored in June 2011 to determine whether the changes continue or return to baseline conditions.

6.1.2 Wetland Monitoring in the Cones of Depression

The wetlands in the cones of depression were not monitored in 2010. They will be monitoring again in 2011 using the CIR aerial photography that will be flown in 2011 for both well fields and the associated cones of depression in Douglas and Saunders Counties.

6.1.3 Hydrological Monitoring

In addition to the wetland monitoring efforts, several different types of hydrological data have been gathered and analyzed as part of the ongoing monitoring efforts. These hydrological data include groundwater monitoring wells, piezometers, monthly average precipitation, monthly average ambient air temperature, and stream gauge data for the Platte and Elkhorn Rivers. A discussion of this hydrological data is included in the following sections.

6.1.3.1 Groundwater Monitoring Wells

The groundwater monitoring well data collected for 2010 have been graphed and are presented for each monitoring well in Figures 1 through 23, Appendix III-A. In looking at the monitoring well data graphed over time, the elevations seem to be experiencing normal, seasonal fluctuation. Some wells showed lower elevations in 2010 which could be as result, in part, of increased pumping within the well fields. An exhaustive analysis of the monitoring well data has not been performed at this time. If impacts to wetlands are identified as Project operation continues, the groundwater monitoring well data will be available to assist in the hydrological evaluation of any potential impacts to wetlands.

6.1.3.2 Piezometers

The piezometer readings for 2010 have been graphed to allow for comparison amongst the piezometers, to baseline data, and with other monitoring data (Figures 1 through 4, Appendix III-C). Water elevation readings from the piezometers will continue to be monitored and comparisons will be made to other hydrological and production data if any impact to wetlands is indicated.

6.1.3.3 Precipitation and Temperature

The monthly precipitation during 2010 was generally below the monthly historical averages with the exception of June during which the monthly total more than doubled the historical monthly average. Overall, the 2010 recorded precipitation total of 24.6 inches was below the annual historical average of 28.4 inches (Figure 1, Appendix III-D). Historically, the amount of precipitation increases from January to a peak in May, declines to a plateau in late summer, and, continues to decline through December.

Average ambient air temperature in 2010 fell within the expected monthly high and low temperature range based on the historical average (Figure 2, Appendix III-D). Average monthly temperatures consistently ranged between 17 °F and 76 °F.

6.1.3.4 Stream Gauges

Historically, stream elevations are highest in spring and lowest in late summer and early fall (Figures 3 and 4, Appendix III-D). In 2010, the mean stream elevation of the Platte River was above normal for most of the year; high levels recorded in January and February can likely be attributed to significant snow melt while the high level in June reflects heavy precipitation in the area. Recorded stream elevations returned to near (and slightly below) normal levels in the last quarter of 2010.

Mean stream elevations in the Elkhorn River closely followed pattern described above for the Platte River. The highest stream elevation was recorded in June corresponding to significantly above average precipitation in the area. Stream elevations returned to historical levels the latter half of 2010.

6.2 RECOMMENDATIONS

This report summarizes the 2010 wetland monitoring efforts. As a result of the conditions observed in the wetlands discussed above, no additional monitoring of secondary wetlands is recommended at this time. However, aerial photography will continue to be obtained on a bi-annual basis and will be available for comparison if and when necessary. It is recommended that wetland monitoring efforts in 2011 continue without changes to the methodology at this time. These efforts are scheduled to take place in June and September of 2011. Data collected in 2011 and in future years will continue to be compared to the baseline data in an attempt to determine the effects, if any, of Project operation.

7.0 REFERENCES

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