2. Watershed Description

This section provides a brief discussion of the overall characteristics describing the BRRWD. The watershed has been divided into seven different planning regions, based on physical watershed features. Discussions for each of these planning regions are provided as Appendices A through G to this Plan, providing for a more in-depth, focused perspective. A review is provided on an overall watershed basis here, to distill these planning region discussions into an overall, broader view of the BRRWD.

2.1 Setting – Location and Size

The BRRWD, located in northwest Minnesota, comprises an area of 1,379 square miles. Other watersheds bordering the BRRWD are the Wild Rice River (north), Pelican River (east), and Cormorant Lakes (east). The southern (Otter Tail River) area of the BRRWD is not bordered by an organized watershed district. The western boundary is the Red River.

The BRRWD is comprised of portions of Clay, Becker, Wilkin, and Otter Tail Counties. Municipalities within the BRRWD include: Moorhead, Dilworth, Glyndon, Hawley, Lake Park, Audubon, Callaway, Georgetown, Sabin, Comstock, Wolverton, Hitterdal, and Barnesville (Figure 2.1). The BRRWD office, responsible for daily operation, is located in Barnesville.

2.2 Physical Setting

2.2.1 Geology

The geology of the Red River Basin and the BRRWD, as a microcosm, consists of glacial lake deposits, lake shore deposits, till and a small amount of ice-contact deposits overlying the bedrock. Bedrock in the east part of the basin consists of Precambrian, undifferentiated igneous, and metamorphic rock. Bedrock in the west part of the basin consists of a small band of Cretaceous, fine-grained sandstone and shell. Clay and silt lake deposits dominate the Lake Agassiz plain bordering the Red River of the North. A transition zone between the lake plain and the glacial moraine areas is formed by lake shore deposits, delta sand, and gravel. Geomorphic regions of the BRRWD are depicted in Figure 2.2.
2.2.2 Ecoregions

The BRRWD transects three ecosystems including: the Lake Agassiz Plain, the North Central Hardwood forests, and the North Lakes and Forests. The majority of the BRRWD is located in the Lake Agassiz Plain with a lesser area of North Central Hardwood forests. Less than 5% of the BRRWD is located in the Northern Lakes and Forests ecoregion. Ecoregions of the BRRWD are depicted in Figure 2.3.

2.2.3 Topography

The BRRWD can be characterized by three physiographic regions extending from the west boundary to the east boundary: the glacial lake bed deposits, the beach ridge area, and the glacial moraine. Over twelve thousand years ago, much of the BRRWD was covered by Glacial Lake Agassiz. Lake Agassiz was formed by an accumulation of melt waters from the last receding glacier. The western portions of Clay and Wilkin Counties are located on this lake bed. The lake bed is characterized by flat, extremely level deposits of lake sediments reaching up to 80 feet in thickness. The beach ridge area is located along the boundary of old Glacial Lake Agassiz. The level of Lake Agassiz fluctuated through the centuries, with the fluctuations leaving their mark on the land in the form of beaches. The beach ridge physiographic region of the BRRWD follows a north-south corridor approximately eight miles wide through the center of the BRRWD and is located on the east boundary of the lake plain. The glacial moraine area is located east of the beach ridge physiographic region. The landscape of this region was formed by the soil, rocks and debris deposited by the glaciers. The glacial moraine area can be characterized as rolling prairie, with scattered areas of sharply rolling hills interspersed with lakes, ponds, wetlands, and bogs. All in all, elevation across the BRRWD slopes from east to west, and ultimately drains to the Red River, as can be seen in Figure 2.4.

2.2.4 Soils

Like the three physiographic regions, there are three distinctive soil groupings in the BRRWD. The soils in the west tend to be clays of low permeability, with poor internal drainage, though very fertile for agriculture. The soils near and within the beach ridge area of the BRRWD tend to be clay loams and sandy loams mixed with sands and gravels and include some moderately steep slopes. The soils of the moraine area are mostly clays and silts, and those areas of more irregular topography tend to have a loamy texture and be dark to moderately dark colored and poorly to well-drained. The glacial moraine upland area has nearly level to steep slopes and many wet areas and pocketed depressions. Figure 2.5 is a map of the BRRWD showing general soil associations and their distribution.
Some of the soils in the BRRWD are susceptible to wind erosion, as seen in Figure 2.6. These soils are mostly associated with sloping areas within the beach ridge geomorphic region. They are also the most susceptible to soil erosion caused by rainfall runoff.

2.2.5 Climate

The BRRWD is located near the center of the North American continent. It has a continental climate, characterized by cold weather and reduced amounts of precipitation. The movement of cold, polar air masses into the area during the winter months result in very cold, dry weather. During the spring and summer, warm moist air from the Gulf of Mexico tends to dominate weather patterns. National Weather Service stations are located at the Cities of Campbell, Fergus Falls, Detroit Lakes, Ada, and Fargo, North Dakota. All of these weather stations are near to, but outside, the BRRWD. Historic weather data indicates extreme variations in temperature and moderate precipitation. Based on historical information (1971-2000) for the Detroit Lakes station, the normal mean monthly temperatures vary from 6°F to 69°F, with a normal mean annual temperature of 41°F. Temperatures have ranged from an extreme low of -53°F to 107°F. The growing season lasts about 121 days, with approximately 2,508 growing degree days during the year. Average annual precipitation for the BRRWD is 26.36 inches. Approximately 69% of the precipitation occurs during the five month growing season, which is May through September. Snowfall depth averages 45.3 inches per year.

2.2.6 Population

Population in the BRRWD is concentrated primarily in the urban areas. The largest urban area is the City of Moorhead. The most recent population value (2000) for Moorhead is 32,177, which is down slightly from 32,295 in 1990. In addition, population within rural areas has experienced a general decline since the 1960’s, due to changes in farming practices and the difficulty of finding employment in small towns. Other areas of increasing growth within the BRRWD are in the eastern region around the lakes. This is probably due to the increasing popularity of the lakes for vacation and retirement homes.

Based on information from the Minnesota State Demographic Center, population projection estimates for counties within the BRRWD can be found in Table 2.1. Although these counties are not located totally within the BRRWD, the general trends previously discussed can be seen. Areas that are more urban (Clay) and more recreationally sought for lakes (Becker and Otter Tail) are increasing in population, while areas that are more rural (Wilkin) are decreasing in population.
Figure 2.5: Soils

Map of Buffalo Red River Watershed District showing planning regions and soil types. Legend includes various soil names and color coding.

Data source: MN DNR Data Deli. Soil data is USDA-NRCS State Soil Geographic (STATSGO) data.
Table 2.1 Population Projection Estimates For Counties in the BRRWD.

<table>
<thead>
<tr>
<th>County</th>
<th>% Change 2005-2015</th>
<th>% Change 2005-2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Becker</td>
<td>13.0</td>
<td>26.7</td>
</tr>
<tr>
<td>Clay</td>
<td>10.7</td>
<td>25.3</td>
</tr>
<tr>
<td>Otter Tail</td>
<td>3.7</td>
<td>10.0</td>
</tr>
<tr>
<td>Wilkin</td>
<td>-4.3</td>
<td>-6.0</td>
</tr>
</tbody>
</table>

2.2.7 Land Use

Land use within the BRRWD is mostly for agriculture. The majority of agricultural activity occurs in the western and central portions of the BRRWD. Prime farmland can be seen as Figure 2.7. Areas in the eastern portion of the BRRWD are mostly forested, with scattered lakes and wetland areas. Riparian zones along the Buffalo and Red Rivers also exist. Municipalities are scattered in the BRRWD. The largest of these municipal areas is the City of Moorhead.

2.3 Fish, Wildlife and Natural Resources

The majority of the areas with biological significance, based on MCBS information, are located in the central portion of the BRRWD in the beach ridge geomorphic region due to the prairies, forests, and grasslands located there. See Figure 1 in each of the Planning Region Planning Summaries (Appendices A through G). Each Planning Region Summary found in the Appendices (A through G) contains five figures. Appendix A (Western Planning Region) contains Figures 1A through 5A; Appendix B (Lakes Planning Region) contains Figures 1B through 5B; and the remaining Planning Regions follow with a different lettering corresponding to each different planning region. There are a number of state-owned Wildlife Management Areas (WMAs) and federally controlled Waterfowl Production Areas (WPAs) located throughout the BRRWD. The District also includes the Hamden Slough and Tamarac National Wildlife Refuges (NWR). Rare natural features (plants and animals) are scattered about the BRRWD, but mostly focused in the key habitat areas previously discussed, water features (lakes, streams, and wetlands), and the riparian areas around these water features.

Assessments of the natural resources in the BRRWD have been performed by the Minnesota Center for Environmental Advocacy (MCEA). Natural resources of the BRRWD mapped by the MCEA based on categories were existing and restorable resources. These maps can be found as Figures 2.8 through 2.10 in this Section and Figures 2 and 3 in the Planning Region Planning Summaries in Appendices A through G. Existing resources were
Legend
- Planning Region
- County Boundary
- BRWRD Legal Boundary
- Township
- Legal Drainage Ditch
- Waterbody

Water Features
- Centerline (River)
- Stream (Perennial)
- Drainage Ditch (Perennial)
- Stream (Intermittent)
- Drainage Ditch (Intermittent)

Priority
- High: 66
- Low: 2

Data source: MN DNR Data Deli and Minnesota Center for Environmental Advocacy.

Priority areas for protection and restoration are identified. Additional information is available at http://www.fws.gov/midwest/HAPET1/Strategy/MgmtAndMapping.htm.

Figure 2.8: Existing Resources - Priority Resource Areas
Species in greatest conservation need (SGCN) are defined as native animals whose populations are rare, declining, or vulnerable to decline and are below levels desirable to ensure their long-term health and stability.

In Minnesota, 292 species meet the definition of species in greatest conservation need (SGCN). This set of SGCN includes mammals, birds, reptiles, amphibians, fishes, invertebrates, and mollusks, and represents about one-quarter of the nearly 1,200 animal species in Minnesota that were assessed for this project.

The number of SGCN species recorded in each township from public sources are presented. Complete information is available at [http://www.orn.state.mn.us/wildlife/index.html](http://www.orn.state.mn.us/wildlife/index.html).
mapped as follows: 1) priority resource areas; 2) species of greatest conservation need (SGCN); 3) key habitats; 4) conservation lands; and 5) restorable wetland. Large blocks of wetlands/grasslands can be found in the beach ridge and glacial moraine geomorphic regions, with woodlands also mostly focused in the eastern part of the BRRWD. SGCN are mostly focused in areas that were identified as key habitats in the BRRWD, which are located in the same resources areas previously discussed. Conservation lands are also located in these same geomorphic regions. The MCEA Natural Resource Assessment is shown in Appendix N.

Restorable resources were identified as those areas that could be restored in function and increase resource value. Those restorable resource areas were identified as partially drained wetlands and buffers along watercourses. Priority habitats were identified as areas that were important for wildlife.

The lakes and streams of the BRRWD provide habitat for a wide variety of fish and wildlife, particularly in the eastern area. A 2001 stream survey of the Buffalo River system by the DNR identified 39 species of fish in the streams of the BRRWD. Common gamefish species include northern pike, walleye, sauger, smallmouth bass, largemouth bass, and channel catfish. Artificial stocking of walleye is practiced in some areas. A copy of the 2001 survey report is shown in Appendix L.

Species of wildlife hunted in the area include deer, waterfowl, pheasants, and rouged grouse. The hunting of waterfowl is attractive because many ducks and geese are produced locally in the BRRWD's numerous prairie potholes, and the watershed lies in the path of the Mississippi flyway. Geese, mallards, wood ducks, and blue-winged teal are most common in the pothole area.

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2.4 Water Resources

2.4.1 Major Streams and Tributaries

The two branches of the Buffalo River traversing and draining the BRRWD are the South Branch of the Buffalo River and the Buffalo River. The South Branch of the Buffalo River receives runoff from several important tributaries including Deerhorn Creek, Stony Creek, Hay Creek, and Whisky Creek. The watercourses consist of an intermingling of natural streams and public and private drainage systems. Most of the land traversed by the South Branch of the Buffalo River is characterized by low relief and is in agricultural production. The South Branch of the Buffalo River generally flows north to the Buffalo River. The Buffalo River flows generally to the west toward Lake Park and Hawley to the confluence with the South Branch of
the Buffalo River, near Glyndon. The Buffalo River then flows in a northwesterly direction to the confluence with the Red River. Wolverton Creek is a relatively large area on the western boundary of the BRRWD and in the southwestern portion of the BRRWD, which flows directly to the Red River of the North, upstream from the Fargo-Moorhead Metropolitan Area (FMMA). Streams and tributaries in the BRRWD can be seen in maps of surface water resources for the BRRWD in *Appendix Figures 4*.

### 2.4.2 Lakes

There are numerous lakes within the northeastern portion of the BRRWD, at the headwaters of the Buffalo River, as well as in the general eastern portion. All of the lakes are essentially in Becker, Clay, and Otter Tail counties. The largest lake is Tamarac Lake, at 1,504 acres. Lakes in the BRRWD can be found in *Appendix Figures 4*.

Lake water quality is important to the residents of the BRRWD. Area lakes are used for recreational opportunities, such as waterfowl hunting, fishing, and swimming. Many of these lakes also have homes located along their banks, since they are a desirable place to recreate. Quality of lake water is, thus, important to the economic progress of the areas in the BRRWD where many lakes are concentrated.

Increased demands on these water bodies, however, also leads to increased risk of water quality degradation. While there are varying degrees of reduced water quality, impacts can already been seen on some of the BRRWD lakes. In this regard, a management framework was developed for the BRRWD to guide the management of the BRRWD’s lake resources. Four possible classes were used in the management framework, which are described as follows:

- **Class I-A** – lakes moderately or highly sensitive to disturbance, with high water clarity; also, highly sensitive lakes with marginal water clarity.
- **Class I-B** – any lakes designated as impaired for stressors other than mercury.
- **Class II** – lakes moderately or highly sensitive to disturbance, with moderate water clarity.
- **Class III** – lakes with low sensitivity to disturbance, but with moderate to high water clarity.
- **Class IV** – lakes with marginal water clarity, having moderate to low sensitivity to disturbance.

Lakes in the BRRWD were screened to develop a group of priority lakes to apply and test the management framework on. Thirty-two lakes were identified through the screening process. Further discussion can be found in Section 4.2.9.

### 2.4.3 Wetlands

Wetlands are common in the glacial moraine (Supraglacial Drift Complex) geomorphic region, as well as in low areas between the beach ridges. At the present time, wetlands are virtually nonexistent in the lake plain (Lacustrine) geomorphic region. Wetlands within the BRRWD
can be found in Appendix Figures 4. These wetlands are either lacustrine, palustrine, or riverine types. Numerous waterfowl production areas (WPAs) are also located within the BRRWD. These are wetland areas that the U.S. Fish and Wildlife Service (USFWS) has acquired for migratory waterfowl.

2.4.4 Drainage Systems

There are numerous public and private drainage systems in the BRRWD, specifically constructed since the early 1900’s, to provide agricultural drainage (Appendix Figures 4). The BRRWD has legal jurisdiction over all these ditch systems, with the authority to approve proposed improvements to be made to the ditches. Most of these drainage systems are located in the lake plain geomorphic region, since this area is flat, has poorly drained soils, and lacks a natural drainage network. Without the drainage network, water would stagnate in the fields and drown crops. The ditch networks have, however, improved the connection between areas that would otherwise not be hydrologically connected.

2.4.5 Water Management Structures

A primary focus of the BRRWD’s efforts since its establishment has been in the promotion and construction of projects to alleviate flooding problems. A primary element of these projects was the construction of several flood control projects throughout the BRRWD. Most of the projects constructed to date were designed and developed by the BRRWD. Some of these projects were developed in conjunction with existing wildlife areas in cooperation with the DNR and the USFWS. A list of the projects is provided in Table 3 of each of the Planning Region Appendices.

2.4.6 Water Use – Surface Water and Groundwater

Surface water and groundwater in the BRRWD is used for municipal, industrial, and rural domestic water supplies. With the exception of Moorhead, public water supply systems in the BRRWD are supplied from groundwater sources. The City of Moorhead also uses groundwater as a source for drinking water, but the largest source is from the Red River.

Wellhead protection is a way to prevent drinking water from becoming polluted by managing potential sources of contamination in the area that supplies water to a public well. The wellhead protection plan is a separate document from the source water assessment, and it is developed by the water system and its wellhead protection planning team. All groundwater based community and nontransient noncommunity public water systems should have begun the wellhead protection planning process by 2006. A map showing WHPA’s in the BRRWD can be found as Figure 2.11.
Figure 2.11: Wellhead Protection Areas
There are many agricultural users within the BRRWD that draw water for irrigation purposes. The majority of this irrigation water is from groundwater sources. There are a few instances where some of the major streams in the BRRWD, such as the Mainstem and South Branch of the Buffalo River, are used for irrigation.

2.4.7 Water Use – Inventory of Public Water Suppliers

An inventory of each municipal’s water use can be found in the Appendices for each Planning Region.

2.4.8 Water Use – Inventory of Municipal Wastewater Treatment Systems

An inventory of each municipal’s wastewater discharge information can be found in the Appendices for each Planning Region.

2.4.9 Groundwater

Aquifers are located primarily in the beach ridge and lake plain areas. The major surficial aquifers are the Buffalo, Trojan, and Pelican. The Buffalo aquifer is the most used aquifer system in the BRRWD. There is also a deeper aquifer further east in the BRRWD, which is called the Cretaceous aquifer. The flow of these aquifer systems trends generally to the west and the Red River.

A groundwater sensitivity to pollution of the shallow systems in the area was produced by the DNR, based upon the water table depths and soil textures. The beach ridge area has the highest sensitivity to pollution, followed by the glacial moraine area, and then the lake plain area. An exception to this is the area around the Buffalo aquifer. A map of this information, related to the groundwater systems in the BRRWD, can be found as Figure 2.12.

2.4.10 Impaired Waters and TMDLs

All waterbodies within the BRRWD are classified by the State of Minnesota (specifically the MPCA) relative to their desired uses and water quality. These uses include: aquatic consumption, aquatic recreation, and aquatic life. The protection of these uses is typically ensured by establishing water quality standards. These standards are generally numeric or narrative (i.e., describe a desired condition). Water bodies failing to attain the water quality standards and support their desired beneficial uses are considered “impaired”. There are several water bodies within the BRRWD that have been identified as being impaired by the MPCA, and the descriptions of these impairments can be found in the discussions relative to each Planning Region in the Appendices.
The main cause, or stressor, for water bodies being impaired within the BRRWD is an excessive amount of sediment (i.e., elevated turbidity levels). Elevated turbidity can affect drinking water quality and the ability of aquatic life to sustain healthy and viable populations. There are other stressors associated with impairment, such as too much ammonia or fecal coliform, low diversity of aquatic life as expressed by a fish Index of Biotic Integrity, and elevated nutrients (such as total phosphorus). All of the impairments in the BRRWD can be found in Figure 3.1.

### 2.5 Economic

#### 2.5.1 Agriculture

Agriculture, and its related economic activities, provides the primary force behind the economy of the BRRWD. The farms in the western portion of the District tend to be very large, concentrating on cash crops rather than on livestock production. The farms further east, on the other hand, are smaller and livestock is more important. Principal crops grown in the BRRWD include small grain, soybeans, sunflowers, sugar beets, corn, and potatoes.

#### 2.5.2 Forestry

Stands of forest exist in the eastern portion of the BRRWD. The White Earth State Forest is located partly within the BRRWD. An active harvest of timber for the pulp wood industry exists, and sawmills are operated on an all-season basis.

#### 2.5.3 Industry

Processing and manufacturing industries are generally located in the BRRWD's primary urban center - Moorhead. Moorhead's urban economy is dependent upon agriculture, for many of the businesses are concerned with either processing agricultural products or in selling equipment, seeds, and fertilizers to the farmers. Other industries in Moorhead include wholesale and retail trade, insurance and banking, construction, transportation, and communications, government, public utilities, health facilities, and education.

The education industry is especially important to Moorhead and the BRRWD. Young people from all over the area are attracted by Minnesota State University - Moorhead, Concordia College, and the Moorhead Area Vocational Technical Institute. The economic effect of these institutions is noticeable.

#### 2.5.4 Recreation and Tourism

Recreation and tourism are important in the lake area to the east. The area provides opportunities for lake enthusiasts for boating and fishing, and people are building lake homes.
there. Many recreational opportunities exist for hunting deer, small game, pheasant, and waterfowl. WMAs and WPAs located in the BRRWD (Figures 1 of each of the Planning Region Summaries in the Appendices) provide most of these hunting opportunities. Fishing opportunities exist in the lakes and the Red River for gamefish species. The Red River is also a popular canoeing destination.