Papio-Missouri River Basin

Water Quality Management Plan

13 June 2018

Project Sponsor

Project Partners

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND

The Papio-Missouri River Natural Resources District (P-MRNRD) has a long history of being proactive in improving water quality and environmental integrity of local watersheds and seeks to enhance those goals with the current planning effort. In 2009, Papillion Creek Watershed Partnership developed the Papillion Creek Watershed Management Plan (WMP), in addition to numerous other watershed management plans completed by the P-MRNRD throughout their district. In 2015 the P-MRNRD Board decided to develop a Papio-Missouri River Basin Water Quality Management Plan (the Plan) to address water quality throughout the entire district. The Plan is based on the Environmental Protection Agency's (EPA) nine key elements (9 Elements), requirements that are critical for achieving improvements in water quality (Table 1-1).

1.1.1 Plan Purpose

The overall purpose of this Plan is to provide a concise summary of water resource conditions to provide direction and a coordinated approach for addressing nonpoint source pollution, and to educate and involve the public and other watershed stakeholders on the importance of supporting conservation actions. Management approaches will support the goals of agencies such as Nebraska Department of Environmental Quality (NDEQ), Natural Resources Conservation Service (NRCS), Nebraska Game and Parks Commission (NGPC) and existing P-MRNRD, City of Omaha, and other municipalities' programs targeted to reduce impacts of nonpoint source pollution.

The Plan lays out a strategy to systematically address water resource deficiencies in the basin and allows for management of individual watersheds or other targeted areas. The focus of the Plan is to address impaired waterbodies and satisfy the EPA requirements to be eligible for 319 funding. Implementation will be guided on a watershed scale by a comprehensive strategy to address water and land use deficiencies that contribute to the degradation of surface water resources, groundwater resources, and aquatic and terrestrial habitat. The ultimate goals it so delist impaired waterbodies from the 303(d) list. The P-MRNRD and City of Omaha are the sponsors of this Plan. It will be implemented in coordination with Papillion Creek Watershed Partnership stakeholders, NDEQ, NRCS, NGPC and other basin stakeholders.

1.1.2 Nebraska Nonpoint Source Management Program and Section 319 Funding

The Water Quality Act of 1987 added Section 319 to the Clean Water Act. Section 319 requires that states prepare a Nonpoint Sources Assessment Report and develop and implement a Nonpoint Source Pollution Management Program. Section 319 further authorizes federal financial assistance for implementation of nonpoint source pollution management activities. The Nebraska Nonpoint Source Pollution Management Program, as administered by NDEQ, helps facilitate management of nonpoint source pollution in the state through the development and implementation of 9 Element Watershed Management Plans and addressing requirements of Section 319 (NDEQ 2015). Projects identified in the Plan as eligible for Section 319 grant funds can apply for funding on an individual basis, anticipating that multiple projects may be developed and implemented under the umbrella of the common basin plan.

NDEQ has developed guidance specific to basin management plans (opposed to smaller-scale watershed plans or project-specific management plans) to provide coverage over an entire NRD area or an area that is greater than one 8-digit Hydrologic Unit Code (HUC 8) in size. A basin is divided into HUC 8 watersheds and the 9 Elements are implemented for each HUC 8 watershed within the basin. Significant targeting is done in basin management plans such that targeted areas make up no more than 20 percent of each individual HUC 8, focusing limited resources toward delisting specific water bodies rather than spreading resources across the entire basin. The Plan is required to be updated every five years. New target areas and projects may be identified at that time if significant progress (e.g. delisting) has been made towards Plan goals in targeted areas. A list of the 9 Elements is provided in Table 1-1 below.

Table 1-1. 9 Elements of Watershed Planning

Element	Subject
A	Identification of Causes of Impairment and Pollutant Sources
B	Estimated Pollutant Loadings and Expected Loading Reductions
C	Describe Management Measures
D	Technical and Financial Assistance, Costs, Funding Sources
E	Information and Education / Public Understanding
F	Schedule for Implementing the Management Measures
G	Description of Measurable Milestones
H	Set of Criteria to Measure Success
I	Monitoring Component to Evaluate Effectiveness of Implementation Efforts

1.1.3 History and Function of NRDs

In 1972, Legislative Bill (LB) 1357 was enacted to combine Nebraska's 154 special purpose entities into 24, later changed to 23, Natural Resources Districts (NRDs). NRDs were created to address natural resources issues such as flood control, soil erosion, irrigation run-off and groundwater quantity and quality issues. Boundaries of the original NRDs were based on Nebraska's major river basins to enable the application of appropriate management practices to areas with similar topography (Figure 1-1). Nebraska's NRDs are involved in a wide variety of projects and programs to conserve and protect the state's natural resources. Water management responsibilities for NRDs are outlined under Nebraska State Law. These responsibilities pertain to human health and safety, resource protection and enhancement and recreation. Specific NRD responsibilities related to water management and how they apply to the Plan are listed below:

- Reduce runoff and control erosion.
- Protect human health and property damage from floodwaters and sediment.
- Develop and protect water supplies for beneficial users.

- Promote the wise development, management, conservation and use of ground and surface water.
- Control pollution to water resources.
- Coordinate drainage improvement and channel rectification.
- Develop and manage fish and wildlife habitat.
- Develop and manage water based recreational facilities.

Each NRD is governed locally by a Board of Directors elected by the public for a 4-year term. The Board of Directors is responsible for establishing annual budgets, priorities, regulations and oversight of NRD staff. Each NRD has its own staff and works with Natural Resource Conservation Service (NRCS), other resource agencies, and Field Office staff in each District county. Funding operations and NRD programs are derived from levied property taxes (a unique feature of NRDs). These levied property taxes are often used to match other local, state and federal funding sources. This Plan was developed through a combination of P-MRNRD funds, City of Omaha budget appropriations, Papillion Creek Watershed Partnership budget appropriations and NDEQ 319 funding.

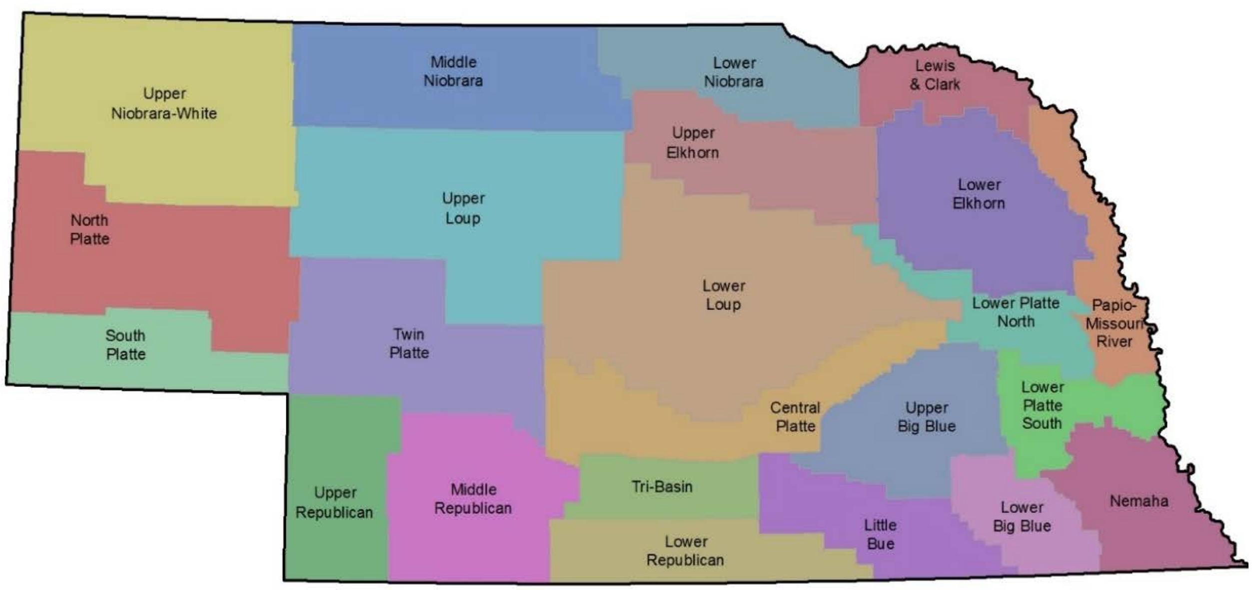


Figure 1-1. Nebraska's NRDs

1.2 BASIN OVERVIEW

1.2.1 Location

The Papio–Missouri River Basin (the Basin) is located in eastern Nebraska and includes 31 incorporated cities and villages, as well as parts of the Nebraska counties of Sarpy, Douglas, Washington, Burt, Thurston, Dakota and Dixon. Nearly all of the Basin exists within the boundaries of, and is managed by, the P-MRNRD (Figure 1-2). The portion of the Basin located in Dixon County is managed by Lewis and Clark Natural Resources District (LCNRD). This area was included in as part of the Basin since the streams in the LCNRD flow into the P-MRNRD. For other instances where this occurs in Burt and Dodge Counties, the area is managed by the Lower Elkhorn Natural Recourses District (LENRD). This area was not included as it is currently being covered by a separate 9 Element Plan. The southern-most portion of the district drains directly into the Platte River, but was not included in the Basin (as directed by NDEQ) since this area is included in the Lower Platte River Corridor Alliance 9 Element Plan.

The Basin is over 1.03 million acres in size. The northern portion is characterized by numerous small creek systems (e.g. Otter, Elk, Pigeon, Cow, Omaha, Blackbird, Elm, Silver, Tekamah and Carr Creeks) that generally flow east into the Missouri River. The southern portion of the Basin is dominated by the Elkhorn River and Papillion Creek watersheds which flow to the Platte River and Missouri River, respectively. General characteristics of the Basin are listed in Table 1-2. The Basin boundary is shown in Figure 1-2.

Table 1-2. Papio-Missouri River Basin Information

Characteristic	Papio-Missouri River Basin
8 Digit Hydrologic Unit Codes	10170101, 10230001, 10220003, 1023006
Counties (Nebraska)	Sarpy, Douglas, Washington, Burt, Thurston, Dakota, Dixon
City (P-MRNRD Office)	Omaha
Population	725,250
Latitude/Longitude (Blair)	41.5415550 °N; 96.1352872 °W
Major Stream Names	Missouri River, Papillion Creek, Blackbird Creek, Pigeon Creek
Basin Area	1,036,739 acres
Watershed Length / Width	98.9 miles/53.7 miles
Major River Watershed	Missouri River
Major Economic Activity	Agriculture
Major Crops	Corn, Soybeans
Major Livestock	Cattle, Swine
Number of Beneficial Use Designated Stream Segments	85
Number of Beneficial Use Designated Lakes/Reservoirs	22
Stream Miles (designated)	844
Tribes	Winnebago and Omaha
EPA Region	VII
TMDL Pollutants	Bacteria, Sediment, Total Phosphorus, Algae, Turbidity
Lake Designated Uses (24 impoundments)	Primary Contact Recreation (24)
	Aquatic Life, Warmwater A (24)
	Water Supply – Ag (24)
	Aesthetics (24)
Stream Designated Uses / # of Reaches	Primary Contact Recreation (11)
	Water Supply – Ag (84)
	Aquatic Life, Warmwater A (11)
	Aquatic Life, Warmwater B (73)
	Aesthetics (84)

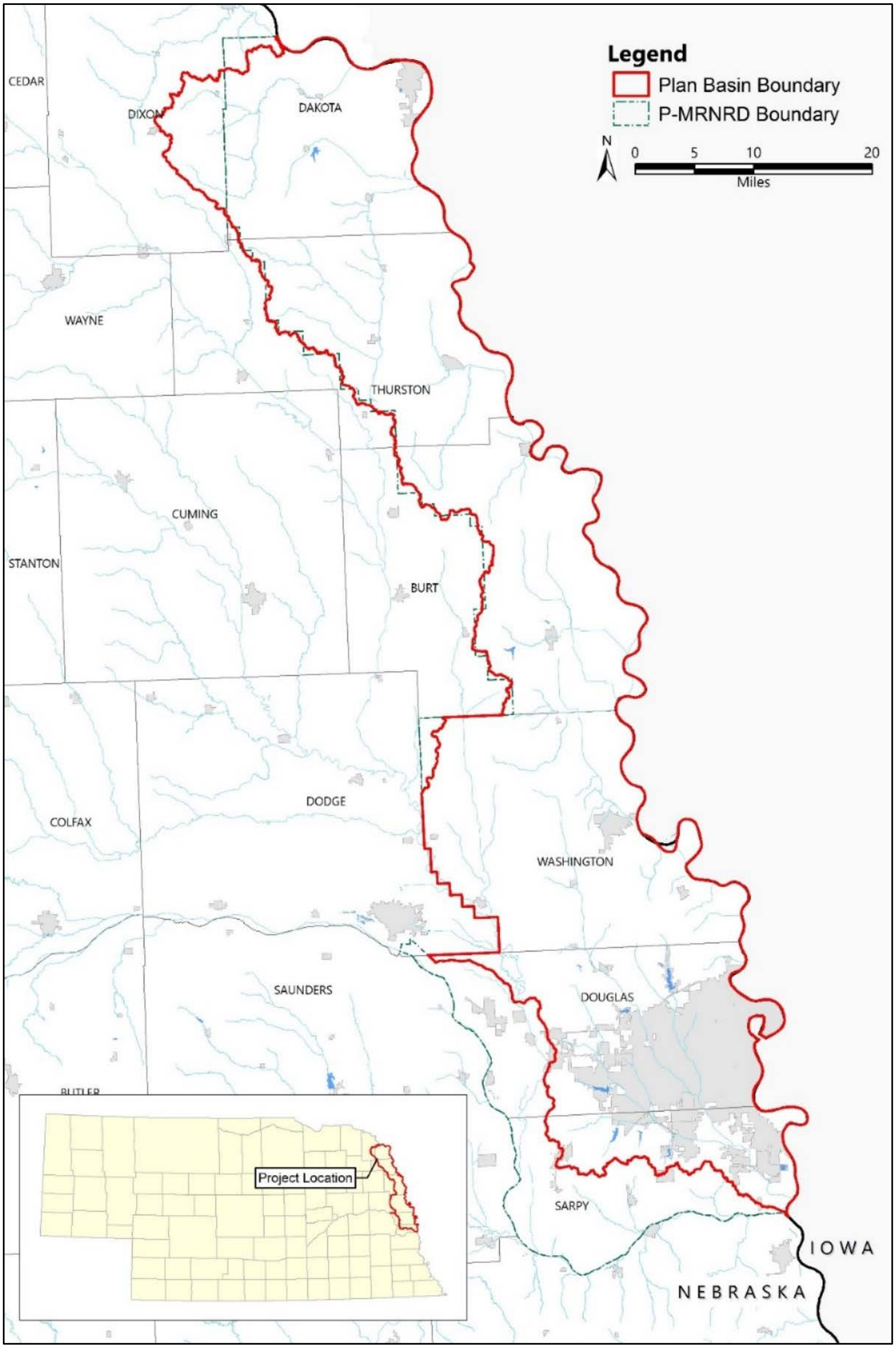


Figure 1-2. Basin Location Map

1.2.2 Historical Concerns and Common Pollutants

There are diverse land uses throughout the Basin, including agricultural and large urbanized areas. Agricultural land is primarily row crop with some livestock production. The primary pollutants associated with this land use are nutrients, pesticides, sediment and bacteria. Impacts such as streambank instability and streambed degradation are prevalent due to the increase in runoff compared to pre-disturbance conditions. Topography of the Basin near the Missouri River transitions from generously sloping to very flat in the floodplain. Sediment deposition at locations in floodplain waterways is a common concern.

Primary pollutants of concern for urban land use areas are nutrients, sediment and bacteria, as well as typical urban pollutants such as oils and greases from roads and industrial areas. Historically, high sediment loads have been problematic in the developing watersheds, followed by a shift to high nutrient loading from turf fertilizers. Substantial changes in hydrology have occurred with conversion of historic prairie to row crop agriculture, and increased impervious area from urban development, that have caused major stream degradation and stability impacts. As part of the stream response to hydrologic changes, streambanks may become near vertical (before failure) and can lose connection with the floodplain, reducing the quality of aquatic habitat. Open space for restoration work is limited along stream corridors in urban areas and frequent issues with bank failure cause costly damages to local infrastructure and adjacent properties.

Throughout the Basin, waterbody impairments are associated with two designated uses: primary contact recreation and aquatic life. Primary causes of these impairments and pollutants of concern include excessive chlorophyll, total phosphorus, total nitrogen, sediment, mercury (a Hazard Index Compound), algal blooms, turbidity, pH, low DO, *E. coli* bacteria, and "unknown" (associated with aquatic community – likely due to loss of habitat).

1.2.3 Past Watershed Planning

In the late 1990's NDEQ worked with NRCS to develop a planning process that would enhance water quality projects, termed Community Based Planning (CBP). The CBP Process is a locally driven approach to solving water quality problems. The process utilizes technical experts and watershed stakeholders to develop local solutions to local problems. Watershed stakeholders participate in determining the resource issues, establishing goals and objectives and formulating an implementation strategy that will help achieve the desired resource conditions. CBP or a similar approach has been utilized for lake restoration projects, stream restoration projects, watershed protection projects and groundwater protection projects in both urban and agricultural settings.

Several watershed plans have been developed in the project area (Table 1-3). Two of these plans have been accepted by EPA as official 9 Element Plans. A majority of the plans were prepared for specific resources with implementation planned. Seven of the plans were developed in conjunction with a Total Maximum Daily Load (TMDL). While most of the reservoir watershed plans have been implemented, protecting these resources is an ongoing process making them a valid tool for guiding future implementation.

Table 1-3. Watershed Plans Completed in the Basin

Watershed	County	TMDL	Completed	9 Element Plans Accepted by EPA	Status
Carter Lake	Douglas	Yes	2008	X	Inactive
Glenn Cunningham Reservoir	Douglas	Yes	2003	X	Inactive
Papillion Creek	Washington Douglas Sarpy	Yes	2004 (R2014)(a)		Active
Pigeon-Jones Creek	Dakota	No	1999		Active
Kramper Lake (PJ-15)	Dakota	No	2010	X	Inactive
Standing Bear Reservoir	Douglas	Yes	1998		Inactive
Walnut Creek Reservoir	Sarpy	No	1997		Inactive
Wehrspann Reservoir	Douglas	Yes	1995		Inactive
Zorinsky Reservoir	Douglas	Yes	1997	X	Inactive
Lower Platte River Corridor	Saunders	Yes	TBD		Began 2014
Thompson Creek	Sarpy	No	NA		Inactive

(a) Plan revised in 2014.

1.3 PLANNING PROCESS SUMMARY

1.3.1 Steering Committees

The P-MRNRD and the City of Omaha began development of two steering committees in February 2016, which consist of stakeholders from wide-ranging backgrounds, areas of interest and technical expertise. The P-MRNRD and the City of Omaha chose to form steering committees based on geographic regions instead of HUC 8 watershed boundaries. Due to large differences in land use, demographics (urban vs rural), and probable resource concerns, the Basin was divided into the North and South Planning Areas along the Washington and Douglas County border, as shown on Figure 1-3, each with a steering committee comprised of local public and technical experts. The purpose of steering committees was to gather input from a diverse set of stakeholders living and working in the Basin, in addition to technical representatives from agencies such as NDEQ and NGPC. Each steering committee is comprised of individuals who participate throughout the process by attending meetings and providing post-meeting feedback to P-MRNRD and the City of Omaha (Tables 1-4 and 1-5). Each steering committee met two times and participated in two public open houses throughout the course of the Plan development. The steering committees, NDEQ, P-MRNRD and the City of Omaha were responsible for ensuring all sources of information were available to plan writers, reviewing plan chapters and providing input on the content of the plan. The steering committees also helped establish resource management priorities, prioritized projects and were utilized regularly as resources during the planning process.

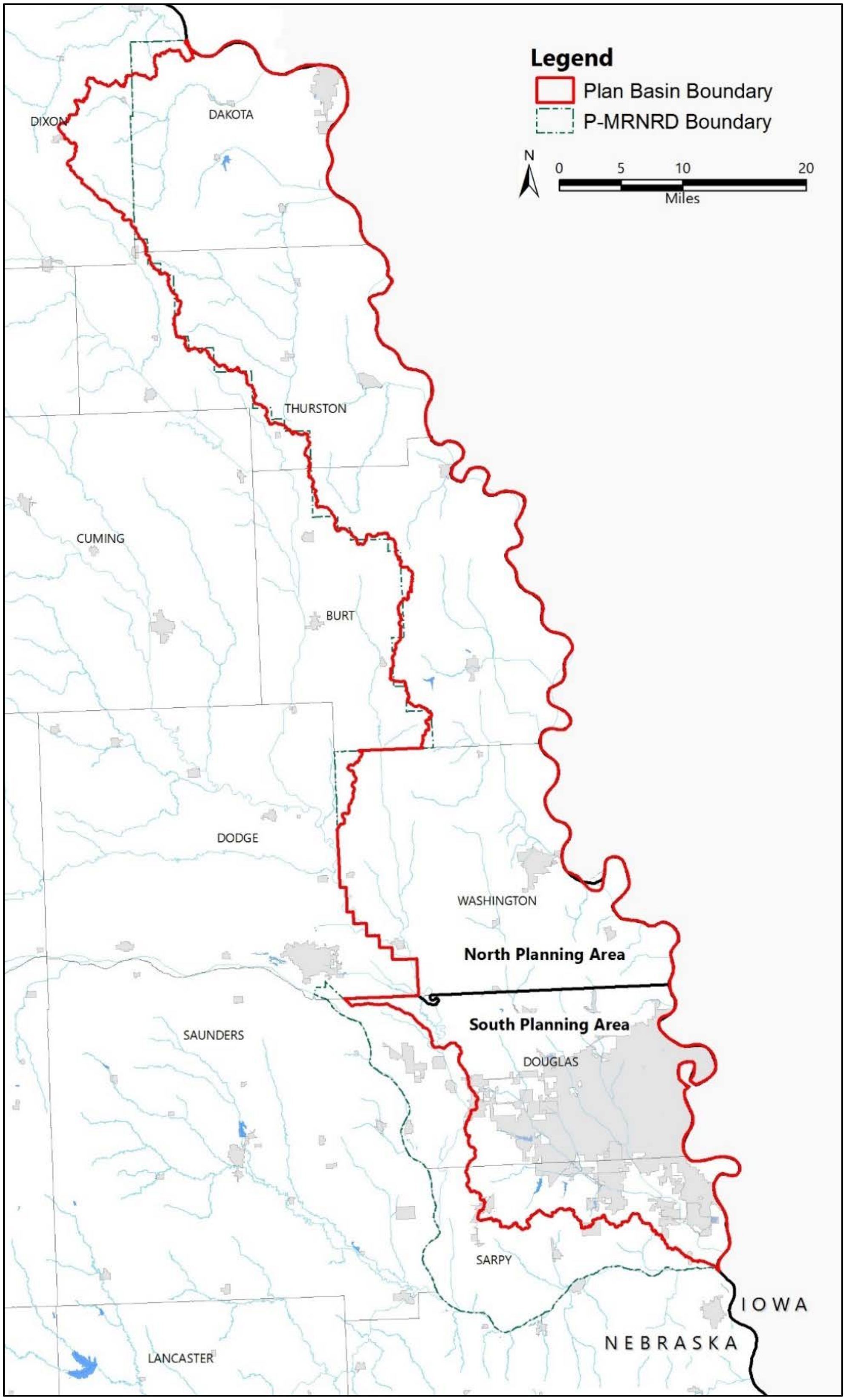


Figure 1-3. Planning Areas

Table 1-4. North Planning Area Steering Committee Members

Name	Representing
Amanda Grint	P-MRNRD
Marlin Petermann	P-MRNRD
Rod Storm	City of Blair
Linda Welsher	City of Fort Calhoun
Justin Novak	P-MRNRD - Blair
Peggy Smith	Burt County
Neil Jensen	NRCS
Terry Schumacher	P-MRNRD - Blair
Andy Bohnenkamp	NRCS
Tanna Wirtz	Washington County
Andy Lux	Public
Robert Parker	NDEQ
John Holz*	FYRA Engineering
Sara Mechtenberg*	FYRA Engineering
Jon Mohr*	LakeTech

*Consultant Team

Table 1-5. South Planning Area Steering Committee Members

Name	Representing
Amanda Grint	P-MRNRD
Marlin Petermann	P-MRNRD
Lori Laster	P-MRNRD
Nina Cudahy	Omaha Public Works
Andy Szatko	City of Omaha
Jim Kee	Omaha Public Works
Bruce Fountain	Sarpy County
Donna Lynam	Sarpy County
Denny Wilson	Sarpy County
Scott Kardel	Boys Town
Mark Stursma	City of Papillion
Jeff Thompson	City of Papillion
Marty Leming	City of Papillion
John Kottmann	City of La Vista
Chris Solberg	City of La Vista
Dan Freshman	City of Ralston
Jerry Chancellor	City of Ralston
Chris Shewchuk	City of Bellevue
Jeff Roberts	City of Bellevue
Kris Faris	City of Gretna
Steve Perry	City of Gretna
Jeff Jackson	NGPC
Marty Grate	Public
Robert Parker	NDEQ
John Holz*	FYRA Engineering
Sara Mechtenberg*	FYRA Engineering
Jon Mohr*	LakeTech

*Consultant Team

1.3.2 Public Outreach in Plan Process

The P-MRNRD project manager was responsible for organizing public feedback received by the NRD. Feedback was shared with the project team and incorporated into the Plan where applicable. Public involvement occurred through a variety of methods during the planning process including:

- Feedback from steering committees
- Feedback from the 11-member P-MRNRD Board of Directors (whom represent the public)
- Feedback from the Papio Creek Watershed Partnership Stakeholders
- The public had the opportunity to meet with the plan developers and steering committee members at open houses held in the North Planning Area and South Planning Areas.
- Public Service Announcements for the project and announcing open houses
- Social media and local newspaper announcements
- Use of a poster and flyers at the P-MRNRD office and outreach events requesting public input
- An opportunity to review the plan on the P-MRNRD website

1.3.3 Plan Organization

The document chapters have been written to make plan reviews convenient and are based on the NDEQ basin management plan guidance to be consistent with the priorities of the State's 2015 NPS Management Plan. Per NDEQ guidance, the Basin was divided into the major HUC 8 watersheds located within the Basin boundary. The majority of the Basin is comprised of two major HUC 8s: Big Papillion-Mosquito Creek (102300006) and Blackbird-Soldier Creek (100230001). A small portion of the Lower Elkhorn HUC 8 (10220003) within the Basin was combined with the Big Papillion-Mosquito Creek HUC 8 area to create what will be referred to in this Plan as the Papillion Creek watershed, and a small portion of the Lewis and Clark Lake HUC 8 (10170101) within the Basin was combined with the Blackbird-Soldier Creek HUC 8 area to create what will be referred to in this Plan as the Blackbird Creek watershed (Figure 1-4 on page 12). These are referenced frequently throughout the Plan and each are addressed in separate chapters that includes all of the 9 Elements.

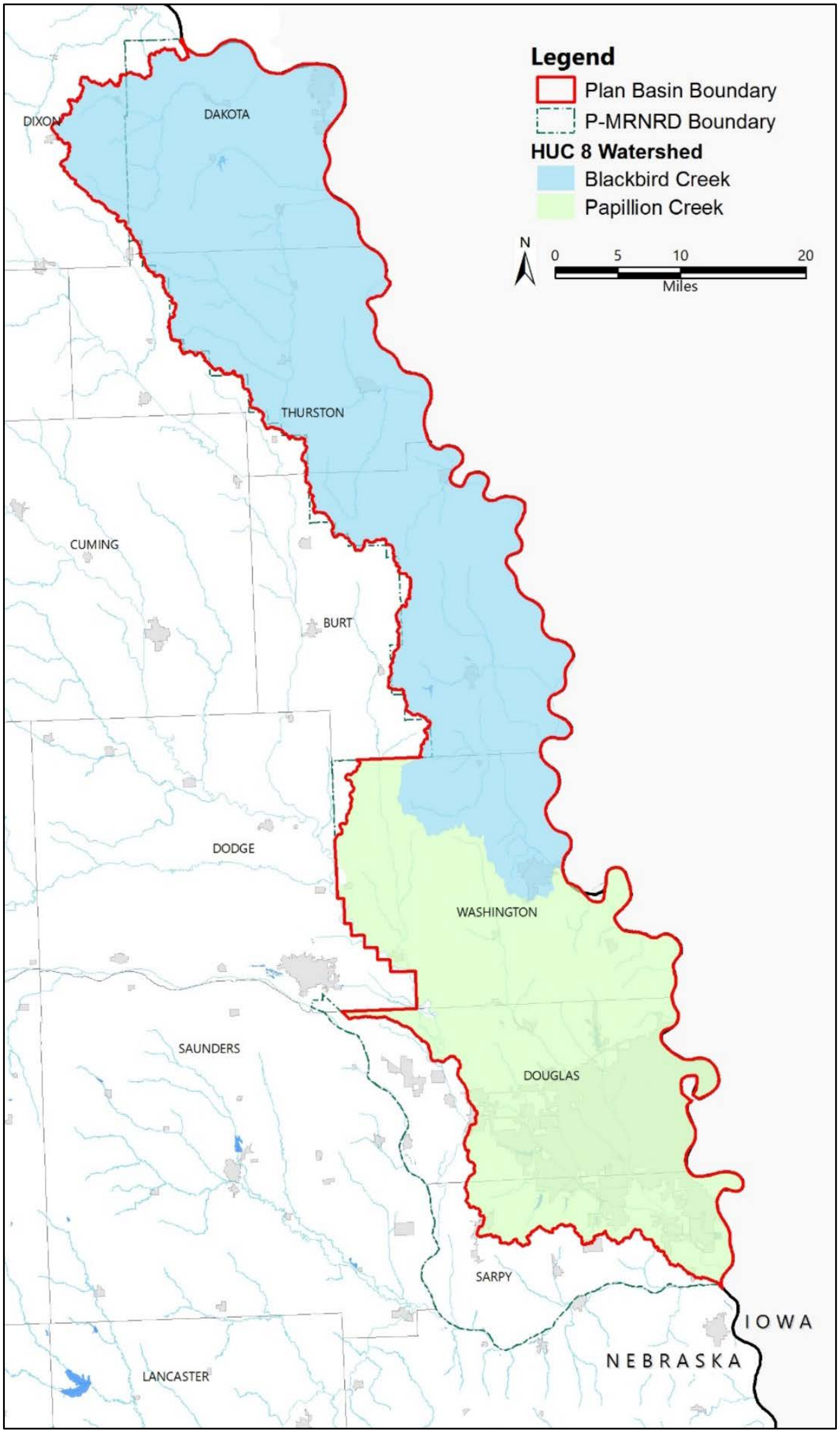


Figure 1-4. HUC 8 Watersheds

2 GOALS AND OBJECTIVES

The goals and objectives of the Plan are designed to guide future management decisions related to improvement of water quality. They will provide a connection between future implementation projects and the goals and objectives of the various conservation programs of partner agencies. In particular, they provide a direct connection to the State Nonpoint Source Pollution Management Plan.

GOAL 1 **Implementation of the Plan will result in attainment of water quality standards through comprehensive and collaborative actions that efficiently and effectively restore and protect water resources from degradation and impairment by nonpoint source pollution.**

Objective 1 *Actions for management of nonpoint source pollution will be based on sound data and effective directing of resources.*

Task 1 Review and, as necessary, revise monitoring and assessment methods and protocols to assure that data accurately detect and quantify natural resources threats and impairments and that data are useful in guiding management decisions.

Task 3 Review and, as necessary, revise the lists of priority watershed/sub-watersheds and special priority areas activities identified for restorative or protective management actions every five years.

Task 4 Review and amend the Plan at least every 5 years to update, at a minimum, the milestones and schedule for implementation.

Objective 2 *Strong working partnerships and collaboration among appropriate local, state, and federal agencies, and non-governmental organizations, will be established and maintained regarding management of nonpoint source pollution.*

Task 1 Participate in existing or newly created inter-organizational advisory committees and work groups to communicate issues regarding management of natural resources.

Task 2 Retain and enhance local agencies to assist in planning and implementing natural resources management projects and activities.

Task 3 Maintain an active working relationship with the Papillion Creek Watershed Partnership (PCWP).

Objective 3 *Comprehensive and systematic strategies will be employed to restore and protect natural resources from nonpoint source pollution and to communicate nonpoint source information.*

Task 1 Develop project plans that implement actions outlined in the Plan.

Task 2 Implement projects in priority watersheds/sub-watersheds and special priority areas that restore and protect natural resources, reduce pollution of water resources, and lead to delisting of impaired waters or protection of high quality waters.

Task 3 Utilize multiple conservation programs and complementary practices in implementing projects.

Objective 4 *The status, effectiveness, and accomplishments of projects and activities directed toward management of water resources will be continually assessed and periodically reported to appropriate audiences.*

Task 1 Conduct progress and financial reviews of grant-funded implementation projects.

Task 2 Track and assess conservation and outreach activities to assure that restoration and protection of natural resources, and distribution of project information, are adequately addressed in a timely manner.

Task 3 Summarize accomplishments and recommendations for further actions in implementing the Plan in annual and final project reports, periodic reports to partners, and project success stories.

GOAL 2 **Resource managers, public officials, community leaders, and private citizens will understand the effects of human activities on water quality and support actions to restore and protect water resources from impairment by nonpoint source pollution.**

Objective 1 *Deficiencies in knowledge needed to improve decision making regarding management of nonpoint source pollution will be identified and investigated.*

Task 1 Identify unique and under-served audiences to be engaged through outreach.

Task 2 Identify knowledge gaps in key audiences that impede their participation in actions to manage natural resources.

Objective 2 *Tools to effectively transfer knowledge and facilitate actions regarding management of natural resources will be developed, improved, and maintained.*

Task 1 Promote the goals and objectives of the Plan, assist key audiences in participating in conservation programs and activities, and serve as knowledgeable ambassadors to inform and educate landowners about natural resources management in their watershed.

Task 2 Develop and improve effective communication programs, projects, and activities to educate key audiences about management of natural resources.

Task 3 Develop and distribute audience-specific materials to inform and engage community leaders, local media, youth, educators, and other defined audiences regarding natural resources management.

Task 4 Utilize the existing PCWP communication networks and websites (e.g., PCWP) to publish information and ongoing Plan activities.

GOAL 3 The water, land, and biological resources in watersheds of the Basin will be healthy, productive, and sustainable.

Objective 1 Reservoirs, streams, and groundwater resources will meet or exceed levels of quality and quantity necessary to serve the needs of the citizens in the Basin.

Task 1 Promote conservation practices and activities that sufficiently reduce pollutant loads to restore or protect designated beneficial uses of surface water resources.

Task 2 Continue to construct structural practices that control and trap pollutants from existing and newly planned reservoirs used for recreation.

Task 3 All new developments in the Papillion Creek watershed must abide by the rules of the PCWP.

Objective 2 The land and stream resources in the watersheds of the Basin will be stable and productive.

Task 1 Coordinate with other agencies to promote agricultural conservation practices and activities that improve soil health by reducing erosion, increasing organic matter, and improving soil structure.

Task 2 Implement agricultural conservation practices and activities that improve soil moisture availability by increasing infiltration and retention of precipitation and irrigation water.

Task 3 Promote practices and activities that repair and prevent bank erosion at critical infrastructure and promote natural bank stabilization at non-critical sites to improve stream stability.

Task 4 Promote practices and activities that repair and prevent stream bed erosion at nick points and reduce gully formation to improve stream stability.

Objective 3 The riparian corridors along streams and tributaries within the Basin will support a natural community of flora and fauna that is healthy and productive.

Task 1 Promote policies that protect stream corridors, waterways, and other sensitive environments from the effects of future development or other changes in the Basin.

Task 2 Encourage low impact development practices into developments that provide green solutions to stormwater management.

Task 3 Promote practices and activities that provide riparian zone and stream habitats with appropriate cover, structure, and substrate to support appropriate aquatic and terrestrial species.

3 BASIN APPROACH

3.1 BASIN CHARACTERISTICS

3.1.1 Climate

Temperatures across the Basin are typical of North American temperate zone latitudes with warm summers and cold winters, and variable seasonal precipitation patterns. The average annual minimum and maximum temperatures for the Basin are 39 degrees F and 61 degrees F, with an average of 50 degrees F. The average winter temperature is 24 degrees F and the average daily minimum is 14 degrees F. In the summer, the average temperature is 74 degrees F and the average daily maximum is 84 degrees F. As expected, these temperatures are conducive to agricultural land use practices, with the highest growing degree days occurring during the months of May through September.

The total annual precipitation ranges from 29 to 30 inches across the Basin (Figure 3-1). Approximately 19 inches of this total, or 64%, occurs in April through September. This precipitation pattern correlates with the annual distribution of growing degree days and produces a climate that is well-suited for agricultural activities. The average seasonal snowfall is 25 inches and an average of 16 days of the year have at least one inch of snow on the ground. However, the number of snow covered days varies significantly from year to year. The prevailing wind is from the north from January through April and from the south during the rest of the year. The average wind speed is highest in March and April, at more than 12 miles per hour.

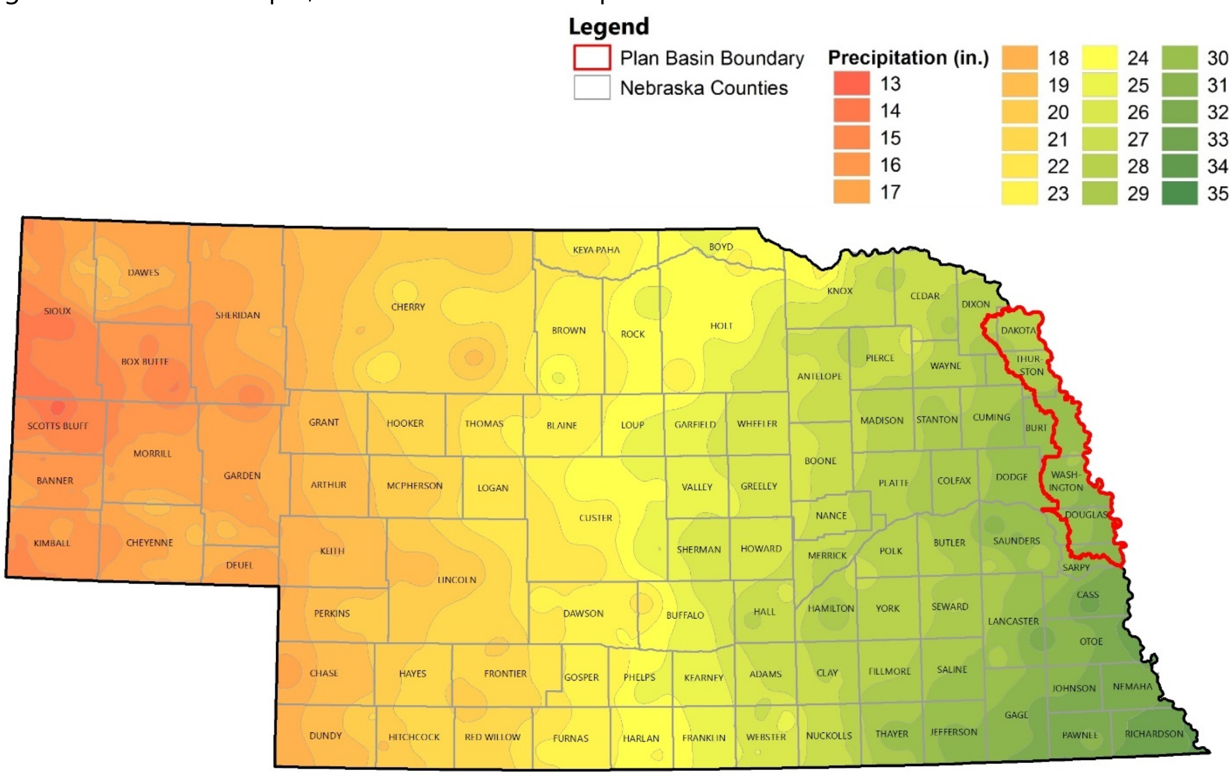


Figure 3-1. Nebraska Average Annual Precipitation

3.1.2 Topography

The Basin is generally characterized by two major landform divisions: the uplands, which were formed in loess and glacial till, and the floodplains, which formed in alluvium along the Missouri River. The uplands consist of the hills and bluffs adjacent to the Missouri River and the rolling loess topography with lower slopes found to the west and central areas of the southern portion of the Basin (Figure 3-2). The floodplains are flat and exist about 100 to 300 feet below the uplands. The lowest elevation of 857 feet above sea level is located in the floodplain located in the southeast corner of the Basin. The highest elevation of 1,608 feet above sea level is found in the northern portion of the Basin (Figure 3-3).

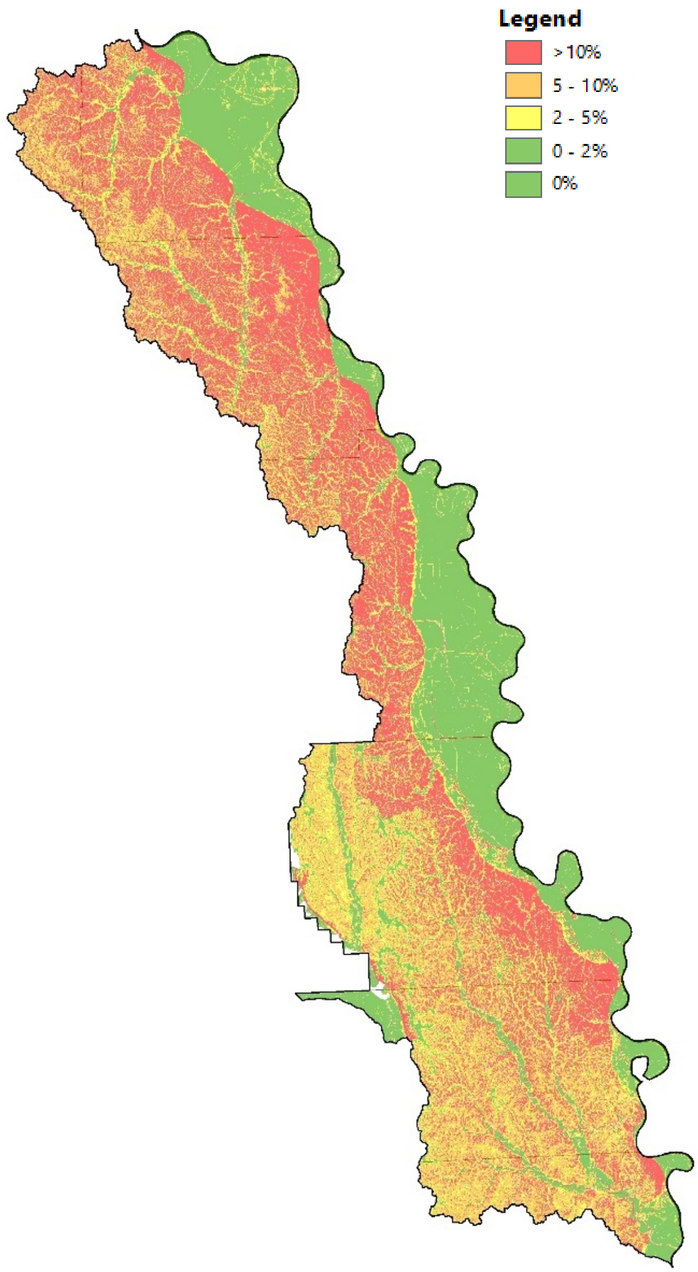


Figure 3-2. Slopes of the Papio-Missouri River Basin

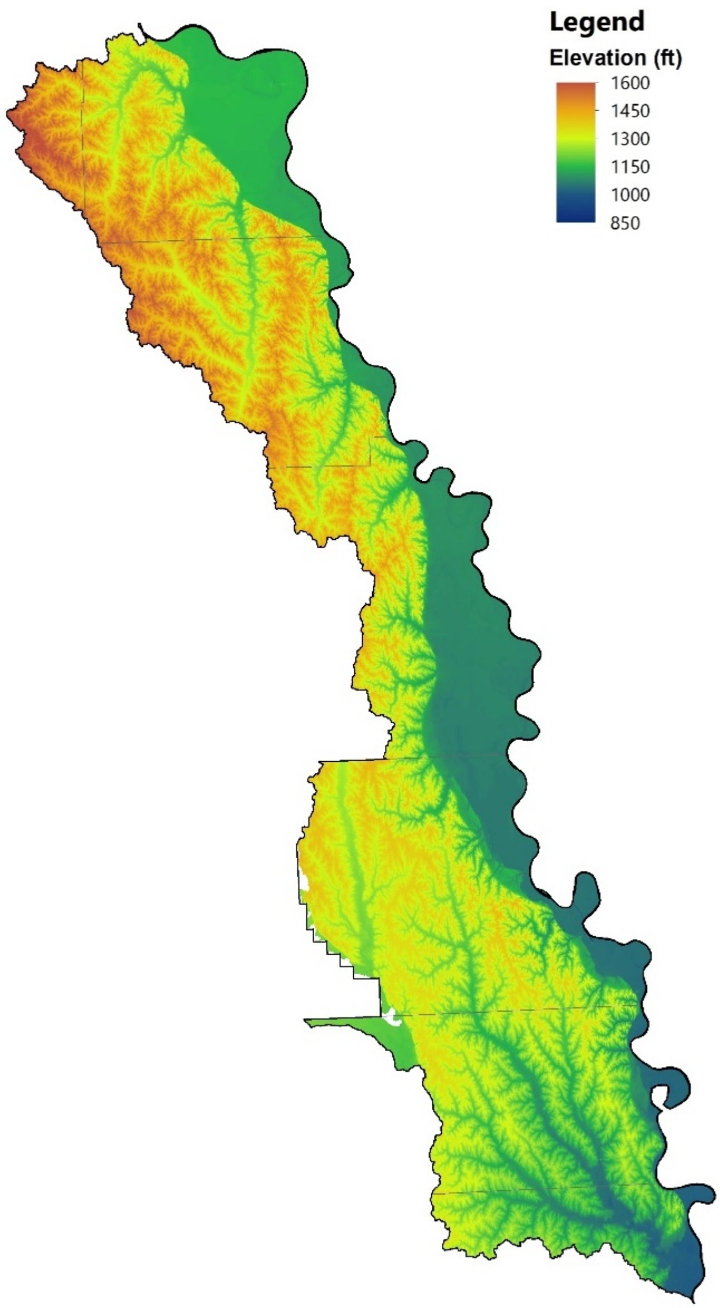


Figure 3-3. Elevations of the Papio-Missouri River Basin

3.1.3 Soils

There are eight described soil associations in the Basin (Figure 3-4), with three main associations comprising over three quarters of the soils (Table 3-1). The Marshall-Ponca and Monona-Ida associations alone include the majority of the soils (52.6%) and are similar in that they are both very deep, well-drained silty soils found on uplands. However, the Monona-Ida soils are more strongly sloping, which is consistent with the topography of the more northerly portions of the Basin. The Albaton-Haynie-Sarpy soils are formed in alluvium in the bottomlands along the Missouri River and account for 22.7% of the total acres of the Basin. These soils can include clays, silts and sands; and are characterized as deep, nearly level and moderately to well drained.

Loess covers most of this area and is very erodible. It consists of pale brown or light grayish brown, calcareous, silty material deposited by the wind. The loess is mainly of Peorian age and it ranges from 6 to 70 feet in thickness. The soils generally have moderate permabilities, with smaller areas of low permeability in bottomlands with higher clay content (Figure 3-5). Moderate to high permeability increases the vulnerability of groundwater to contaminant leaching, while low permeability increases the vulnerability of surface water.

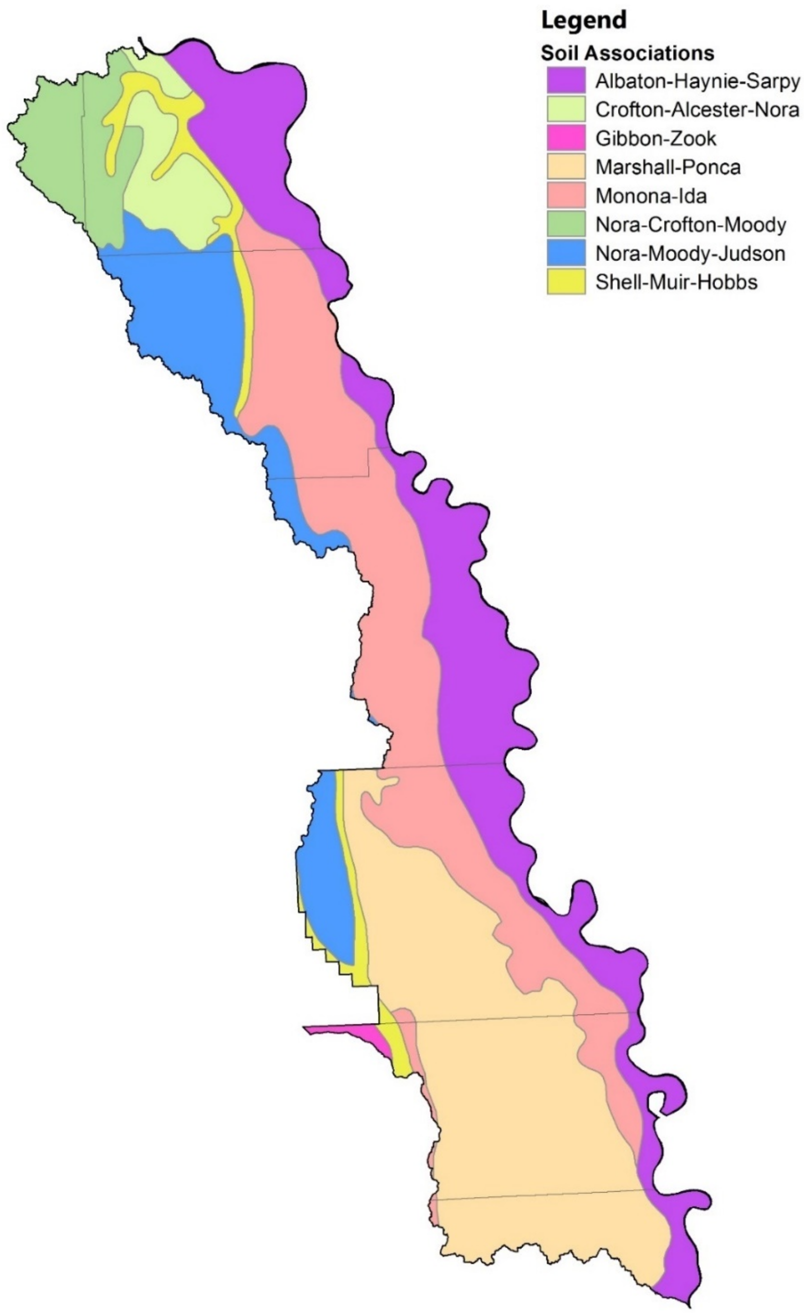


Figure 3-4. Soil Associations of the Papio-Missour River Basin

Table 3-1. Soil Associations by Total Acres and Percentage

Soil Association	Area (ac)	% of Total
Marshall-Ponca	282,328	27.5%
Monona-Ida	257,127	25.1%
Albaton-Haynie-Sarpy	232,858	22.7%
Nora-Moody-Judson	110,964	10.8%
Nora-Crofton-Moody	56,903	5.5%
Shell-Muir-Hobbs	41,445	4.0%
Crofton-Alcester-Nora	40,871	4.0%
Gibbon-Zook	3,868	0.4%

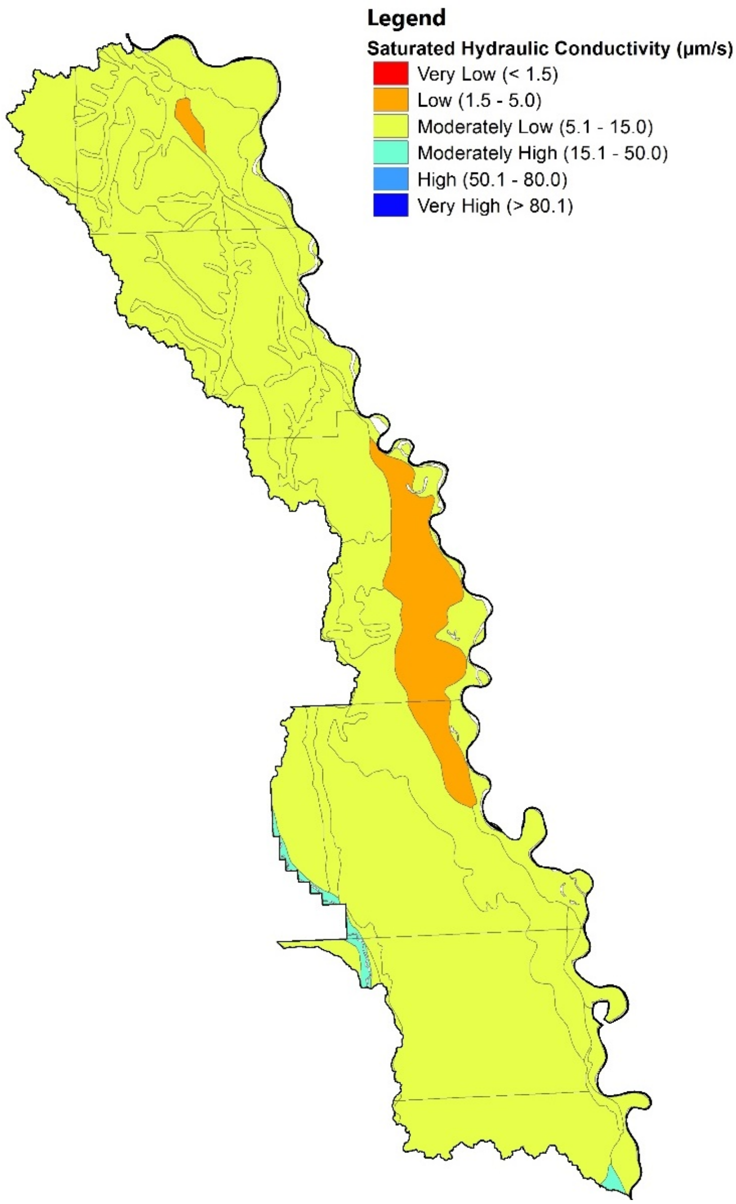


Figure 3-5. Soil Permeability in the Papio-Missour River Basin

3.1.4 Land Use

Land use in the Basin is generally dominated by agriculture with corn and beans being the primary land cover, especially in the northern areas of the Basin. The southern portion has a much higher "developed" land use category which is primarily attributed to metro Omaha (Figure 3-6). Land cover changes associated with those categories can have a significant impact on water quality. An analysis of land use changes from 2009 to 2015 shows a twelve percent increase in developed land, indicating the need for innovative urban BMPs and land development plans that account for water resource protection as urbanization continues (Table 3-2). However, the trend analysis also reveals that agricultural land use is likely putting increased pressure on water resources. Non-crop land use decreased by 15% and crop land use increased by 13%, suggesting a conversion of land to cropping practices (Table 3-3).

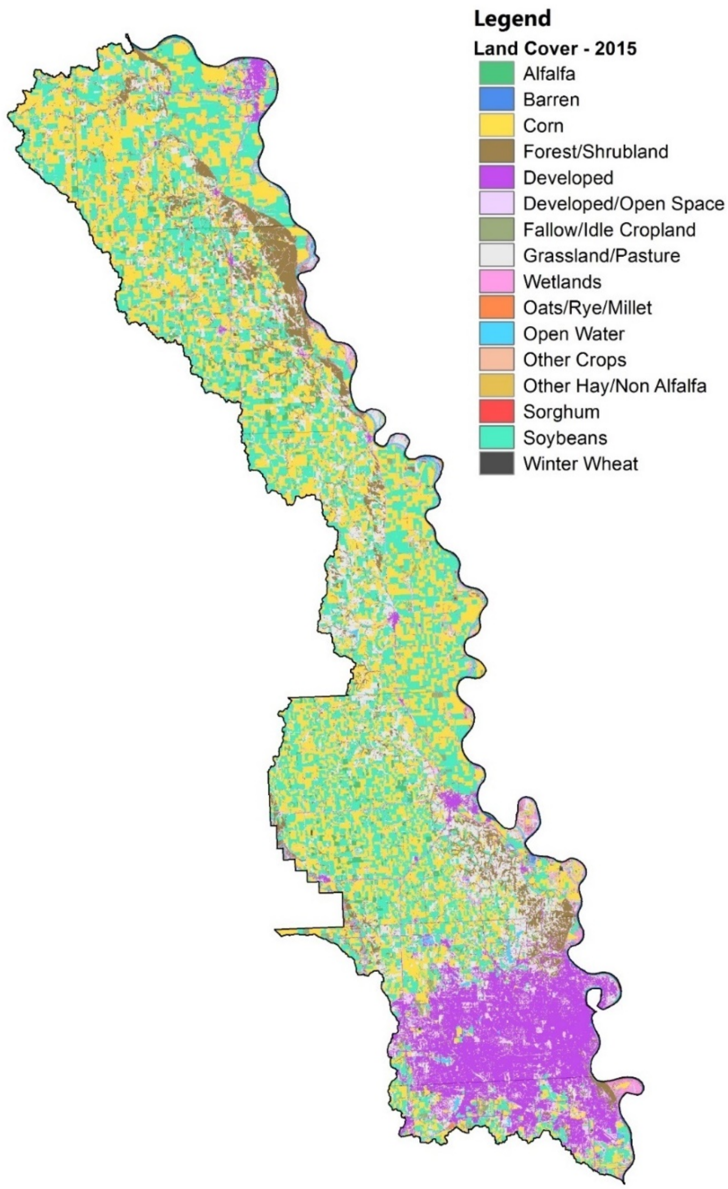


Figure 3-6. 2015 NASS Land Cover for the Papio-Missouri River Basin

Table 3-2. Land Cover Changes from 2009 to 2015

Category	2009 Land Cover (ac)	2015 Land Cover (ac)	Change from 2009 to 2015 (ac)	Change from 2009 to 2015 (%)
Corn	288,242	317,411	29,169	10%
Soybeans	239,917	267,075	27,158	11%
Grassland/Pasture	207,726	125,674	-82,052	-40%
Developed	108,300	121,439	13,139	12%
Forest/Shrubland	68,712	75,785	7,074	10%
Developed/Open Space	71,661	54,667	-16,994	-24%
Alfalfa	17,269	24,068	6,800	39%
Wetlands	14,432	19,668	5,236	36%
Open Water	13,999	15,894	1,895	14%
Fallow/Idle Cropland	126	7,497	7,371	5857%
Other Hay/Non Alfalfa	2,172	3,237	1,064	49%
Oats/Rye/Millet	2,037	1,770	-267	-13%
Barren	410	950	540	132%
Winter Wheat	1,413	871	-542	-38%
Sorghum	48	371	323	666%
Other Crops	276	363	87	32%

Table 3-3. Row Crop and Undeveloped Land Cover Changes

Category	2009 (ac)	2015 (ac)	Change (ac)	Change (%)
Crop*	551,500	622,662	71,163	13%
Non-Crop**	485,240	414,077	-71,163	-15%

*crops which require some level of tillage, including corn, soybeans, sorghum, and winter wheat

**non crop includes all other categories, such as barren ground, forest, shrubland, developed, water and grass/pasture

3.2 BASIN WATER RESOURCES

3.2.1 Streams

Streams are distributed throughout the Basin and are located in more rural areas in the northern portion and in more urban settings in the southern portion of the Basin (Figure 3-7). Concerns associated with the rural streams include stream bank stability and streambed degradation due to hydrologic modification of natural drainage systems. These modifications have led to steeper streambed slopes, stream incision, stream bank erosion and decreased habitat. The topography of the Basin near the Missouri River transitions from generously sloping to very flat in the floodplain. Sediment deposition at locations in floodplain waterways is a common concern. The use of commercial fertilizers and manure on crops has resulted in increased nutrient loading to streams. Runoff from animal feeding operations (dependent upon control measures) and wildlife are potential sources of animal waste that can carry bacteria, viruses and additional nutrients. Livestock overgrazing in some areas has exposed soils, increased erosion, compromised fish habitat, and contributed to bank failure.

Urban streams area located in areas with impervious surfaces which has reduced infiltration and increased runoff. The drainage to many urban stream segments in the south portion of the Basin includes runoff from rural area in the headwaters from the north, therefore entering in the urban area carrying the associated pollutant load. Storm sewers have also concentrated the urban runoff and increased the stream bank and bed erosion. Space along the stream corridors is often limited and frequent issues with bank failure cause costly damages to local infrastructure and adjacent properties. Higher sediment loads and decreases in stream bank vegetation and habitat are common. Turf fertilizers, pet waste and failing septic systems contribute nutrients, bacteria and viruses to these waterbodies.

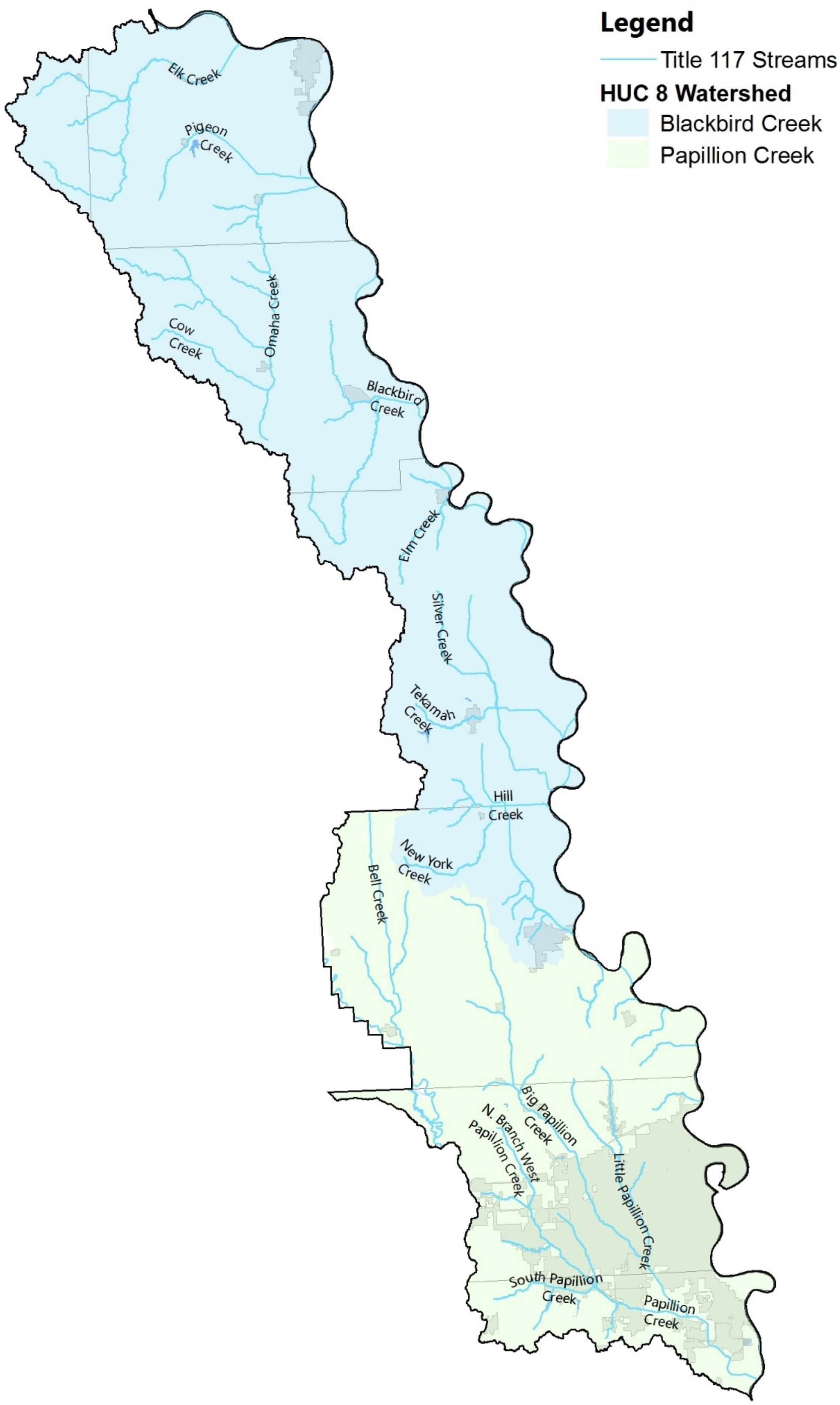


Figure 3-7. Major Streams in the Papio-Missouri River Basin

3.2.2 Lakes

The majority of the lakes are located in southern portion of the Basin (Figure 3-8) and are primarily impacted by sediment, phosphorus, nitrogen and bacteria from inflowing streams and stormwater. As a result, these lakes can have sediment turbidity, excessive algal production, low oxygen concentrations, poor transparency and algal toxins. Sedimentation has decreased the storage capacity of some reservoirs and reduced light penetration has inhibited macrophyte establishment in the littoral zone, thus reducing aquatic habitat. High bacterial inputs from streams and stormwater have also reduced recreational opportunities and waterfowl inputs of nutrients and bacteria are a growing concern.

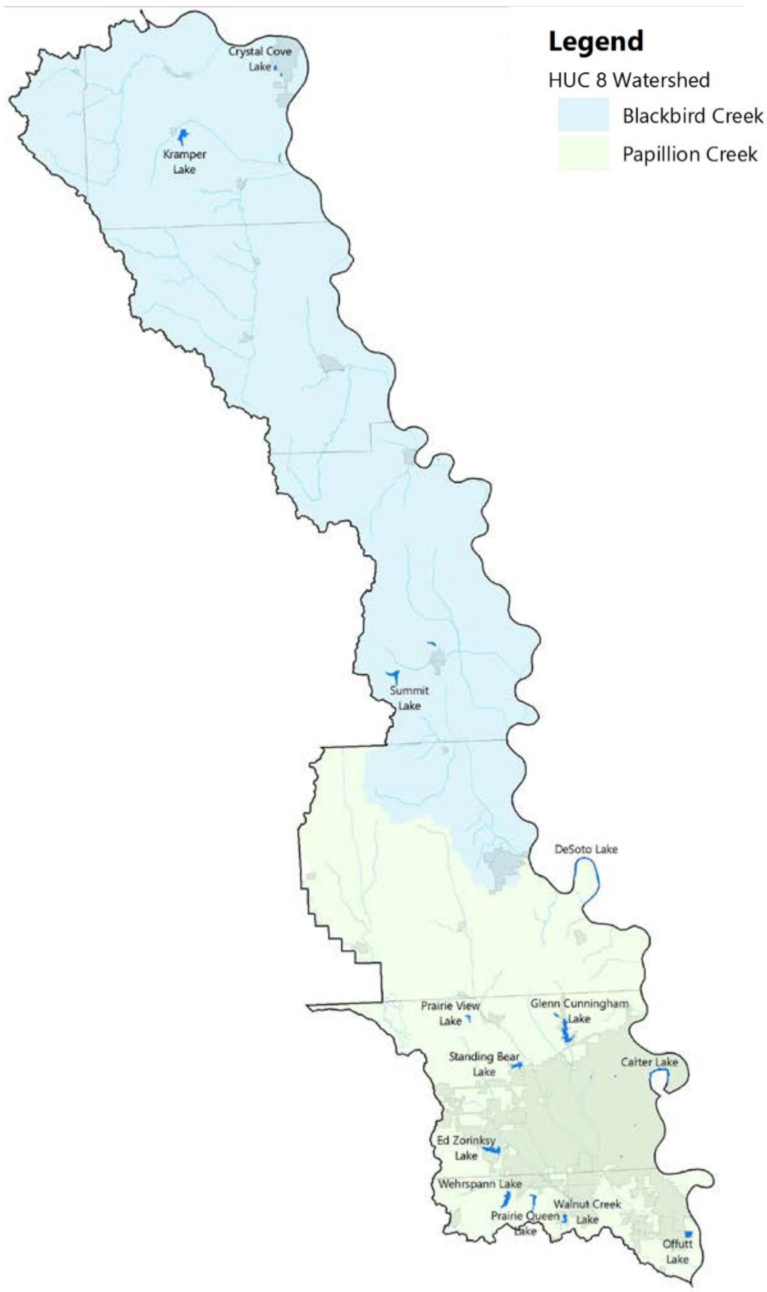


Figure 3-8. Major Lakes in the Papio-Missouri River Basin

3.2.3 Wetlands Resources

There are no major wetland complexes within the Basin. The National Wetlands Inventory (NWI) map (Figure 3-9) indicates there is a tendency for wetlands to establish in the floodplains, with large accumulations in locations where historic river meanders were severed to create oxbows. The remaining area in the bluffs with steeper slopes tend to establish linear wetlands connected with the stream system in the Basin.

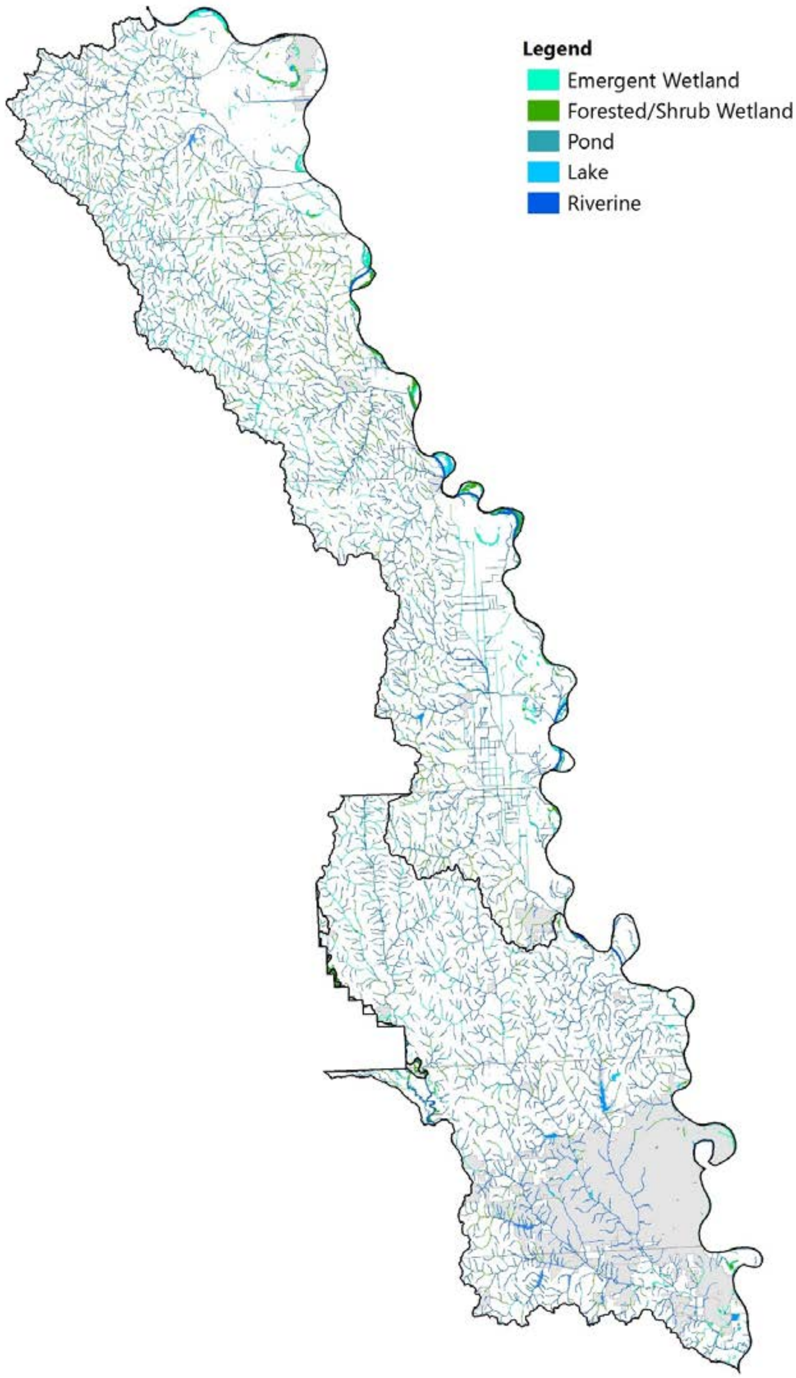


Figure 3-9. National Wetlands Inventory Map

3.2.4 Groundwater Resources

Nitrate leaching into the aquifer is a prime nonpoint source pollution threat. The majority of those living and working within the Basin depend on groundwater for drinking water. Nitrates are not a major concern throughout the area, but are present in isolated areas and necessary management action is required to limit issues. The P-MRNRD is tasked by state law to regulate both groundwater quality and quantity and is in the final steps of updating their Groundwater Rules and Regulations as part of their Groundwater Management Plan update. Communities are responsible for actions related to Wellhead Protection (WHP) and the P-MRNRD will assist in most cases, if requested.

The hydrogeology of the Basin is fairly complex due to a large distribution of glacial till, which is common in Nebraska east of the Elkhorn River (see Figure 3-10). The presence of glacial till limits the availability of water for high capacity uses such as irrigation. In areas where no glacial till is located, sand and gravel materials are present, and groundwater is more plentiful. This is the case along the Missouri River where a large alluvial aquifer is present. These areas are more susceptible to contamination due to high infiltration soils in combination with row crop agriculture and use of commercial fertilizers.

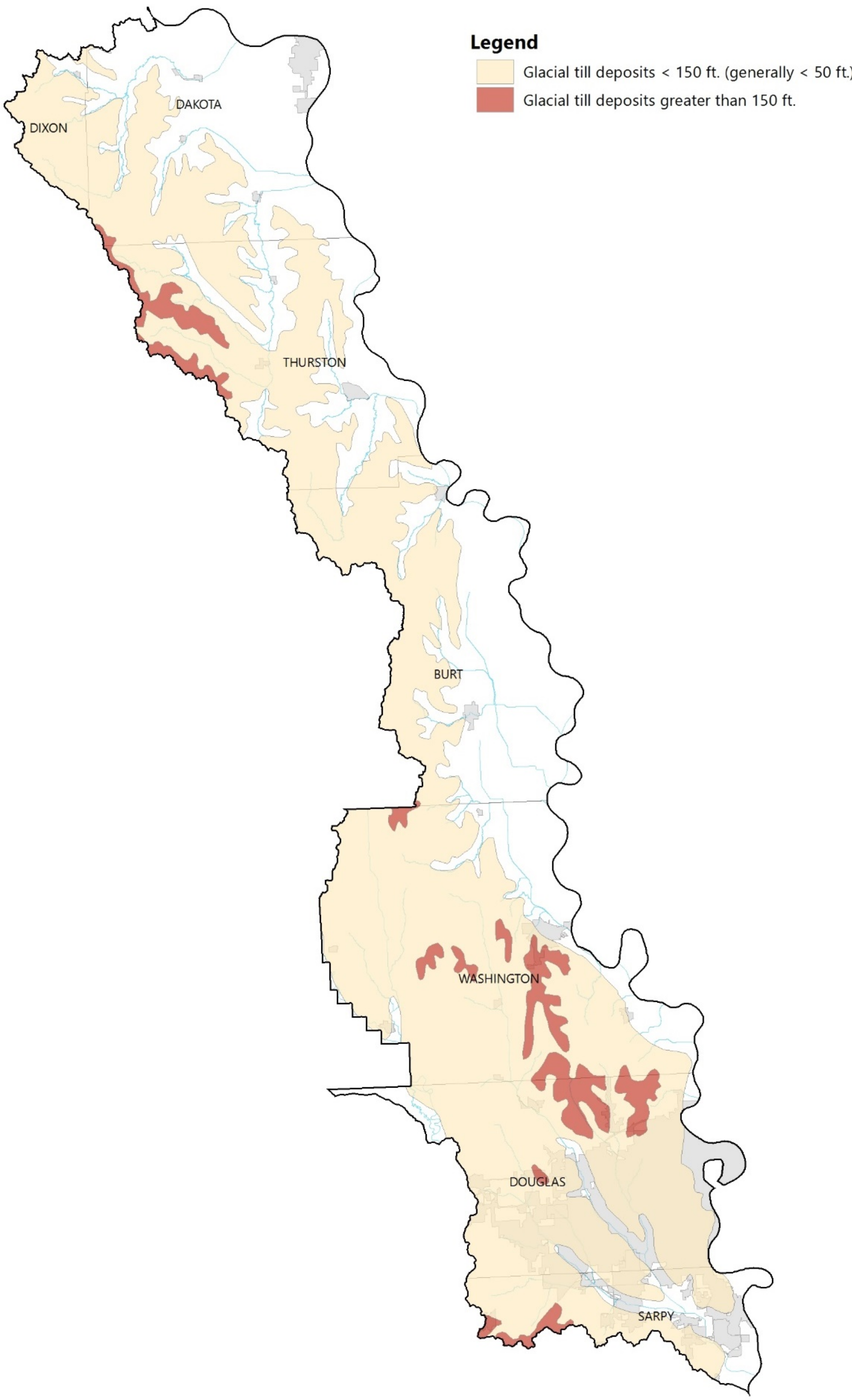


Figure 3-10. Glacial Till Deposits

3.2.5 Registered Wells

There are a total of 5,577 registered wells within the Basin. Unlike other parts of Nebraska, irrigation wells are not the most common, rather monitoring and domestic wells are, accounting for a total of 59 percent (locations in Figure 3-11). The distribution of all registered well use is shown in Figure 3-12.

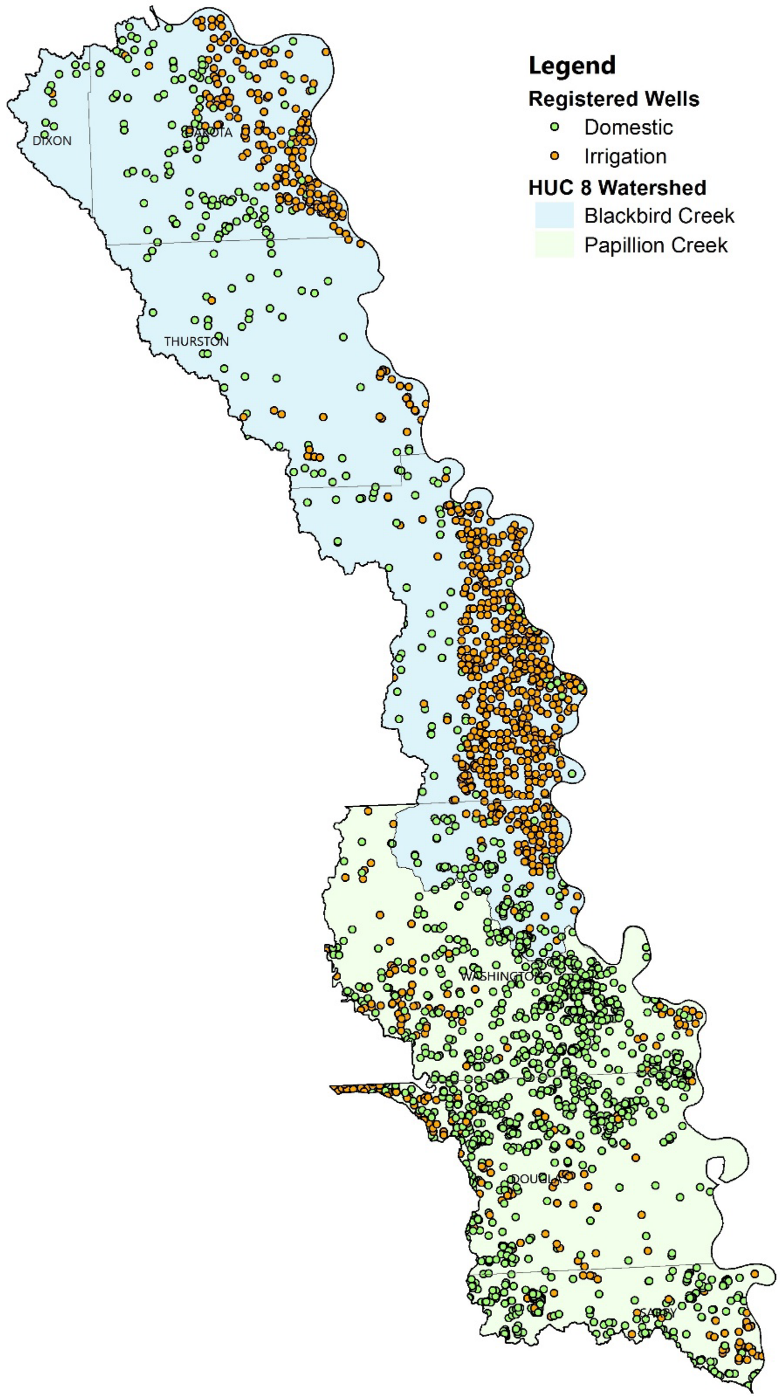


Figure 3-11. Registered Domestic and Irrigation Well Locations

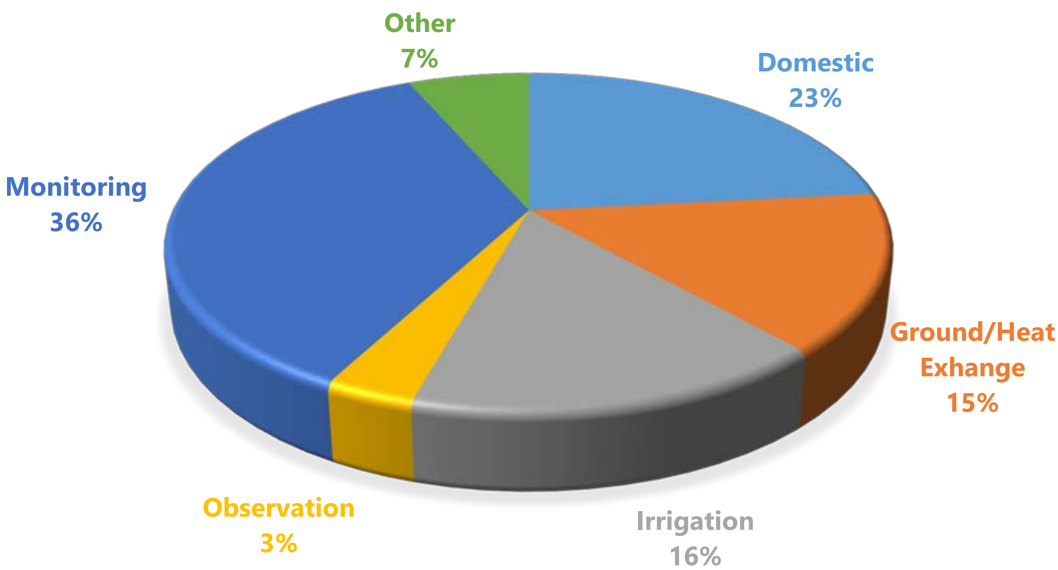


Figure 3-12. Distribution of Active Registered Wells

3.2.6 Wellhead Protection Areas

WHP areas have been delineated for all public water systems in the Basin. There are a total of 15 WHP areas, each shown in Figure 3-13 categorized by the highest nitrate level within the wellfield between 2014 and 2015. Nitrate levels within WHP areas are relatively low, especially in the north portion of the Basin (Table 3-6). Tekamah is the only community with a significantly elevated nitrate concentration. Due to elevated nitrate concentrations, the Tekamah WPA has been identified in the Groundwater Management Plan as a Phase II Groundwater Quality Management Area (concentration greater than 5 ppm) that must abide by more stringent rules and regulations.

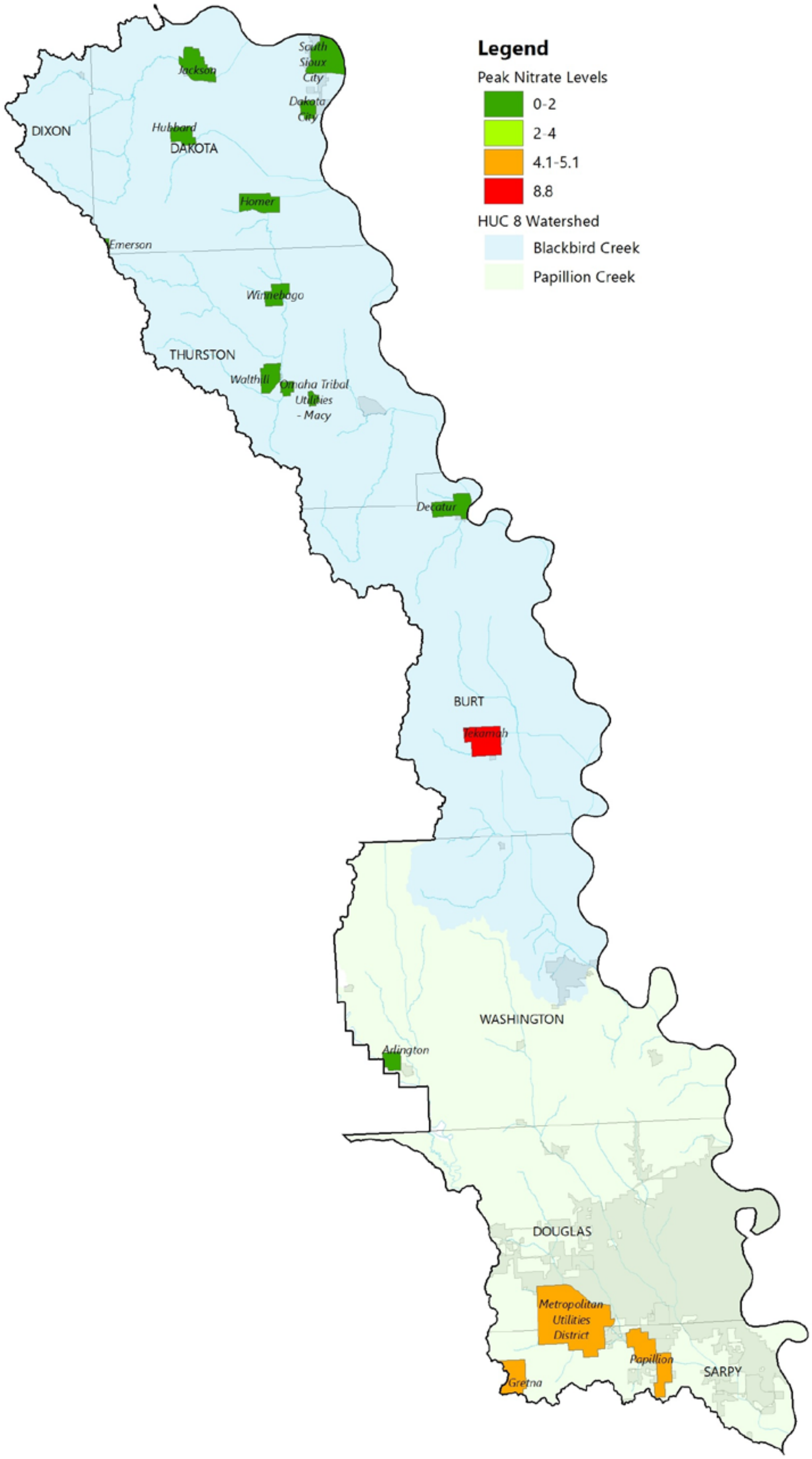


Figure 3-13. Wellhead Protection Areas

Table 3-4. Wellhead Protection Area Peak Nitrate Levels 2015

Public Water Supplier	NO_3 ppm
Tekamah	8.8
Gretna	5.1
Metropolitan Utilities District (Omaha Metro)	5.1
Papillion	4.4
Omaha Tribal Utilities	0
Macy	0
Hubbard	1.6
Jackson	0.9
Dakota City	0.7
South Sioux City	0.4
Homer	0.5
Arlington	0.1
Walthill	0
Decatur	0
Winnebago	0

3.2.7 Nitrate levels

Nitrate data for the Basin is relatively limited. The best available data was from the NDEQ Clearinghouse, which was sorted to show only data from 1997 through 2013. Nitrate levels are shown in Figure 3-14, displaying relatively low nitrate concentrations throughout most of the watershed.

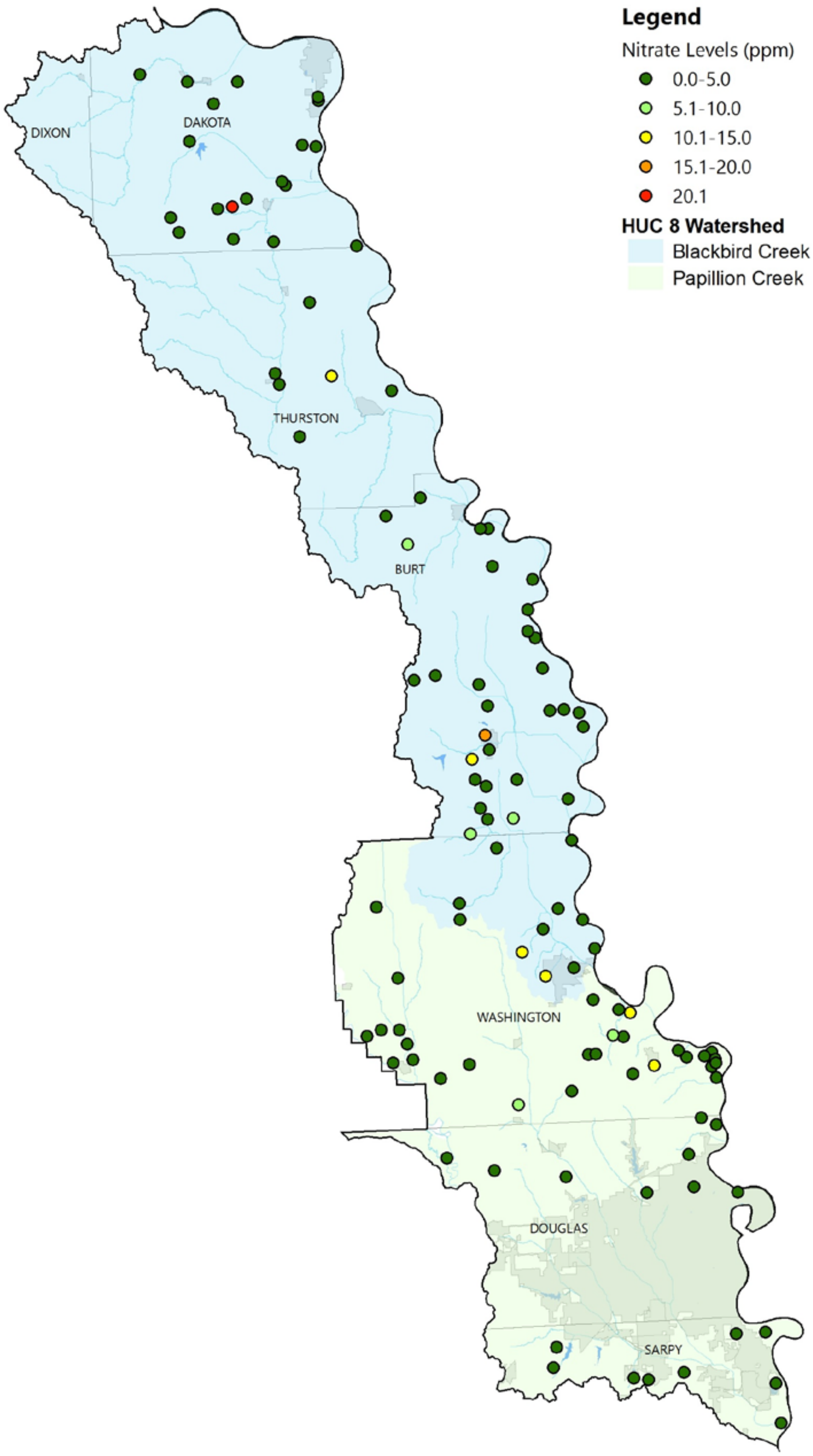


Figure 3-14. NDEQ Clearinghouse Nitrate Data

3.3 BASIN BIOLOGICAL RESOURCES

Historically, the dominant native vegetation on the bottom land and bluffs along the Missouri River was deciduous trees and it was tall grass prairie on the rolling uplands. However, very little of the land in the Basin still has an undisturbed cover of trees and grasses. Land use and management of native areas has significantly altered the original vegetative cover. A variety of wildlife is native to, or has adapted to, the diverse habitat of the Basin. Big game, upland game, furbearers, waterfowl and non-game species have been documented to reside within the Basin. Federally endangered species that have an estimated current range in the Basin and are dependent on water resources include the Pallid Sturgeon and Interior Least Tern. Federally threatened species include the Piping Plover.

4 MONITORING AND EVALUATION

4.1 INTRODUCTION

Successful resource management is best achieved when adequate data and information are available to make educated management decisions. Monitoring and data collection is critical as it allows for the assessment of resource health and condition, identification of specific resource concerns, the development of sound projects and the tracking of water quality and quantity trends over time.

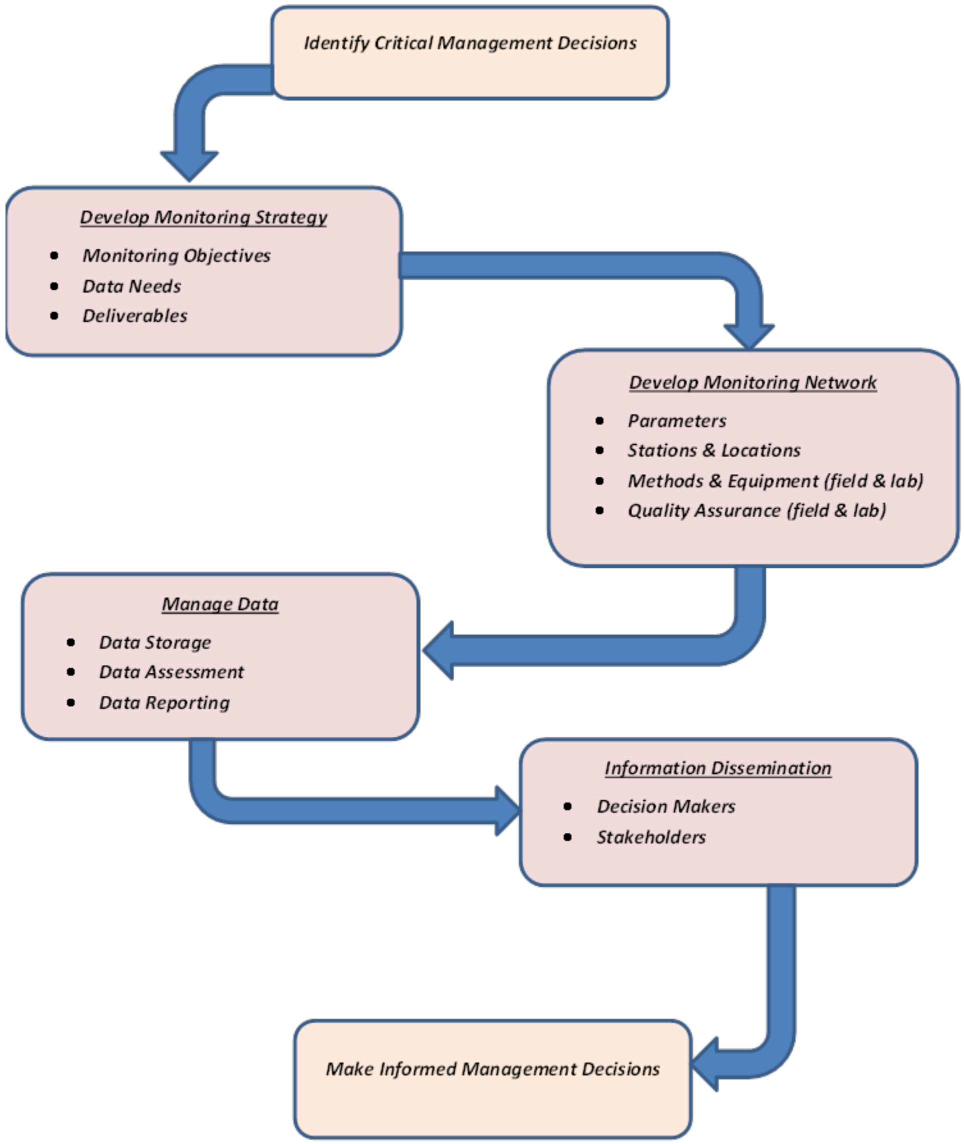
The P-MRNRD and the City of Omaha will follow appropriate planning approaches in order to ensure the most efficient and effective use of monitoring funds. This includes developing sound and defensible monitoring strategies and networks, properly managing data and disseminating information to decision makers and other stakeholders (Figure 1). Monitoring goals are achieved through coordinated monitoring, monitoring partnerships, and other available data that meets the required data quality. Steps will be taken to ensure the collection of scientifically valid data, which can include the development of Quality Assurance Plans and Monitoring Plans (QAPPs) for state and federal review.

The monitoring strategy in this Plan was designed to address a broad range of water resource management activities that are relevant to basin-wide and localized water planning, project development and implementation. This strategy provides an overall monitoring framework for project sponsors and provides the basis for more detailed monitoring plans such as QAPPs.

4.2 PURPOSE OF MONITORING

An adequate understanding of the intended use of data is critical to effectively designing monitoring networks that facilitate water resource management. Physical, chemical and biological monitoring conducted in the Basin will be used for the follow purposes:

1. Evaluate current water quality conditions.
2. Provide water quality safety information to water users.
3. Maintain long term data sets for trend assessments.
4. Support water project or activity development.
5. Identify causes and sources of water quality problems.
6. Estimate pollutant transport.
7. Evaluate water management effectiveness.
8. Support future hydrologic modeling.
9. Ensure compliance with state and federal standards.
10. Evaluate water infrastructure for maintenance and repair.



Adapted from USEPA Monitoring Guidance (USEPA, 2016)

Figure 4-1. Water Monitoring Approach for the Papio-Missouri River Basin

4.3 DATA NEEDS AND USES

Identifying any gaps in water quality data, both in terms of spatial coverage and tested parameters, allows resource managers to utilize current efforts to meet the intended use of the data. In some cases, current networks may not provide enough information to evaluate, screen, prioritize and design future implementation strategies. In other cases, gaps in current data sets may not be sufficient to evaluate the effectiveness of existing improvement strategies.

The required data for these needs can be gathered through larger-scale, ongoing monitoring networks and targeted, project-specific monitoring.

Basin wide uses of monitoring data focuses on meeting four primary purposes:

- *Evaluate conditions by conducting beneficial use support assessments*. A comprehensive evaluation of beneficial use support conducted across the Basin over time provides an indication of regional water quality, including regional issues, and impairment causes.
- *Provide water quality safety information to water users*. Collect *E.coli* bacteria and algal toxin data that indicate health and safety concerns for body contact recreational waterbodies.
- *Maintain long term data sets for trend assessments*. An evaluation of multi-year water quality data sets allows the identification of emerging resource concerns, provides a basis for assessing basin-wide improvements or declines and is a method to evaluate the impact of implementation strategies.
- *Evaluate water management effectiveness*. Analyzing changes in the number of impaired waterbodies (and the cause of the impairment) over time (along with the long term trend assessments) provides an additional evaluation of the effectiveness of basin-wide implementation strategies.

4.4 CURRENT MONITORING NETWORKS

Effective monitoring networks are regularly evaluated individually and collectively to ensure the best possible use of all data and information. This entails the combined efforts of all entities involved in monitoring within the Basin (Table 1). While individual water monitoring networks are designed to meet the specific objectives of coordinating and funding agencies, many times the data and information can also be used to answer other important questions. These networks should be periodically revisited and addressed in order to address changing environments and water policies. Several networks utilize a "rotational" site approach, in which monitoring site locations change annually. A description of all current monitoring networks is provided in subsequent sections of this strategy.

Table 4-1. Current Monitoring Programs and Activities in the Papio-Missouri River Basin

Monitoring Networks	**NDEQ**	**NDNR**	**DHHS**	**NGPC**	**UNL**	**USGS**	**County**	**Municipality/ Facility**	**Landowner**
Rainfall						**X**			**X**
Surface Water - Basin Rotation	**X**								
Surface Water - Ambient Water Quality	**X**					**X**			
Surface Water - Beach Water Quality	**X**					**X**			
Surface Water - Stream Biological	**X**			**X**					
Surface Water – Specialized	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Surface Water - Flow/Discharge		**X**				**X***			
Surface Water - Volume Impounded	**X**	**X**							
Surface Water - NPDES Permit	**X**								**X**
Groundwater - Ambient Quality	**X**					**X**			
Groundwater - Livestock Facilities	**X**								**X**
Groundwater – Observation Wells						**X***			
Groundwater - Well Metering									**X**
Groundwater – Nitrate Monitoring						**X***			**X**
Fish Kills/Spills/Citizen Complaints	**X**	**X**	**X**	**X**					
Soil Sampling									**X**

**P-MRNRD provides cost-share*

4.5 SUMMARY OF ONGOING MONITORING NETWORKS

Both fixed and rotating site monitoring are used to evaluate water quality on streams, rivers and impounded waters across the Basin. Core indicators and stressors are used in conjunction with supplemental data collection to address a specific management decision or support project development. A majority of the surface water quality monitoring in the Basin is conducted either by NDEQ or USGS through a variety of surface water monitoring and assessment programs. Information from past surface water quality monitoring can potentially be used as a pre-project benchmark for tracking water quality improvements and trends in the Basin as this Plan is implemented. Project coordination with agencies such as NDEQ will be vital before moving forward with a program or project targeted to improve surface water. The following section summarizes key individual monitoring networks that are currently ongoing and will continue in the Basin.

Precipitation

Precipitation data plays an important role in water quality and quantity management. Natural precipitation cycles lead to complicated water management decisions, whether it be addressing a drought or reducing impacts from floods. The intensity, duration and amount of precipitation during a single event can define the extent of water issues such as pollutant transport or having the necessary storage to impound excessive runoff. Localized rainfall information can be obtained through volunteer monitoring networks such as NERAIN. The City of Omaha and the P-MRNRD maintain a network of gages to collect rainfall data.

Stream Flow

USGS, P-MRNRD and NDNR maintain continuous real time stream monitoring for stream height and discharge. Flow and discharge data are critical for calculating pollutant loads, identifying sources and delivery mechanisms, and conducting flow-based assessments.

Ambient Stream Monitoring

NDEQ maintains an "ambient" monitoring network across the state for streams and rivers. Ambient monitoring consists of fixed sites that are sampled each year. In addition to being able to assess current conditions, consistent monitoring at the same location allows for the establishment of long term data sets for trend assessments. Sites are monitored monthly for the following parameters: water temperature, dissolved oxygen, pH, conductivity, total suspended solids, ammonia, total nitrogen, total phosphorus, total chlorides, pesticides (April through September only), and metals (quarterly). Data collected through this network is available to resource managers and the general public EPA's STORET (STOrage and RETrieval) data management system (www.epa.gov/storet). Information from past basin rotation monitoring can be used as a pre-project benchmark for water quality improvement tracking in the Basin.

Basin Rotation Monitoring

Each year NDEQ selects "Basin Rotation" water quality monitoring sites on flowing and impounded waters which are focused on specific basins across the state. Each basin in the state is targeted for sampling every six years. The Papio-Missouri River Basin was monitored in 2016, setting the next the next rotation for 2022. From the months of May through September, streams and rivers are sampled weekly while lakes and reservoirs are sampled monthly. Data collected through this network is available to resource managers and the general public EPA's STORET data management system.

Beach Monitoring

NDEQ conducts water quality monitoring at selected swimming beaches across the state to determine the suitability for full body contact recreation. Beach monitoring for *E.coli* bacteria and the microcystin toxin produced by blue green algae is conducted during the recreation season (May 1 – Sep 30). Monitoring results are posted on the NDEQ website on a weekly basis (www.deq.state.ne.us). Carter Lake and Cunningham Lake are currently the only waterbodies monitored under this network in the Basin.

Lake Monitoring

NDEQ conducts lake monitoring statewide on an annual basis. Physical, chemical and biological data is gathered from May through September. These data are used to document existing water quality conditions, evaluate long-term trends, design watershed and lake restoration/protection projects and evaluate project effectiveness. Monitoring focuses on nutrients, sediment, pesticides, heavy metals, dissolved oxygen, pH, temperature, conductivity and water clarity.

Fish and Insect Community Monitoring

The Basin's streams and rivers contain a rich diversity of aquatic life including aquatic insects, fish, amphibians and mammals. Since aquatic communities are in constant contact with the water, the health of these communities can provide insight on stressors that may not show up through traditional water monitoring. NDEQ's Stream Biological Monitoring Program (SBMP) uses fish and aquatic insect communities to provide statewide assessments of the biological conditions of Nebraska's streams. Each year 34-40 randomly selected wadeable stream sites (i.e. streams that are shallow enough to sample without boats) are chosen for study in two or three river basins throughout Nebraska (NDEQ 2012). Fish communities are also frequently monitored by the NGPC to evaluate species composition and abundance.

Aquatic Invasive Species Monitoring

Due to continued work at public reservoirs, NGPC staff is able to continually monitor aquatic invasive species (AIS) through field observations. Invasive species of aquatic vegetation, primarily Curly Leaf Pondweed, is currently being managed by the NGPC via boat inspections.

Fish Tissue Monitoring

Since the 1970s, NDEQ has monitored fish from flowing and impounded waters to determine the suitability for human consumption. In cases where contaminants are a concern, a fish consumption advisory is issued. Fish tissue monitoring sites are determined annually, but are generally located where the most fishing occurs. Information on fish tissue monitoring results are provided in an annual report prepared by NDEQ. This report can be found on the NDEQ web site.

Fish Kills, Spills, and Citizen Complaints

Chemical spills can have significant contamination impacts to both surface and groundwater. A host of local, state and federal entities may be involved in a spill depending on the nature of the chemical, the amount spilled and the potential for downstream impacts. In most cases, spill monitoring is conducted by regulatory agencies, however, NRDs have and will continue to, provide monitoring assistance and support to lead agencies. Sampling protocol for these activities will be defined by the lead or coordinating agencies.

Fish kills can be either related to "natural conditions" or anthropogenic events. Fish kills are investigated by the NDEQ and NGPC. Monitoring associated with these kills are typically conducted by these two agencies.

Airborne Electromagnetic Survey (AEM) Flights

The P-MRNRD is a participant in the Eastern Nebraska Water Resources Assessment (ENWRA) a group of six NRDs and other organizations working to increase the understanding of groundwater-surface water relationships by gathering detailed data in order to better define and understand aquifers. Through ENWRA, Airborne Electromagnetic Survey (AEM) flights are being conducted to collect data.

Bathymetric Surveys

Bathymetric surveys address several water quality planning purposes. Surveys conducted on impoundments in the Basin will specifically be used for: 1) estimating historic sediment loads to reservoirs, 2) determining sediment trapping efficiencies of wetland/sediment basins, 3) estimating reservoir and basin maintenance requirements and financial needs, and 4) facilitating in-lake improvements.

Recent surveys have been completed at Glenn Cunningham Lake (2013), Wehrspann Lake and sediment basin (2015) and Lawrence Youngman Lake (2015). Three additional reservoirs in the Basin are recommended for bathymetric surveys (Walnut Creek Lake, Ed Zorinsky Lake and Standing Bear Lake), as the most recent surveys occurred 14 years ago at all three waterbodies. Information gathered will increase confidence in assessments and better allow the NRD to better determine watershed impacts and the performance of implemented corrective actions.

4.6 GROUNDWATER QUALITY NETWORKS

The P-MRNRD has been working with the USGS since 1992 to collect and analyze samples from wells across the NRD to determine the quality of groundwater. Samples have been collected from a variety of well types within the five primary aquifers within the district. The USGS has provided a Scientific Investigation Report for a variety of parameter groups, including nutrients (nitrate plus nitrite and nitrite concentrations as nitrogen). Other monitoring results have been obtained from NDEQ's Ag Data Clearinghouse, a database that houses state-wide information, mostly collected by NRD's or state agencies such as NDEQ. The P-MRNRD currently has no sub-areas delineated within the 1995 Groundwater Management Plan.

4.7 PROJECT MONITORING APPROACH

Upon project implementation, site specific monitoring protocol will be developed at that time. Each will utilize the applicable ongoing monitoring networks describe above to the fullest extent in order to maximize the use of the existing efforts. Additional monitoring efforts may be added if the current monitoring efforts do not sufficiently provide the information needed to determine the success and effectiveness of the project.

4.7.1 Purpose and Use

A detailed understanding of the water quality problem, contaminant sources and contaminant loads is needed to develop and implement an effective water quality improvement strategy for targeted projects. Currently, most stream water quality data is concentrated in larger stream segments that occur in the lower reaches of the watershed. This allows for the determination of impairment, but limits the ability to identify and quantify sources from higher in the watershed. This necessitates the need to quantify the contaminant loads from the separate sub-watersheds to target conservation projects to those areas and to measure the impact of those conservation projects in reducing contaminant loads. Because of this, more detailed monitoring is required in Priority and Special Priority Areas. Monitoring objectives for those areas include:

- Support water project or activity development.
- Identify causes and sources of water quality problems.
- Estimate pollutant transport.
- Evaluate water management effectiveness.
- Support future hydrological modeling.

4.7.2 Quality Assurance, Data Management, Analysis, and Assessment

There are a variety of monitoring methods and different levels of technology that range from inexpensive to very expensive. There is no single method that can apply to all situations. Managers need to use a blend of methodologies specific for the situation and intent of the data. Traditionally, water-sampling operations include in-situ measurements, sampling of appropriate media (water, biota and particulate matter), sample pre-treatment and preservation, identification and shipment. Quality assurance responsibilities typically fall within the entity coordinating the monitoring network. If environmental data is collected as part of a 319-funded project, a QAPPshould be prepared to ensure the scientific validity of monitoring and laboratory activities.

Any NRD or City efforts that result in the collection of data and/or information will be identified for proper data management activities. Data collected by other agencies, such as the NDNR and NDEQ, will not be managed by the NRD unless specific arrangements to do so have been made. In most cases, data collected by state agencies are entered into public accessible databases such as EPA's STORET data management system.

4.8 REPORTING AND DISTRIBUTING RESULTS

P-MRNRD will utilize all pertinent data and information to make informed resource decisions. Ultimately, resource decisions within the P-MRNRD are made by the Board of Directors. The P-MRNRD staff has in place a set of processes that are used to disseminate such data and information to the Board. Some of these processes include: monthly board meetings, subcommittee updates, special meetings and presentations by consultants and professionals. The NRD is continually disseminating data and information to the general public. Dissemination processes in place for the general public include: NRD Newsletters, NRD websites, public meetings and special events.

Raw data, reports, and other information gathered by entities outside the P-MRNRD may not be made directly available to the P-MRNRD. Data collected by NDEQ can be found in many different reports. The Federal Clean Water Act requires the State to provide certain reports and lists, including the Section 305(b) Water Quality Inventory Report and Section 303(d) List of Impaired Waters. In some cases, data and information will be reported in other documents such as standards revisions, water quality based permits, total maximum daily loads (TMDLs) and nonpoint source watershed plans. Data from the groundwater level monitoring well network is currently available through UNL CSD. The information provided includes well location and construction information, aquifer designation and water level measurements for the well.

4.9 REFERENCES

Benefits of Stream Gaging Program, USGS, March 2006, National Hydrologic Warning Council

Schilling, K.E., Peter Jacobson, Jason Vogelgesang, Jounal of Environmental Management, Volume 153, 15 April 2015, pages 74-83

5 WATER QUALITY ASSESSMENT

5.1 WATER RESOURCES AND BENEFICIAL USES

5.1.1 Surface Water

The Basin contains 84 Title 117 stream segments and 25 lakes which total 731 streams miles and 2,967 acres, respectively. Forty-eight stream segments occur in the Blackbird Creek watershed, which total 318 streams miles and accounts for 37% of the total miles found in the Basin (MT2-10000 was not included since only a very small portion of the entire segment is in the Basin). Thirty-six stream segments are in the Papillion Creek watershed, which total 413 stream miles and represents 63% of the total Basin miles (including MT1-10000 and EL1-10000). Seven lakes are in the Blackbird Creek watershed and total 528 acres, or 18% of the total lake surfaces acres in the Basin. The remaining 18 lakes are found in the Papillion-Bell Creek watershed and those lake account for the majority (2,439 acres or 82%) of the lake acres in the Basin.

Beneficial uses for surface waters are designated under the Clean Water Act §303 in accordance with regulations contained in 40 Code of Federal Regulations (CFR) 131. Nebraska is required to specify appropriate water uses to be protected, which is achieved through Title 117 – Nebraska Surface Water Quality Standards (NDEQ 2014). Beneficial use designations must take into consideration: the use and value of water for public water supplies; protection and propagation of fish, shellfish and wildlife; recreation in and on the water; aesthetics; and agricultural, industrial and other purposes including navigation. The uses that apply to all surface waters include Aquatic Life (AL), Agricultural Water Supply (AWS), and Aesthetics. The Primary Contact Recreation (PCR) use only applies to streams that meet designation criteria, however, the use applies to all lakes. Industrial Water Supply (IWS) and Drinking Water Supply (DWS) uses are only designated for specific waters.

State Resource Waters (SRWs) are surface waters that constitute an outstanding State or National resource (regardless of Nebraska's designated use), and include waterbodies within national or state parks, national forests or wildlife refuges and waters of exceptional recreational or ecological significance. SRW designations are not based on water quality and these waterbodies are addressed by an antidegradation clause that states the current uses shall be maintained and protected. There is one SRW in the Basin (DeSoto Lake) that is in the DeSoto National Wildlife Refuge.

Eleven stream segments and all 25 lakes in the Basin are designated for PCR use. All lakes and streams have the AL and AWS designation, and one stream is designated for DWS and IWS in the Basin (Tables 5-1 and 5-2).

Table 5-1. Designated Uses for Stream Segments in the Basin

HUC 8 Watershed	SRW	PCR	AL	DWS	AWS	IWS	Aesthetics
Blackbird Creek	0	3	48	0	48	0	48
Papillion-Bell Creek	0	8	36	1	36	1	36
TOTAL	0	11	84	1	84	1	84

SRW=State Resource Waters, PCR=Primary Contact Recreation, AL=Aquatic Life, DWS=Drinking Water Supply, AWS=Agricultural Water Supply, IWS=Industrial Water Supply

Table 5-2. Designated Uses for Lakes Number of Lakes in the Basin

HUC 8 Watershed	SRW	PCR	AL	DWS	AWS	IWS	Aesthetics
Blackbird Creek	0	6	6	0	6	0	6
Papillion-Bell Creek	1	18	18	0	18	0	18
TOTAL	1	24	24	0	24	0	24

SRW=State Resource Waters, PCR=Primary Contact Recreation, AL=Aquatic Life, DWS=Drinking Water Supply, AWS=Agricultural Water Supply, IWS=Industrial Water Supply

Nebraska Water Quality Standards identifies four Aquatic Life classes; Warmwater A, Warmwater B, Coldwater A, and Coldwater B. All lakes and 11 stream segments in the Basin are classified as Warmwater A and 73 stream segments have the Warmwater B classification (Table 5-3).

Table 5-3. Stream Segment Distribution of Aquatic Life Classes in the Basin

HUC 8 Watershed	Warmwater A	Warmwater B	Coldwater A	Coldwater B
Blackbird Creek	3	45	0	0
Papillion-Bell Creek	8	28	0	0
TOTAL	11	73	0	0

5.1.2 Groundwater

Groundwater is used for drinking water by 20 communities (Table 5-4) and nearly all the rural residents within the plan area. NDEQ has delineated a Wellhead Protection (WHP) Area for each of the public water supply systems to be used as a target area for management practices (see Chapter 3). The primary nonpoint source pollutant of concern to groundwater is nutrients, specifically nitrate contamination. Nitrates enter groundwater by leaching through sand, gravel and clay layers above the aquifer. The primary source of excess nutrients derives from commercial fertilizers used for row crop production, as well as from livestock production, manure storage and application, onsite wastewater systems and influences to groundwater from nutrients in surface water.

Information from the Nebraska Health and Human Services (NHHS), Nebraska Quality-Assessed Agrichemical Contaminant Database and USGS was used to determine areas where nitrates are the largest concern. The NHHS regulates public water supply systems and there are currently no systems in violation for nitrates, which has a maximum contaminant level (MCL) of 10 parts per million (ppm). The P-MRNRD is the process of updating their Groundwater Rules and Regulations as part of their Groundwater Management Plan. With a peak nitrate concentration of 8.8, the Tekamah WPA has been identified as a Phase II Groundwater Quality Management Area (concentration greater than 5 ppm) that must abide by more stringent rules and regulations.

Table 5-4. Wellhead Protection Area Peak Nitrate Levels 2015

Public Water Supplier	NO_3 ppm	Public Water Supplier	NO_3 ppm
Tekamah	8.8	South Sioux City	0.4
Gretna	5.1	Emerson	0.2
Metropolitan Utilities District (Omaha Metro)	5.1	Valley	0.1
Papillion	4.4	Arlington	0.1
Cass County RWD #1	4.3	Waterloo	0
Springfield	2.3	Walthill	0
Hubbard	1.6	Decatur	0
Jackson	0.9	Omaha Tribal Utilities-Macy	0
Dakota City	0.7	Louisville	0
Homer	0.5	Winnebago	0

5.2 WATER QUALITY CONCERNS AND CONDITIONS

Outside of fish tissue contamination, water quality degradation across the Basin can be tied to four pollutants; sediment, phosphorus, nitrogen, and bacteria. These pollutants contribute to the majority of the impaired designations by either directly causing an impact or indirectly contributing to other concerns (e.g., low dissolved oxygen, excessive algal production, degraded aquatic habitat).

5.3 IMPAIRED AND HIGH QUALITY WATERS

5.3.1 Streams

Water quality information from the NDEQ 2016 Integrated Report (2016 IR) was used to summarize conditions across the Basin and the status of the 84 Title 117 stream segments is shown on Figure 5-1. Beneficial use assessments for at least one use has been conducted on 36 stream segments in the Basin and 19 of these segments were identified as impaired. A summary of the assessments for the Blackbird Creek and Papillion-Bell Creek watersheds is presented below.

<u>Blackbird Creek</u>

- NDEQ conducted beneficial use support assessments on 15 of the 48 segments in this watershed.
- 131 miles of the total 318 miles in this watershed were assessed or 41%.
- Five of the streams are classified as impaired (Figure 5-2 and 5-3).

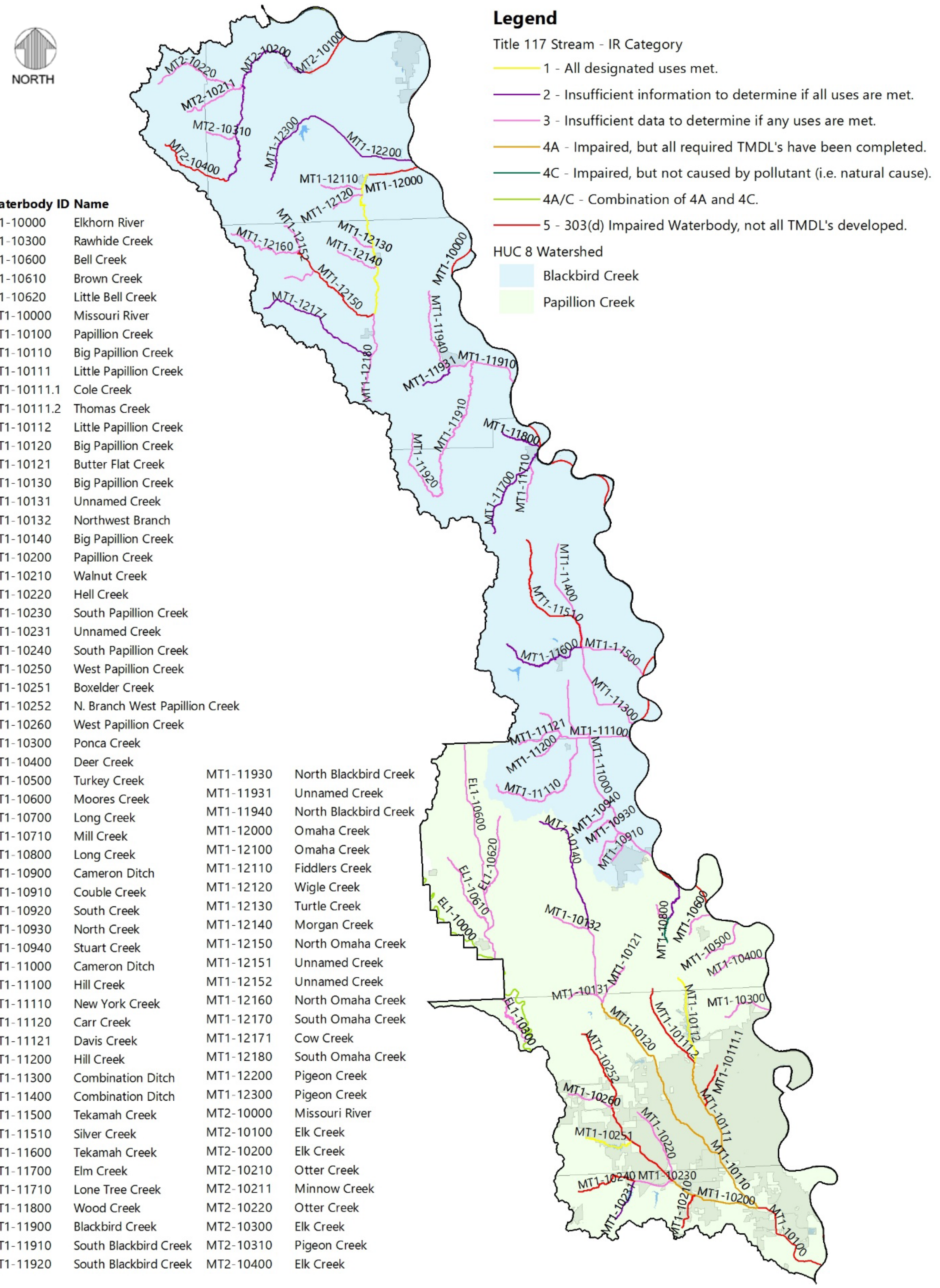
- Impaired segments represent 38 miles of the total 318 stream miles or 12% (Figure 5-4).
- Three segments are identified as having an impaired aquatic community.
- Two segments have a bacteria impairment.
- There are no coldwater streams or streams with exceptional quality, and therefore no high quality streams in this watershed.

Papillion-Bell Creek

- NDEQ conducted beneficial use support assessments on 21 of the 36 segments in this watershed.
- 334 miles of the total 413 miles in this watershed were assessed or 81%.
- Fourteen of the streams are classified as impaired (Figure 5-2 and 5-3).
- Impaired segments represent 276 miles of the total 413 stream miles, or 74%.
- Nine segments are identified as having an impaired aquatic community.
- Eight segments have a bacteria impairment.
- Two segments are impaired for selenium.
- One segment is impaired for dissolved oxygen.
- One segment is impaired due to a fish consumption advisory.
- There are no coldwater streams or streams with exceptional quality, and therefore no high quality streams in this watershed.

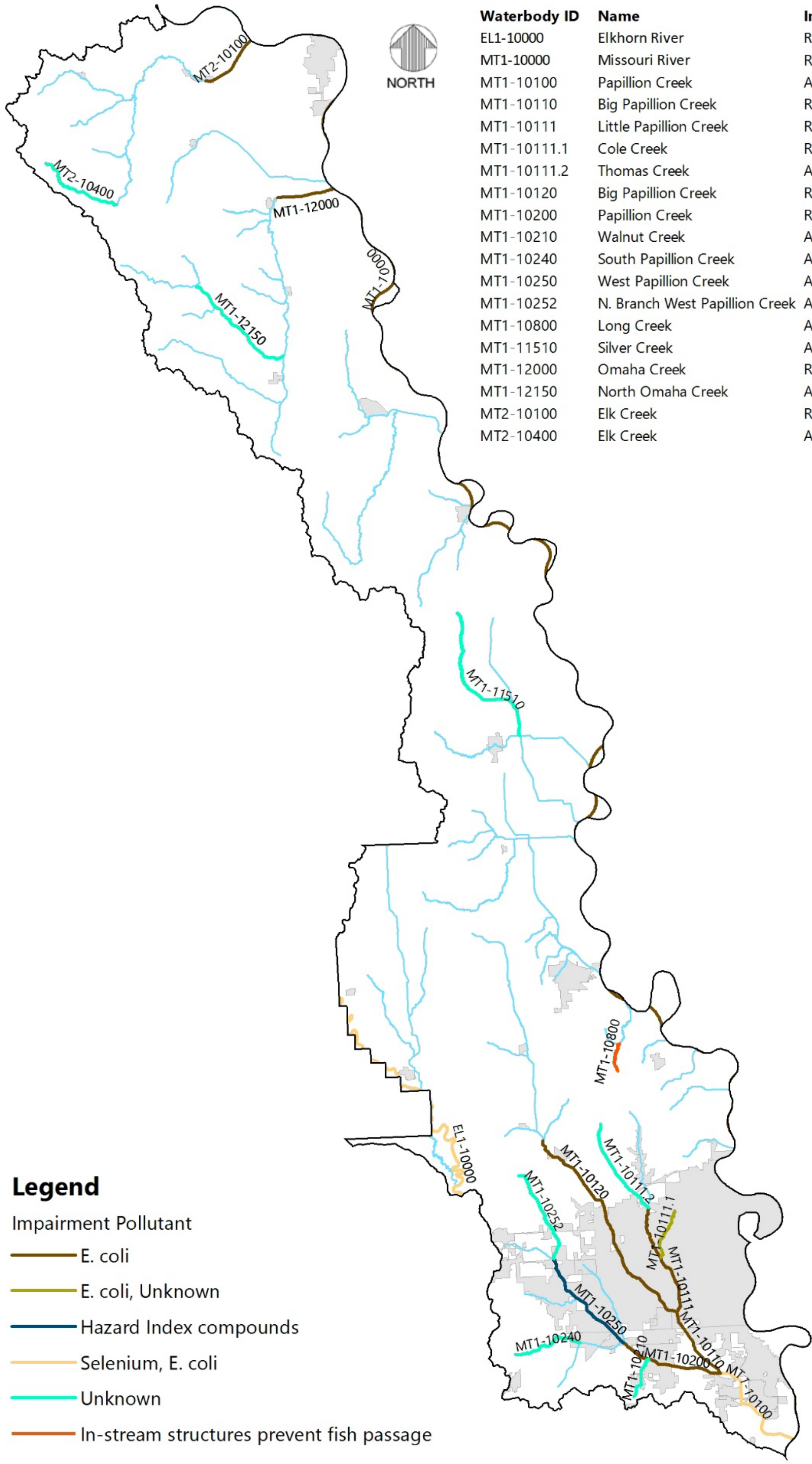
Table 5-5. Beneficial Use Support Summary for Streams in the Papio-Missouri River Basin

HUC 8 Watersheds	Blackbird Creek	Papillion - Bell Creek	Basin Total
Number of Segments	48	36	84
Number of Segments Assessed	15	21	36
% Segments Assessed	31%	58%	43%
Number Impaired	5	14	19
% of Segments Impaired	10%	39%	23%
Total Miles	318	413	731
Miles Assessed	131	334	465
% Miles Assessed	41%	81%	69%
Miles Impaired	38	276	314
% of Miles Impaired	12%	67%	43%



Waterbody ID	Name
EL1-10000	Elkhorn River
EL1-10300	Rawhide Creek
EL1-10600	Bell Creek
EL1-10610	Brown Creek
EL1-10620	Little Bell Creek
MT1-10000	Missouri River
MT1-10100	Papillion Creek
MT1-10110	Big Papillion Creek
MT1-10111	Little Papillion Creek
MT1-10111.1	Cole Creek
MT1-10111.2	Thomas Creek
MT1-10112	Little Papillion Creek
MT1-10120	Big Papillion Creek
MT1-10121	Butter Flat Creek
MT1-10130	Big Papillion Creek
MT1-10131	Unnamed Creek
MT1-10132	Northwest Branch
MT1-10140	Big Papillion Creek
MT1-10200	Papillion Creek
MT1-10210	Walnut Creek
MT1-10220	Hell Creek
MT1-10230	South Papillion Creek
MT1-10231	Unnamed Creek
MT1-10240	South Papillion Creek
MT1-10250	West Papillion Creek
MT1-10251	Boxelder Creek
MT1-10252	N. Branch West Papillion Creek
MT1-10260	West Papillion Creek
MT1-10300	Ponca Creek
MT1-10400	Deer Creek
MT1-10500	Turkey Creek
MT1-10600	Moores Creek
MT1-10700	Long Creek
MT1-10710	Mill Creek
MT1-10800	Long Creek
MT1-10900	Cameron Ditch
MT1-10910	Couble Creek
MT1-10920	South Creek
MT1-10930	North Creek
MT1-10940	Stuart Creek
MT1-11000	Cameron Ditch
MT1-11100	Hill Creek
MT1-11110	New York Creek
MT1-11120	Carr Creek
MT1-11121	Davis Creek
MT1-11200	Hill Creek
MT1-11300	Combination Ditch
MT1-11400	Combination Ditch
MT1-11500	Tekamah Creek
MT1-11510	Silver Creek
MT1-11600	Tekamah Creek
MT1-11700	Elm Creek
MT1-11710	Lone Tree Creek
MT1-11800	Wood Creek
MT1-11900	Blackbird Creek
MT1-11910	South Blackbird Creek
MT1-11920	South Blackbird Creek
MT1-11930	North Blackbird Creek
MT1-11931	Unnamed Creek
MT1-11940	North Blackbird Creek
MT1-12000	Omaha Creek
MT1-12100	Omaha Creek
MT1-12110	Fiddlers Creek
MT1-12120	Wigle Creek
MT1-12130	Turtle Creek
MT1-12140	Morgan Creek
MT1-12150	North Omaha Creek
MT1-12151	Unnamed Creek
MT1-12152	Unnamed Creek
MT1-12160	North Omaha Creek
MT1-12170	South Omaha Creek
MT1-12171	Cow Creek
MT1-12180	South Omaha Creek
MT1-12200	Pigeon Creek
MT1-12300	Pigeon Creek
MT2-10000	Missouri River
MT2-10100	Elk Creek
MT2-10200	Elk Creek
MT2-10210	Otter Creek
MT2-10211	Minnow Creek
MT2-10220	Otter Creek
MT2-10300	Elk Creek
MT2-10310	Pigeon Creek
MT2-10400	Elk Creek

Figure 5-1. Title 117 Stream Status for 2016 as Reported by NDEQ



Waterbody ID	Name	Impairment
EL1-10000	Elkhorn River	Recreation - Bacteria, Aquatic Life - Selenium
MT1-10000	Missouri River	Recreation-Bacteria
MT1-10100	Papillion Creek	Aquatic Life-Selenium, Recreation-Bacteria
MT1-10110	Big Papillion Creek	Recreation-Bacteria
MT1-10111	Little Papillion Creek	Recreation-Bacteria
MT1-10111.1	Cole Creek	Recreation-Bacteria, Aquatic Life-DO
MT1-10111.2	Thomas Creek	Aquatic Life-Impaired Aquatic Community
MT1-10120	Big Papillion Creek	Recreation-Bacteria
MT1-10200	Papillion Creek	Recreation-Bacteria
MT1-10210	Walnut Creek	Aquatic Life-Impaired Aquatic Community
MT1-10240	South Papillion Creek	Aquatic Life-Impaired Aquatic Community
MT1-10250	West Papillion Creek	Aquatic Life-Fish Consumption Advisory
MT1-10252	N. Branch West Papillion Creek	Aquatic Life-Impaired Aquatic Community
MT1-10800	Long Creek	Aquatic Life-Impaired Aquatic Community
MT1-11510	Silver Creek	Aquatic Life-Impaired Aquatic Community
MT1-12000	Omaha Creek	Recreation-Bacteria
MT1-12150	North Omaha Creek	Aquatic Life-Impaired Aquatic Community
MT2-10100	Elk Creek	Recreation-Bacteria
MT2-10400	Elk Creek	Aquatic Life-Impaired Aquatic Community

Figure 5-2. Impaired Streams in the Papio-Missouri River Basin

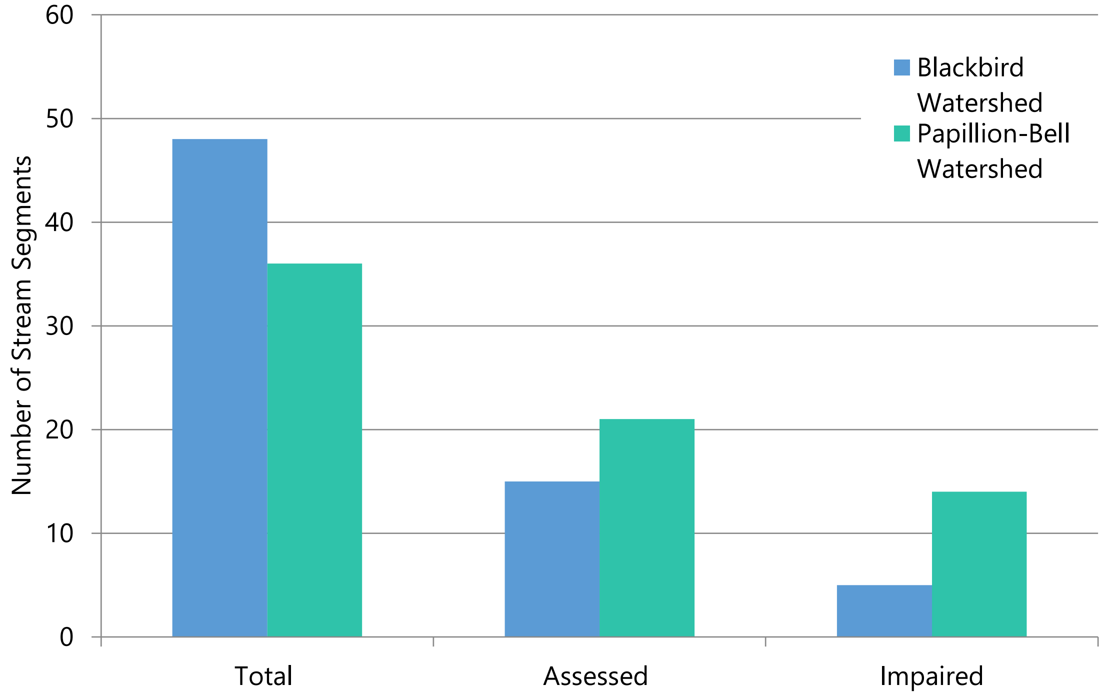


Figure 5-3. Stream Segment Assessment and Impairment

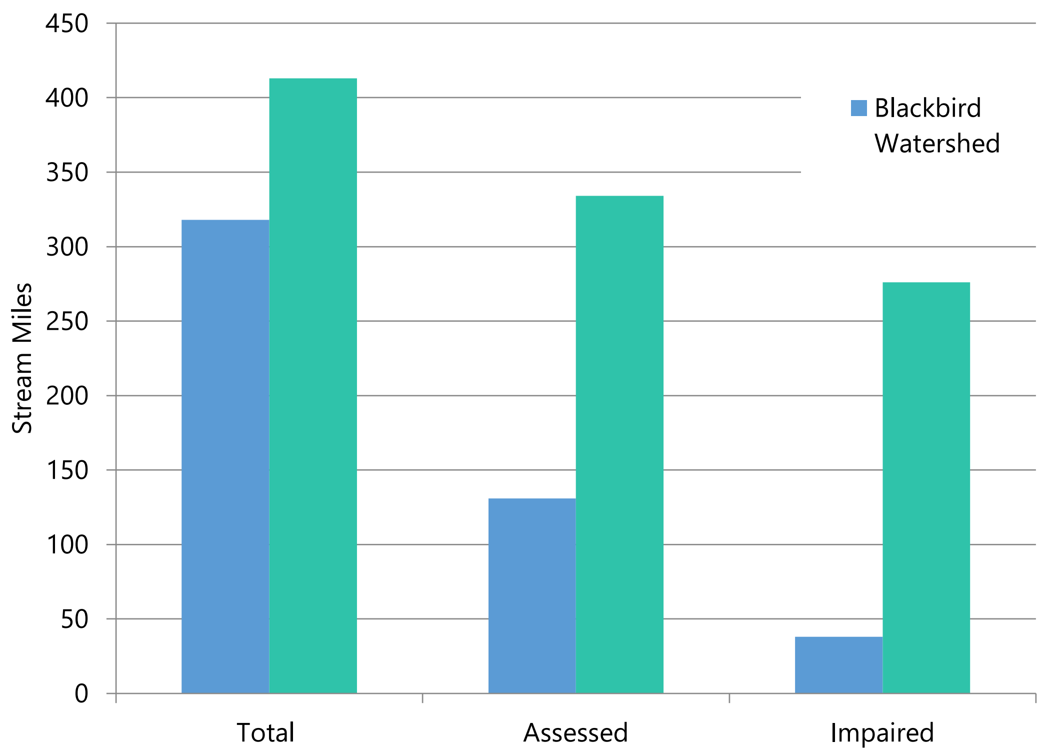


Figure 5-4. Stream Mile Assessment and Impairment

5.3.2 Lakes

Water quality information from the NDEQ 2016 Integrated Report (2016 IR) was used to summarize conditions across the Basin and the status of the 24 Title 117 lakes is shown on Figure 5-5. Beneficial use assessments for at least one use has been conducted on 18 lakes in the Basin and 13 of these lakes were identified as impaired. A summary of the assessments for the Blackbird Creek and Papillion-Bell Creek watersheds is presented below.

<u>Blackbird Creek</u>

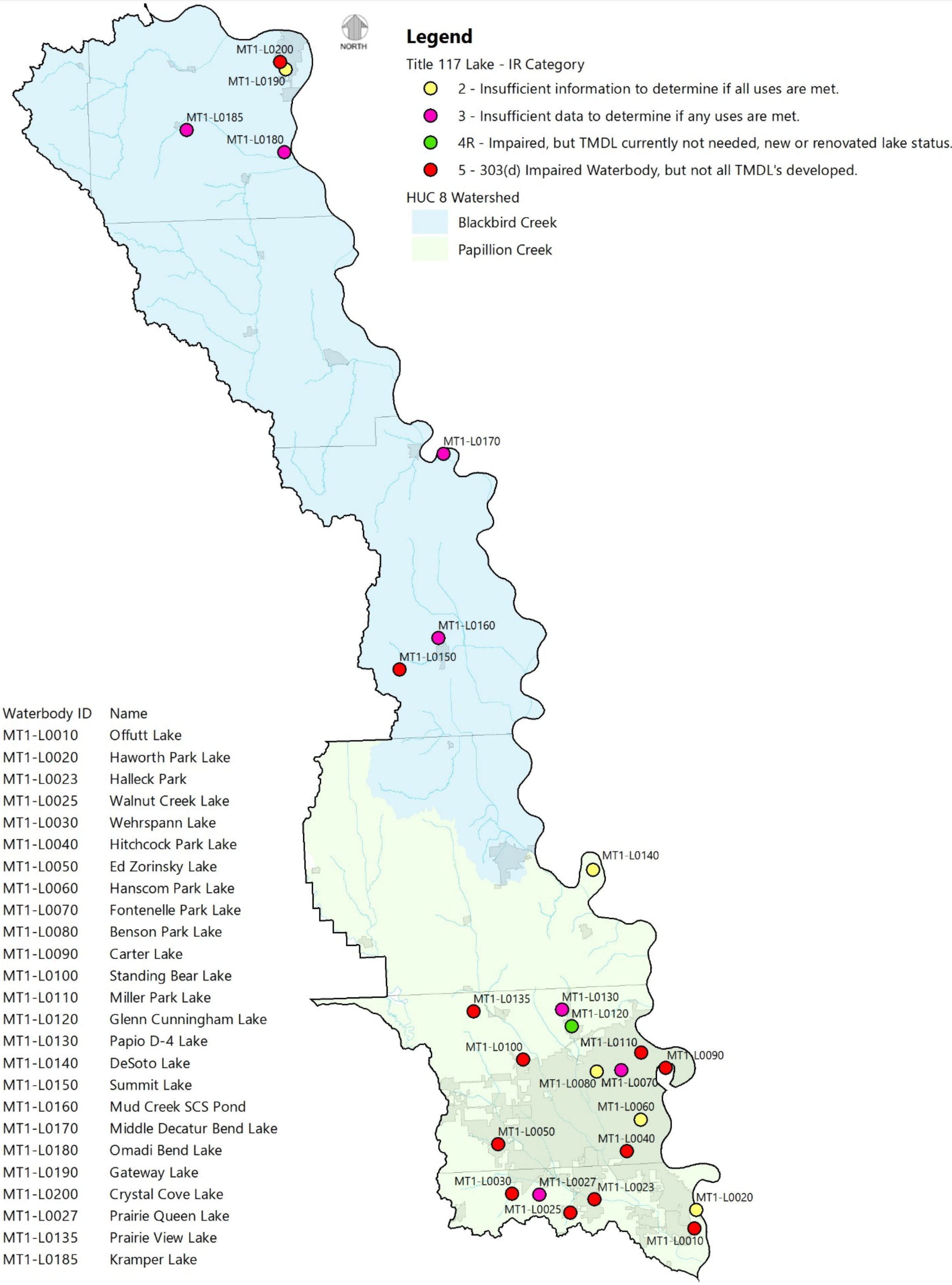
- NDEQ conducted beneficial use support assessments on 3 of the 7 lakes in this watershed.
- 228 acres of the total 528 acres in this watershed were assessed or 43%.
- Two lakes are classified as impaired (Figure 5-6 and 5-7).
- Impaired lake area represents 213 acres of the total 528 acres, or 40% (Figure 5-8).
- One lake is impaired for bacteria, nutrients and chlorophyll.
- One lake is impaired due to a fish consumption advisory.
- There are no lakes with exceptional quality, and therefore no high quality lakes in this watershed.

<u>Papillion-Bell Creek</u>

- NDEQ conducted beneficial use support assessments on 15 of the 18 lakes in this watershed.
- 2,308 acres of the total 2,439 acres in this watershed were assessed or 95%.
- Eleven lakes are classified as impaired (Figure 5-6 and 5-7).
- Impaired lake area represents 1,451 acres of the total 2,439 acres, or 58% (Figure 5-8).
- Three lakes are impaired due to a fish consumption advisory.
- Two lakes are impaired for bacteria, nutrients, chlorophyll a and a fish consumption advisory.
- Two lakes are impaired for nutrients, chlorophyll a and a fish consumption advisory.
- Two lakes are impaired for pH.
- One lake is impaired for nutrients, chlorophyll a, a fish consumption advisory and algal blooms.
- One lake is impaired for nutrients, chlorophyll a, a fish consumption advisory and sedimentation.
- There are no lakes with exceptional quality, and therefore no high quality lakes in this watershed.

Table 5-6. Beneficial Use Support Summary for Lakes in the Basin

HUC 8 Watersheds	Blackbird Creek	Papillion-Bell Creek	Basin Total
Number of Lakes	7	18	25
Number Assessed	3	15	18
% Lakes Assessed	43%	83%	72%
Number Impaired	2	11	13
% Lakes Impaired	29%	61%	52%
Total Acres	528	2,439	2,967
Acres Assessed	228	2,308	2,536
% Acres Assessed	43%	95%	85%
Acres Impaired	213	1,451	1,664
% Acres Impaired	40%	59%	56%



Waterbody ID	Name
MT1-L0010	Offutt Lake
MT1-L0020	Haworth Park Lake
MT1-L0023	Halleck Park
MT1-L0025	Walnut Creek Lake
MT1-L0030	Wehrspann Lake
MT1-L0040	Hitchcock Park Lake
MT1-L0050	Ed Zorinsky Lake
MT1-L0060	Hanscom Park Lake
MT1-L0070	Fontenelle Park Lake
MT1-L0080	Benson Park Lake
MT1-L0090	Carter Lake
MT1-L0100	Standing Bear Lake
MT1-L0110	Miller Park Lake
MT1-L0120	Glenn Cunningham Lake
MT1-L0130	Papio D-4 Lake
MT1-L0140	DeSoto Lake
MT1-L0150	Summit Lake
MT1-L0160	Mud Creek SCS Pond
MT1-L0170	Middle Decatur Bend Lake
MT1-L0180	Omadi Bend Lake
MT1-L0190	Gateway Lake
MT1-L0200	Crystal Cove Lake
MT1-L0027	Prairie Queen Lake
MT1-L0135	Prairie View Lake
MT1-L0185	Kramper Lake

Figure 5-5. Title 117 Lake Status for 2016 as Reported by NDEQ

Waterbody ID	Name	Impairment
MT1-L0010	Offutt Lake	Aquatic Life-Fish Consumption Advisory
MT1-L0023	Halleck Park	Aquatic Life-Fish Consumption Advisory
MT1-L0025	Walnut Creek Lake	Recreation - E. coli, Aquatic Life-Nutrients, Chlorophyll a, Fish Consumption Advisory
MT1-L0030	Wehrspann Lake	Aquatic Life-Nutrients, Chlorophyll a, Fish Consumption Advisory
MT1-L0040	Hitchcock Park Lake	Aquatic Life-pH
MT1-L0050	Ed Zorinsky Lake	Aquatic Life-Nutrients, Chlorophyll a, Fish Consumption Advisory
MT1-L0090	Carter Lake	Aquatic Life-Nutrients, Chlorophyll a, Fish Consumption Advisory, Aesthetics-Algae Blooms
MT1-L0100	Standing Bear Lake	Aquatic Life-Nutrients, Chlorophyll a, Fish Consumption Advisory, Aesthetics-Sedimentation
MT1-L0110	Miller Park Lake	Aquatic Life-pH
MT1-L0120	Glenn Cunningham Lake	Aquatic Life-Nutrients, Chlorophyll a
MT1-L0150	Summit Lake	Recreation - E. coli, Aquatic Life -Nutrients, Chlorophyll a
MT1-L0200	Crystal Cove Lake	Aquatic Life-Fish Consumption Advisory
MT1-L0135	Prairie View Lake	Aquatic Life-Fish Consumption Advisory

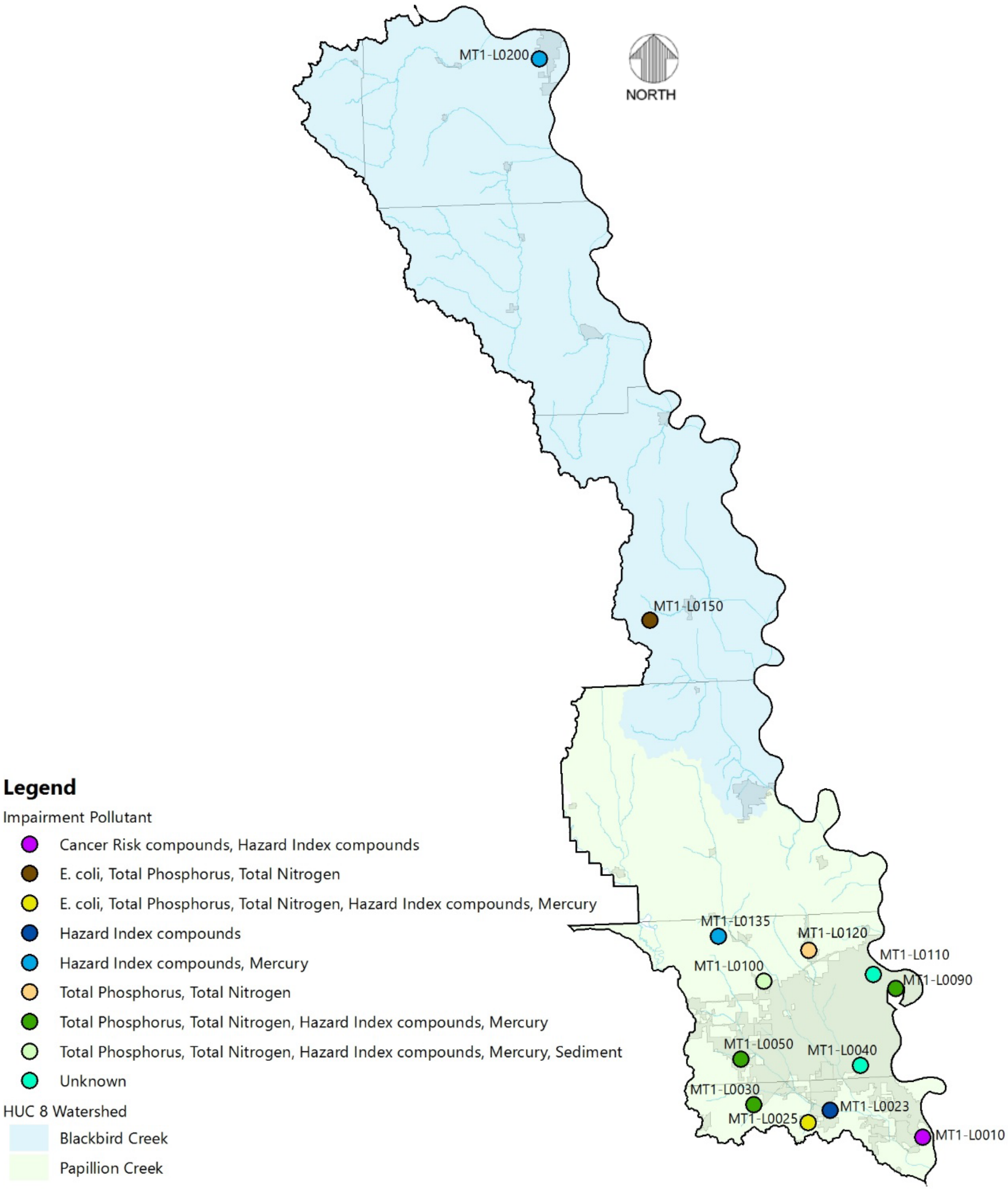


Figure 5-6. Impaired Lakes in the Papio-Missouri River Basin

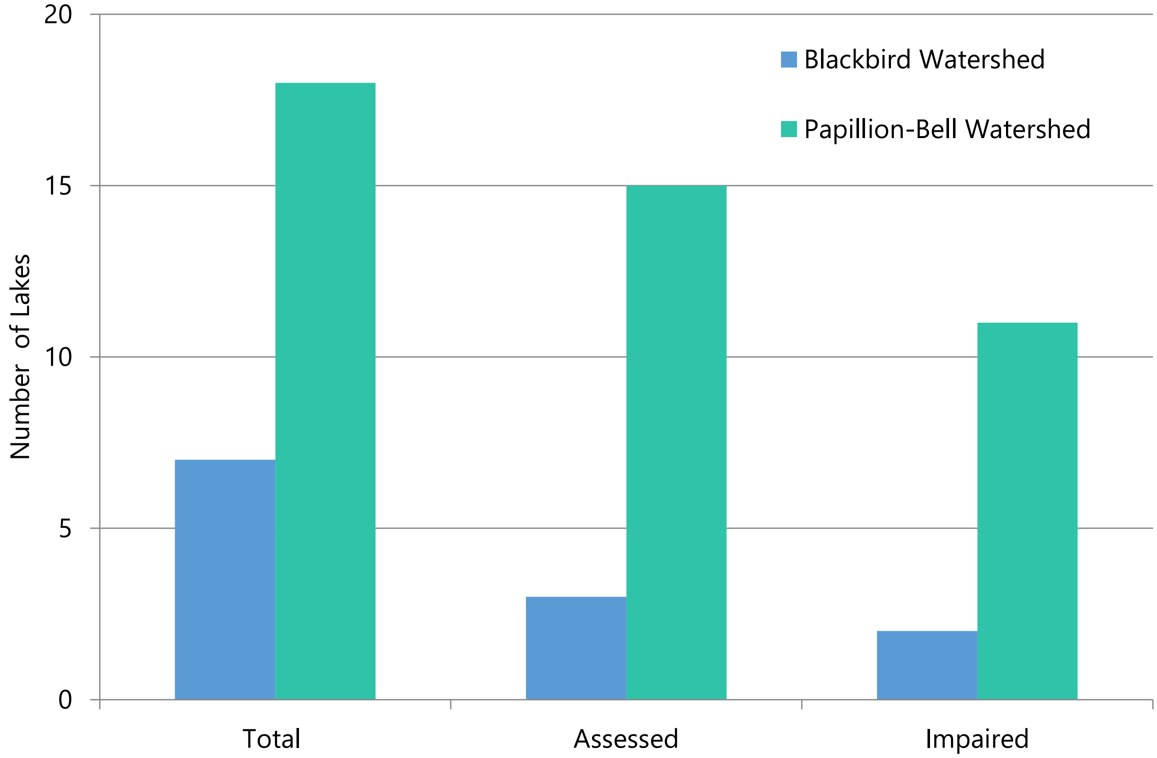


Figure 5-7. Lake Assessment and Impairment

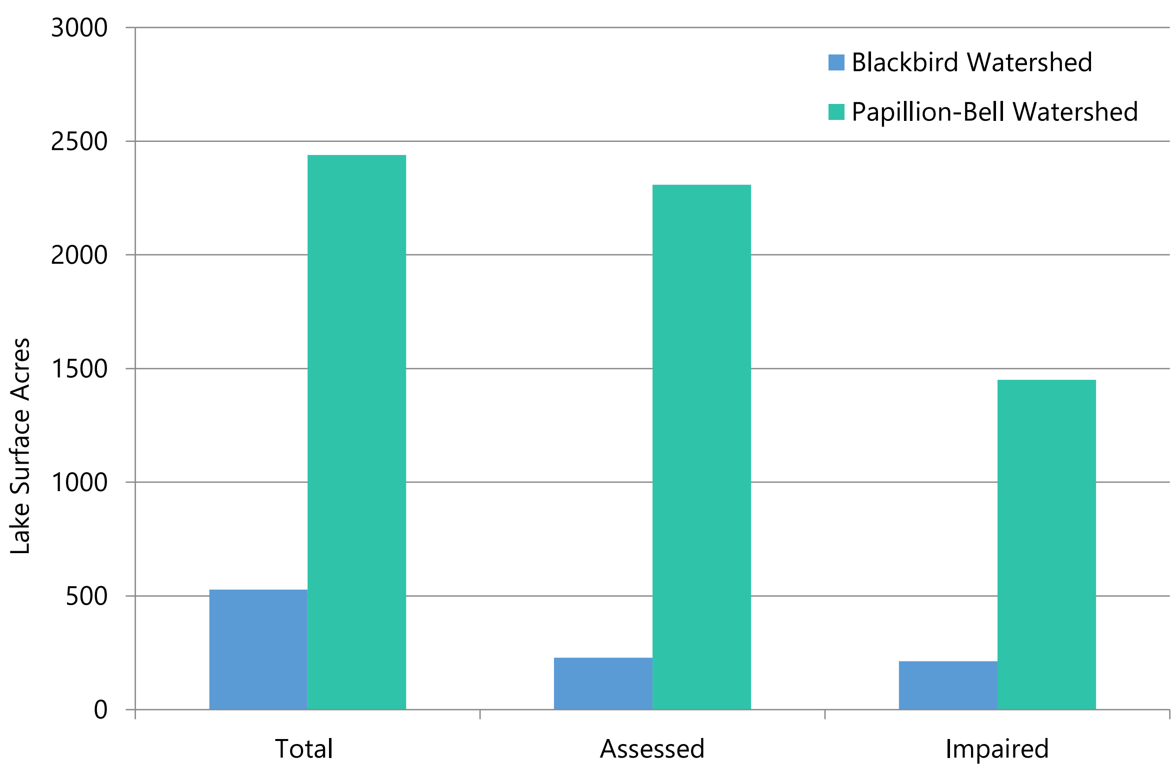


Figure 5-8. Lake Surface Acre Assessment and Impairment

5.4 COMMON CAUSES

The general categories of sources for the pollutants of concern in the watershed include natural, urban and agricultural/rural (Table 5-7). In the agricultural areas of the Basin, sedimentation, nutrients, privately-owned septic systems, animal feeding operations, livestock grazing, irrigation, tillage, hydromodification, and large concentrations of waterfowl are common causes of pollutant inputs. The primary pollutants exported from cropland are sediment, phosphorus, nitrogen and pesticides, however, no impairments from pesticides have been documented. Runoff and percolation from feedlots, animal management areas and intensively grazed pasture and rangeland can contribute nutrients, organic matter (which impacts oxygen demand), ammonia and fecal bacteria to the receiving surface waters and underlying groundwater. Livestock within stream riparian areas can destabilize stream banks and shorelines through compaction and damage to riparian vegetation, which increases erosion and in-stream/lake sedimentation issues (NDEQ 2000).

For the urban areas, hydromodification, sedimentation, nutrients and animal and human waste are common causes of pollution. Impervious surfaces such as roads, parking lots and rooftops reduce infiltration and increase the volume of runoff. Storm sewer systems concentrate runoff into smooth, straight conduits. These modifications increase runoff velocity and the erosive potential of the water. Sedimentation occurs as the increased runoff delivers sediments from streets and parking lots to storm sewers. Increased stream bank erosion from the higher velocities also contributes to sediment loads and decreases stream bank vegetation and habitat. Lawn fertilizers and pet/wildlife waste deliver nutrients and bacteria in the increased runoff from urban landscapes.

Table 5-7. Priority Pollutants and Nonpoint Sources in the Watershed

	Priority Pollutants			
Sources	**Sediment**	**Phosphorus**	**Nitrogen**	**Bacteria**
Urban				
Pet Waste		●	●	●
Commercial Fertilizer		●	●	
Rural Domestic				
Septic Systems		●	●	●
Agriculture				
Tillage	●	●	●	●
Livestock Production		●	●	●
Commercial Fertilizer	●	●	●	
Natural Fertilizer	●	●	●	●
Bank/Shoreline Erosion	●	●	●	●
Natural				
Stream Erosion	●	●	●	●
Wildlife		●	●	●
Bank/Shoreline Erosion	●	●	●	●

Atmospheric Deposition		●		
Internal Loading		●		

Sedimentation occurs when precipitation runoff carries soil particles into streams and lakes. In addition, other pollutants like fertilizers and heavy metals are often attached to the soil particles and are deposited into waterbodies along with the sediment. Slope, geology and soil characteristics, and land uses with reduced vegetative cover increase runoff, create more erosion and increase sediment related impacts to streams and lakes. Soil organic content across the basin also contributes to the natural occurrence of some pollutants such as phosphorus.

Nutrients in the form of commercial fertilizers and manure are applied to crops. When fertilizer application exceeds the needs of the plants or when applied immediately prior to a runoff event, nutrients are transported to water resources and can cause excessive algal growth, low dissolved oxygen and subsequent fish kills, and nitrate migration into groundwater supplies. Runoff from animal feeding operations (dependent upon control measures), along with wildlife are potential sources of animal waste that can carry pathogens and nutrients. Livestock overgrazing exposes soils, increases erosion, compromises fish habitat, contributes to bank failure and reduces floodplain vegetation necessary for habitat and water quality filtration.

Sediment and phosphorus contributions from stream banks can be considerable nonpoint sources of pollution to waterbodies in Nebraska. For example, recent research within the Wagon Train Reservoir near Lincoln, Nebraska shows that the sediment and phosphorous pollutant reduction targets for the reservoir have not been met even after wide-spread implementation of field-scale BMPs throughout the 9,988-acre watershed (UNL 2008). The study found that stream bank and stream bed erosion contributed 26 percent and 21 percent of the annual sediment and phosphorus load, respectively.

Inefficient application of irrigation water to crops to supplement natural precipitation can lead to water quality concerns such as increasing erosion, transporting nutrients and altering flows through drainage ways. Increased impervious area due to soil compaction and/or high levels of development decreases infiltration and increases the rate of runoff. These hydrologic modifications often increase runoff volume, increase water velocity, contribute to stream incision, increase stream bank erosion and decrease habitat. These modifications especially increase pollutant concerns related to sedimentation and nutrient inputs.

Wildlife undoubtedly contributes to the nonpoint source bacteria load. Canada and Snow geese, along with numerous other waterfowl species, can be highly abundant on rural and urban lakes during migration seasons. Waterfowl located in the parklands surrounding lakes have grown substantially over recent decades. Open water, gently-sloped near-shore areas, short (i.e., mowed) grass, and feeding of waterfowl by park users, attract migrating waterfowl looking to rest and feed and have contributed to larger resident geese populations. Waterfowl in and around lakes can have substantial impacts on nutrient and bacteria concentrations, particularly in small waterbodies.

For lakes, internal sources of pollutants (e.g., phosphorus) are often less studied and recognized, but are also important sources in the basin. While eutrophication management in lakes has historically focused on controlling external nutrient loading, it is becoming increasingly clear that internal mechanisms can also contribute to the processes of eutrophication (Dzialowski, 2012). Lakes receiving higher loads of sediment and organic material typically exhibit higher internal pollutant loads.

5.5 PRIORITY AREA SELECTION

As directed from the EPA in comments on the PIP, Priority Areas selected for this Plan should be no larger than 20% of the total Basin area to focus plan efforts. Efforts prescribed in this Plan will be concentrated in the selected Priority Areas with the goal to delist the waterbodies from the 303(d) list of impaired waterbodies.

A very rigorous process was followed to identify Priority Areas within the Basin to focus implementation efforts. The philosophy followed is depicted in Figure 1 below.

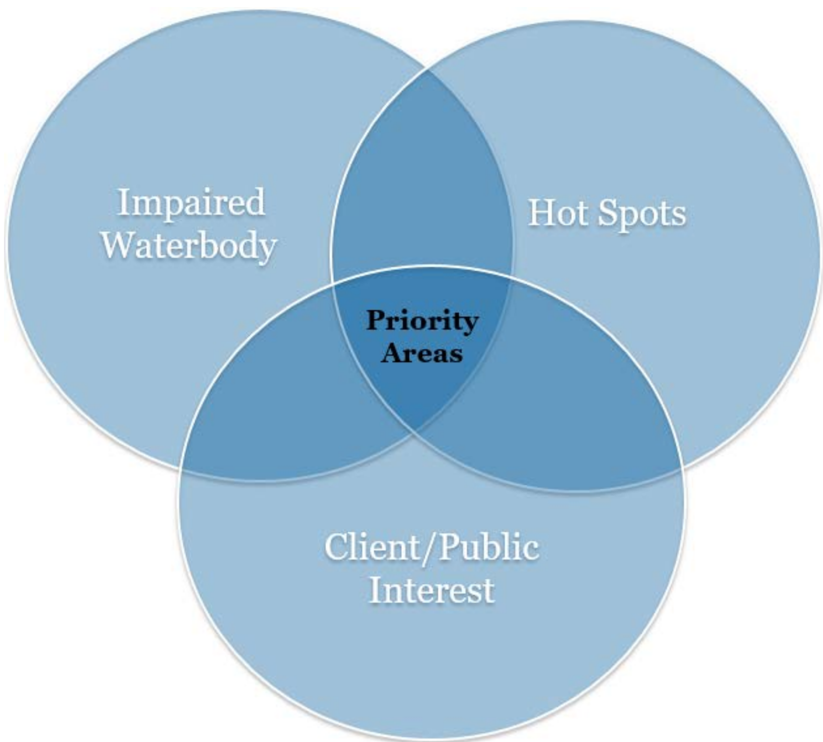


Figure 5-9. Priority Area Selection Philosophy

With the focus to delist impaired waterbodies, it was important to ensure the Priority Areas selected are watersheds to impaired waterbodies. Figure 5-10 below identifies all impaired waterbodies and delineates their watersheds in the Basin.

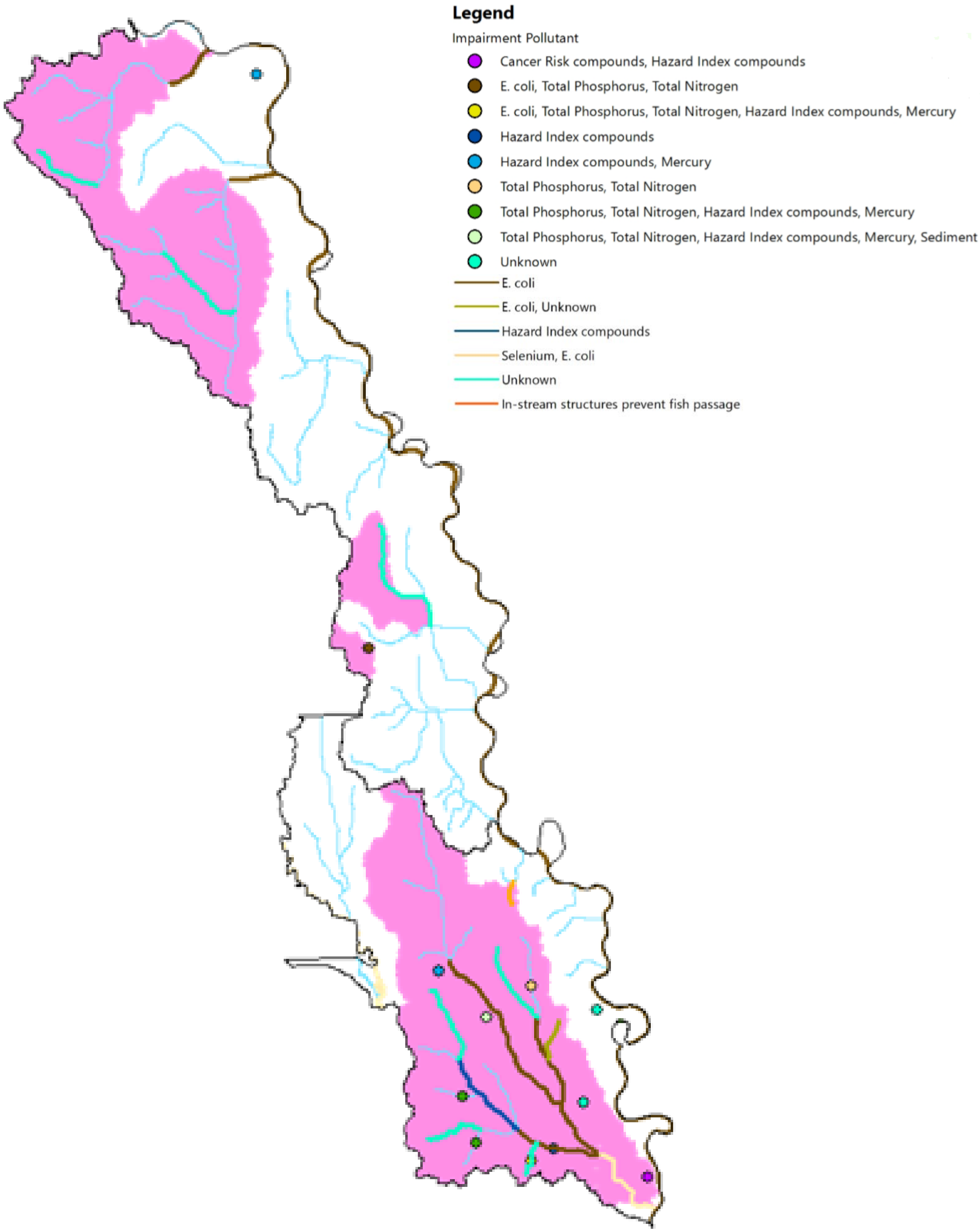


Figure 5-10. Impaired Waterbodies and Associated Watershed

The Basin was also assessed to identify 'hot spots' (based on SPARROW data) to provide a of sense where pollutant concentrations are the highest and are likely contributing the largest pollutant loads within the Basin. Once these hot spots were identified, they were overlapped with the designated impaired waterbody watersheds to identify the hot spots eligible for 319 funding.

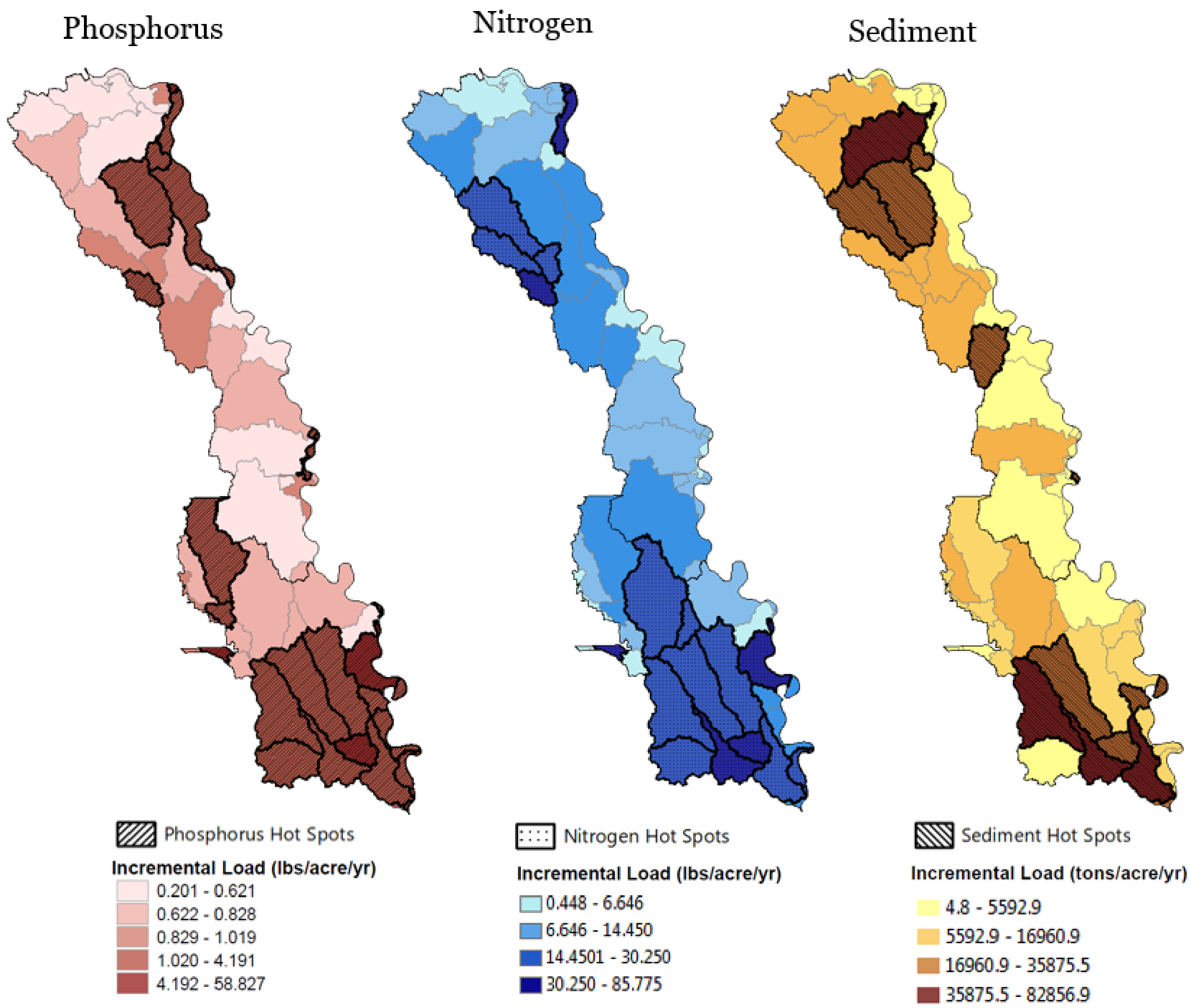


Figure 5-11. Phosphorus, Nitrogen and Sediment Hot Spot Maps

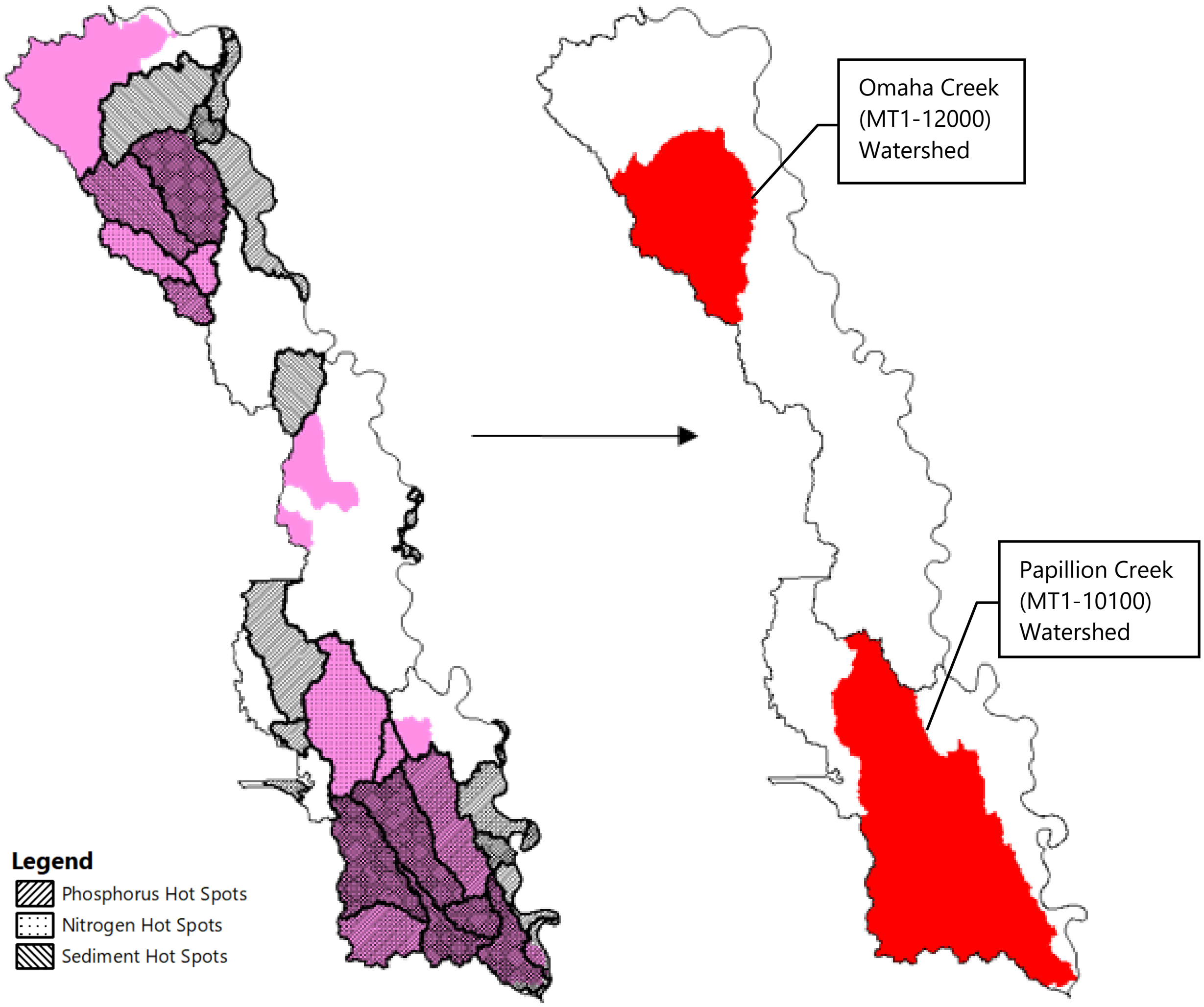


Figure 5-12. Combined Impaired Waterbody Watersheds with Hot Spots Map and Overlap Map

Along with this data, months of coordination amongst the owners, stakeholders, public and the NDEQ was conducted. The idea was to select a Priority Area that either has some existing momentum and/or potential funding partners to increase the likelihood of project implementation. During the coordination, the level of interest was gaged throughout the entire basin. Below is a summary of the coordination regarding the two waterbodies identified in red in Figure 5-12 above.

Currently, the Winnebago Tribe located within the Omaha Creek (MT1-12000) watershed is going through their own water quality sampling and planning process. It was determined including Omaha Creek as part of the Priority Area would be duplicative, however the P-MRNRD will plan on helping support their efforts as appropriate.

Several waterbodies within the Papillion Creek (MR1-10100) watershed are impaired and were evaluated for possible selection as Priority Areas. When this information was presented to the NDEQ, it was suggested that the entire Papillion Creek be selected as the Priority Area. The area of the Papillion Creek watershed is 257,280 acres and covers a large portion of their District. There are 11 impaired streams segments and 9 impaired lakes that could ultimately benefit from water quality improvement projects, and the Papillion Creek watershed was selected as the Priority Area for this Plan and will be investigated in more detail in Chapter 10.

6 COMMUNICATION AND EDUCATION

The purpose of this chapter is to describe how the public will be involved at the project level during the plan's implementation. This chapter contains a strategy that describes how the information and education component will be used to enhance the public's understanding of programs, projects, and activities that are conducted as a result of this plan's implementation.

6.1 CURRENT OUTREACH SYSTEMS

Outreach to the public can be communicated in several ways. Traditional methods are still utilized, however non-traditional methods, such as the use of social media and websites announcements, are gaining popularity. The following methods are currently used for outreach:

- Websites and social media such as Facebook, Twitter, and YouTube
    - Papillion Creek Watershed Partnership – Education and Outreach www.papiopartnership.org/community/education_and_outreach.shtml
    - P-MRNRD- Lakes and Streams Water Quality: https://www.papionrd.org/water-quality-supply/lakes-and-streams-water-quality/
    - P-MRNRD Facebook Page: www.facebook.com/papioNRD
    - P-MRNRD Twitter @PapioNRD
    - Omaha Stormwater: http://omahastormwater.org/
    - Omaha Plants – Rain Gardens and Bioretention: http://www.omahaplants.org/bio-retention-and-rain-gardens/
    - Omaha Stormwater Facebook: www.facebook.com/omahastormwater
    - Keep Omaha Beautiful: https://www.facebook.com/KeepOmahaBeauitful/
- Under the Sink: http://omahastormwater.org/ourprojects/under-the-sink/
    - Household Hazardous waste collection facility
    - Facility educates citizens about harvesting rain water and rain garden construction
    - Site hosts 14 rain gardens and interpretive signs describing their construction, purpose and benefits
- Brochures
    - Keep Our Lakes and Streams Clean (City of Omaha): educates residents on the steps they can take to prevent pollution. Steps include picking up after pets, sweeping up grass clippings and marking storm drains with no dumping discs.
    - Keep the Stream Clean (Papillion): disposing of pet waste properly, fertilizing responsibly, Reducing runoff, Recycling household chemicals
    - Rain Garden Fact Sheet
    - Pet Waste Fact Sheet
- Provide water quality professionals for school speaking engagements
- Open houses for specific projects or plan efforts

- Public service announcements on neighborhood pollution which focus on pet waste, chemical dumping and fertilizing
- News releases for ongoing programs and projects to local newspapers, radio stations, magazines, and local TV programs
- Papio-Missouri River Basin Water Quality Management Plan Traveling Display -—several poster presentation boards that discuss the project's intent, goals, and benefits. Display at planned P-MRNRD events or other local community events such as such as operator education and certification workshops.
- Omaha Neighborhoods Stormwater Education Program (Saddle Hills, TV Towers and Benson)

6.2 BASIN DEMOGRAPHICS

There is drastic variability of demographics within the Basin between the urban and rural areas. While 83% of the land is rural (includes towns less than 2,500 people), approximately 78% of the Basin's population resides in the urban setting.

	Area	% Area	Population	% Population
Rural	860,634	83%	156,967	22%
Urban	176,106	17%	568,283	78%
Total	1,036,740	100%	725,250	100%

The cities in the urban classification include: Omaha, Papillion, LaVista, Bellevue, Ralston, Gretna (1/2), Blair, South Sioux City. The remaining towns in the basin were included in the rural classification. Since there are two dramatically different demographics within the basin, each will be described separately below.

6.2.1 Rural

In the rural segments of the study area (including Burt, Thurston, and Washington Counties) the median age is 39.1 years with a median income per household of $51,355 (2015 dollars). Of individuals older than 25 years, 91.1% reported having a high school diploma or higher and 20.2% reported having a Bachelor's degree or higher. The gender distribution of the population is 50.6% female and 49.4% male. Owner-occupied housing is reported at 73.5%, resulting in a home rental rate of 26.5%.

Tenant farming is very popular in the Basin with over half of agricultural land under a cash rent agreement. Most commonly on rented grounds, long term tenants remain on the same land and make the majority of the decisions regarding land management. Land owners have to agree to any EQIP contracts and potentially pay for the implementation of conservation practices, as requested by the tenant. All the agricultural land in the Native American territory in Thurston and Dakota Counties is managed by the Bureau of Indian Affairs (BIA) and rented through three year leases. The BIA requires a conservation plan and the tenant works with the local NRCS to ensure compliance. The conservation plan is revisited every three years when the lease is expired. There is minimal prevalence of absentee landowners.

6.2.2 Urban

In the urban areas, the median age is 33.9 years with the median income is $58,329. The education survey indicated that 86.2% of individuals older than 25 had a high school diploma or higher, and 28.3% had a Bachelor's degree or higher. The gender distribution was 50.2% female and 49.8% male. Owner-occupied housing is reported at 65.6%, with a higher rental rate of 34.4%.

6.3 TARGET AUDIENCE

The targeted audience for the educational needs described have been identified below. Specific outreach efforts will be targeted toward each audience.

Rural

- Farmers/land managers
- Livestock producers
- Farmsteads along streams

Urban

- Pet Owners
- Home Owners
- Commercial Property Owners

6.4 EDUCATIONAL NEEDS

The educational needs regarding water resources in the Basin vary from small items such as trash and illegal dumping, to large items such as the impacts of pesticides and fertilizers to our stormwater. Most commonly, outreach efforts are promoted to help control nutrients and sediment. It was determined for this Plan that the education outreach efforts will focus on the control and reduction of bacteria loading to the local waterbodies. Below are multiple educational outreach efforts that would be beneficial for both the urban and rural communities in the Basin.

6.4.1 Rural

Manure and Land Application Management
Audience: Farmers/land managers-

- Awareness: Land application of manure is causing elevated bacteria loading in streams
- Knowledge: Understanding E.coli loads that area spread with the rates being applied. Fields are not for disposal, only apply what is necessary for fertilizing needs. Other options are available for disposal.

- Knowledge: Best management practices on fields reduce bacteria counts that reach the stream
- Behavior: Reduce application rates of manure, promote storage/composting
- Behavior: Implement riparian buffers, cover crop practices, or other structural BMPs

Small Dams Program
Audience: Farmers/land managers-

- Awareness: The P-MRNRD offers a cost share, plus potential 319 funding that can also cover the cost of design and permitting
- Knowledge: Small sediment basins on private land help trap and reduce bacteria loads
- Behavior: Individual landowners to implement structures on their land

Livestock Exclusion
Audience: Livestock producers

- Awareness: Cattle grazing in streams cause destruction to streambanks and direct bacteria loading to waterways
- Knowledge: Cattle exclusion from streams will greatly reduce bacteria load. Funding assistance to be available to find alternate water source
- Behavior: Remove cattle from stream and find alternate water source

Septic System Failure
Audience: Farmsteads Along Streams

- Awareness: High potential for septic system failure, especially with age
- Knowledge: Failing systems will contribute high loads to local stream. Funding assistance available for inspections and repairs
- Behavior: Inspect septic systems and upgrade to code as necessary to completely remove the associated load

6.4.2 Urban

Pet Waste Cleanup
Audience: Pet Owners

- Awareness: Pet waste runoff contributes bacteria loads to local waterways
- Knowledge: Bacteria loads can be reduced if pet waste if picked up immediately and disposed of in the trash.
- Behavior: Pet waste pick up sufficient to reduce loading by one third

Rain Garden Initiative
Audience: Home Owners

- Awareness: Help is needed to control bacteria loads
- Knowledge: Bacteria is transported in stormwater runoff, capturing it can reduce loads
- Behavior: Implement rain gardens in yards to reduce stormwater runoff and thereby less pollution could be carried to water resources.

Bioretention Initiative
Audience: Commercial Property Owners

- Awareness: Help is needed to control bacteria loads
- Knowledge: Bacteria is transported in stormwater runoff, capturing it can reduce loads
- Behavior: Implement bioretention systems in parking lots to reduce stormwater runoff and thereby less pollution could be carried to water resources.

6.5 PUBLIC INVOLVEMENT OPPORTUNITIES

Public involvement opportunities are variable dependent upon when projects and planning efforts occur. When they arise, several of the outreach systems in section 6.1 are utilized to promote upcoming opportunities. There are permanent pages on both the P-MRNRD's and City of Omaha's website promoting actions the public can take.

- P-MRNRD- How Can You Help: www.papionrd.org/water-quality-supply/lakes-and-streams-water-quality/how-you-can-help/
- Omaha Stormwater- Things You Can Do: http://omahastormwater.org/residential/things-you-can-do/

6.6 OUTREACH STRATEGY

The approach to each project or target audience may vary. Outreach for this Plan will follow the simple Partnership, Information and Delivery (PID) strategy that provides framework for the approach, but allows flexibility to tailor it specific to each project or message.

Partnership – form necessary partnerships that will generate the relevant input to address the issue at hand. Some situations may require agency partnerships to develop technical information that needs to be delivered. Other situations would benefit from the formation of a local citizens council or stakeholder group that would provide insight on data gaps and educational needs, as well as the most effective delivery systems.

Information – generate a message for the issue at hand and develop educational information. Each outreach effort should have a very clear message that defines the purpose and the intended outcome.

Delivery – assess the available outreach systems (Section 6.1) that would be most effective to deliver the message. Consider the audience and the geographic distribution required for each situation.

6.7 EVALUATION METHODS FOR OUTREACH EFFECTIVENESS

Measuring the effectiveness of education and outreach can be completed several different ways. Below are several methods that can be used to evaluate the public involvement strategy:

- Track and measure increases in management practice implementation.
- Total attendance records of events over time; determine if increases in attendance is occurring due to outreach efforts
- Provide opportunities for the public to deliver input on the outreach strategies that reached them
- Online, email, intercept or mail-in surveys
- Track the number of hits on websites or social media recipients

6.8 STAFFING NEEDS AND RESPONSIBILITIES

The P-MRNRD has staff that are dedicated to managing implementation of the Plan. The owner of any project implemented (either the P-MRND, a local city or government agency) will provide staff for the management and any outreach efforts required for each project. Each project will be assessed whether or not a Watershed Coordinator should be hired to manage the efforts required to implement a successful outreach program.

7 BEST MANAGEMENT PRACTICES

7.1 INTRODUCTION

The intent of Chapter 7 is to present a tool box of practical management alternatives for consideration during the project planning phase for all waterbodies across the Basin. This chapter outlines upland, stream, lake, and groundwater management practices, both structural and non-structural, that are feasible within the Basin to achieve the water management goals and objectives identified in this Plan. BMPs presented in this chapter have been identified due to their capability to reduce nutrients, sediment, and bacteria loading to waterbodies. BMPs will ultimately be selected based upon their effectiveness to address a specific issue or issues at the project level and their suitability to field scale conditions. It is important to note that literature-based load reduction estimates are presented throughout this chapter to give the reader a sense of possible BMPs performances. These estimates are mainly intended to be used for planning purposes. The actual performance of implemented BMPs is highly dependent on watershed characteristics, the position of the BMP in the watershed, drainage area, storage volumes, other BMPs in the watershed, maintenance of existing BMPs, and a host of other factors. BMP selection and expected efficiencies are best determined (often aided by watershed models) during specific project planning.

Project level details, such as permitting requirements, sizing, detailed cost estimates, and locating practices, are either provided in the implementation strategy section of each watershed plan chapter, or will be identified as a need for future project level planning.

7.2 MANAGEMENT PRACTICE SUMMARY

A wide variety of management practices are available in this chapter that might be used by project sponsors when planning at the project level. These management practices have been identified due to their capability to reduce pollutant loading to water resources. Projects will encourage the NRCS 'systems approach' to address priority natural resource concerns. The main point of this approach is that a variety of BMPs in sequence often work better than individual BMPs. A cornerstone of this approach is to encourage producers to implement a system of practices that has been determined to address specific high-priority resource concerns in selected watersheds. A variety of BMPs can be implemented that reduce pollutants by Avoiding, Controlling, or Trapping, or "ACT" (NRCS 2013). The concept of ACT (NRCS 2013) is defined as:

- Avoiding (A) - Avoidance helps manage nutrients and sediment source control from agricultural lands, including animal production facilities. Practices such as nutrient management, cover crops, and conservation crop rotation help producers avoid pollution by reducing the amount of nutrients available in runoff or leaching into priority water bodies and watersheds.
- Controlling (C) - Land treatment in fields or facilities that prevents the loss of pollutants includes practices such as conservation tillage practices and residue management, which improve infiltration, reduce runoff, and control erosion. Specific practices such as no-till/strip

till/direct seed and mulch tillage are foundation practices to recommend to producers in priority watersheds.

- Trapping (T) - The last line of defense against potential pollutants at edge of field, or in facilities to trap or treat. Practices such as filter strips, wetland forebays, bioretention areas, water quality basins, and the suite of wetland practices to enhance and/or restore wetlands all serve to trap and uptake nutrients before entering water bodies.

Pollutant removal efficiencies for several priority watershed-based practices have been documented and are provided in Table 7-1. Upon assessment of the Basin, these practices were identified as the most applicable to the Basin's characteristics (land use, topography, soils ,etc) that would most effectively address the impairments suffered by the waterbodies. All practices described in this chapter can be considered on an individual basis and implemented where suitable. While these performance estimates can be used for planning purposes, actual performance may be much different than documented in the literature. Whenever possible, management practice performance should be measured locally and documented for understanding their effectiveness.

Table 7-1. Pollutant Removal Efficiencies for Priority BMPs

Practice\pollutant and removal	Sediment (%)	Phosphorus (%)	Nitrogen (%)	*E. coli* (%)
Constructed wetlands [1,8]	89	69	55	70[8]
Wet detention basin[1,8]	86	69	55	70
Sediment control basin[4]	75	53	30	70
Cover crops[1,11]	70	15[*]	38	33[*]
No-till farming[1]	75	45	55	33
Terraces[1]	85	70	20	25
Grassed waterways[1,*]	75	75	75	50[*]
Manure and Land Application Management[1]	-	5	6	33
Onsite Waste Water Management[5]	-	75	75	75
Onsite Runoff Management[6]	75	75	65	50
Livestock Exclusion[4]	86	65	27	70
Riparian Buffer[4]	86	65	27	70
Pet Waste Management[1]	-	5	6	33
Rain garden[1,9]	-	81	43	70
Bioinfiltration system[1,9]	90	65	50	58
Stream restoration [1]	75	75	75	75[*]
Average reduction	81	59	43	56

1) Statistical Tool for the Estimation of Pollutant Load (STEPL) model, TetraTech 2011, 2) Hargrove 1991, 3) Strock et al. 2004, 4) Miller et al. 2012, 5) Pennsylvania Department of Environmental Protection 2006, 6) Wilson et al. 2011, 7) Massachusetts Department of Environmental Protection 1996, 8) UWRRC 2014/Wright Water Engineers and Geosyntec 2012, 9) Wright Water Engineers and Geosyntec 2012, 10) Winer 2000, and 11) United States Environmental Protection Agency 2014.
* See BMP description for additional details.

Nonpoint Source Control Effectiveness

The impact of urban and agricultural practices on water quality has received considerable attention during the last two decades, with a number of studies indicating that agricultural chemicals are one of the main sources of nonpoint source pollution (Gilley and Risse 2000). Intensive agricultural practices are identified to release significant amounts of nutrients, especially nitrogen and phosphorus, fecal bacteria, and sediment to receiving water bodies (Monaghan et al. 2005).

The effectiveness of individual BMPs in reducing nonpoint source pollution loads can be highly variable based on a number of site-specific factors. Additionally, the installation or use of one BMP is rarely sufficient to completely control the pollutant of concern. Combinations of BMPs that control the same pollutant are generally more effective than individual BMPs. These combinations, or systems, of BMPs can be specifically tailored for particular agricultural and environmental conditions, as well as for a particular pollutant (Osmond et al. 1995). To most effectively control nonpoint source pollution, BMP systems should be designed based on the following:

- Pollutant type, source, and cause;
- Agricultural, climatic, and environmental conditions;
- Farm operator’s economic situation;
- System designer’s experience;
- Acceptability by the producer of the BMP components.

Even though various BMPs have been shown to reduce losses of nonpoint pollutants and improve water quality at the scale of implementation (i.e., field/farm scales), their effectiveness in improving water quality at a watershed scale is less clear. Some BMPs may be effective in controlling one pollutant while, at the same time, may adversely affect the losses of other pollutants (Merriman et al. 2009). This should be considered when the selection is being made rather than after a new problem arises. However, even properly designed BMP systems constitute only part of an effective land treatment strategy. For a land treatment strategy to be really effective, properly designed BMP systems must be placed in the correct locations in the watershed (critical areas) and the extent of land treatment must be sufficient to achieve water quality improvements. Generally, 75 percent of the critical area must be treated with the appropriate BMP systems. If the problem derives from livestock, generally 100 percent of the critical area within the watershed must be treated with BMP systems (Meals 1993).

Response to Nonpoint Source Controls

Nonpoint source watershed projects sometimes fail to meet expectations for water quality improvement because of lag time - the time elapsed between adoption of management changes and the detection of measurable improvement in water quality in the target water body (Meals 2010). Even when management changes are well-designed and fully implemented, water quality monitoring efforts may not show definitive results if the monitoring period, program design, and sampling frequency are not sufficient to address the lag between treatment and response.

The main components of lag time include the time required for an installed practice to produce an effect, the time required for the effect to be realized in the waterbody, the time required for the waterbody to respond to the effect, and the effectiveness of the monitoring program to measure the response. Important processes influencing lag time include hydrology, vegetation growth, transport rate and path, hydraulic residence time, pollutant sorption properties, and ecosystem linkages. The magnitude of lag time is highly site- and pollutant-specific, but may range from months to years for relatively short-lived contaminants such as indicator bacteria, years to decades for excessive phosphorus levels in agricultural soils, and decades or more for sediment accumulated in river systems.

Groundwater travel time is also an important contributor to lag time and may introduce a lag of decades between changes in agricultural practices and improvement in groundwater quality. Approaches to deal with the lag between implementation of management practices and water quality response include characterizing the watershed, considering lag time in BMP selection, siting, and monitoring, selecting appropriate indicators, and designing effective monitoring programs to detect water quality response.

7.3 UPLAND STRUCTURAL PRACTICES (AGRICULTURAL)

Structural practices, such as terraces, ponds, and sediment forebays, are effective in retaining pollutants at or near the source. Structural practices, while more expensive, are longer-term solutions that are less likely to be abandoned. Benefits of these practices for controlling, trapping and attenuating pollutants increase when used in combination with non-structural practices. Table 7-2 displays the structural upland practices likely to be utilized in the basin based upon the ACT approach as described in the Nebraska State Nonpoint Source Management Plan (NDEQ 2015). Pollutant reduction estimates for each practice have been provided based upon available literature.

Table 7-2. Upland Structural ACT/Pollutants Addressed

Upland Practice	Practice Mode of Action			Pollutants Addressed			
	Avoid	Control	Trap	*E. coli*	Atrazine	Sediment	Nutrients
Constructed wetland		x	x	x		x	x
Wet detention basin		x	x	x	x	x	x
Dry detention basin*		x	x	x	x	x	x
Sediment control basin		x	x	x		x	x

*Source: ACT criteria not reported in Nebraska State Nonpoint Source Management Plan

Constructed Wetlands

Constructed wetlands are treatment systems that control and trap pollutants using natural biological processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality. Constructed wetlands are often used as a nonpoint source management practice to reduce sedimentation and nutrient loading to reservoirs by water mechanically filtering and trapping sediment within the wetland, rather than traveling to the waterbody. Wetland systems are unique because of their ability to uptake nutrients, provide natural attenuation, and provide solar disinfection. Constructed wetlands are designed specifically to a size and depth to maximize pollutant removal efficiencies. STEPL reports 85 percent reduction in sediment, 69 percent reduction in phosphorous, and 55 percent reduction in nitrogen (TetraTech 2011). However, nutrient reduction efficiencies can be reduced as the wetland community accumulates nutrients in plant biomass and ultimately releases them back into the system upon senescence. The removal (harvesting) of plant biomass (and nutrients contained in the plants) can be required to meet removal goals as wetlands age. *E. coli* reduction efficiency was assumed at 70 percent based on analysis of data provided by the International Stormwater BMP Database (UWRRC 2014; Wright Water Engineers and Geosyntec 2012).

<u>Wet Detention Basins</u>

Wet detention basins, also referred to as wet ponds, farm ponds, or retention basins, control and trap pollutants by holding runoff and allowing settling of particles. The retention pond has a permanent pool of water that fluctuates in response to precipitation and runoff from the contributing areas. Maintaining a pool reduces re-suspension and assists in keeping deposited sediments at the bottom of the holding area. Natural attenuation of pollutants occurs through breakdown of contaminants by soil microorganisms or other biological processes, especially nutrients and bacteria. This is a key benefit to retention facilities. The renovation of existing structures is a practice to be utilized as part of this Plan, and can be a more cost effective practice than constructing new ponds. STEPL reports pollutant reduction using wet ponds at 86 percent for sediment, 69 percent for phosphorus, and 55 percent for nitrogen (TetraTech 2011). In a 2012 study published on the International Stormwater BMP Database, a collaborative study between Wright Water Engineers and Geosyntec found that wet detention basins reduced *E. coli* by 70 percent.

<u>Dry Detention Basin</u>

Dry detention ponds also control and trap pollutants and are similar to retention basins, but do not permanently hold water, and can serve as infiltration or bioretention features. They are designed to remain dry except during or after rain or snow melt, which allows for agricultural use to continue on a regular basis above the structure. Their purpose is to slow down water flow and hold it for a short period of time to allow natural treatment of pollutants, for stormwater to infiltrate into the ground, or to settle out of the water during retained times rather than flow into a waterbody. The average depth at the peak water level after a rainfall event will be dependent on the frequency of event for the facility is designed. For example, a facility designed for a 2-year event won't be as deep at the maximum detention pool as a facility designed for a 10-year event. A reasonable estimate would be six to ten feet, with a drawdown time of approximately three days. STEPL reports pollutant reduction estimates of 58 percent for sediment, 26 percent for phosphorus, and 30 percent for nitrogen. According to the Massachusetts Stormwater Handbook, *E. coli* reduction efficiency in dry detention basis is less than 10 percent, for this study efficacy is assumed to be 9 percent (MassDEP 2017).

<u>Sediment Control Basin</u>

Sediment control basins can be used to control and trap pollutants, mainly by storing sediment produced by agricultural or urban activities, or serve as flow detention facility for fields with irregular topography. Sediment traps are much smaller than a retention or detention basin and can reduce runoff and sediment, prevent gullies, controls erosion on hilly uniform land, and improves the farm-ability of irregular cropland. A sediment control basin is constructed by excavation or by placing an earthen embankment across a low area or drainage swale. They may include a riser and pipe outlet with a small spillway. The Minnesota BMP Guidebook records sediment reduction between 60 to 90 percent (a mean value of 75 percent was used), phosphorus at 34 to 73 percent (a mean value of 53 percent was used), nitrogen reductions at 30 percent, and bacteria reductions at 70 percent (Miller et al. 2012).

Grassed Waterways

Grassed water ways are vegetated channels through fields that provide a means for concentrated flows to drain from a field without causing erosion. They can be installed on most fields but are especially effective in controlling gully erosion on steeper slopes. Grassed waterways are commonly used to convey runoff from terraces and diversions but are an important BMP when concentrated flows occur (Miller et al. 2012). For the purposes of this study, pollutant load reductions for grassed waterways are considered to be similar to streambank stabilization: 75 percent load reduction for sediment, phosphorous, and nitrogen (Tetra Tech 2011). *E. coli* reduction efficiency is conservatively estimated to be 50 percent. This is much lower than removals cited by the University of Minnesota Extension for a simulated study of bacteria removal in grass filter strips, which ranged from 75 to 92% for fecal coliforms and 68 to 74% for streptococci (Coyne et al., 1995).

7.4 UPLAND NON-STRUCTURAL PRACTICES (AGRICULTURAL)

Non-structural practices are less expensive and easier to implement, but often require a change in landowners' operations in order to be successful. While there are a host of practices available to producers to address specific or multiple issues, there are core practices that have either been widely accepted or have a high potential to benefit water resources. The core practices are shown in Table 7-3 and further explanation of these practices are provided.

Table 7-3. Upland Non-Structural ACT/Pollutants

Practice	Practice Mode of Action			Pollutants Addressed			
	Avoid	Control	Trap	*E. coli*	Atrazine	Sediment	Nutrients
Cropland							
Crop to grass/CRP	x				x	x	x
Cover crop	x	x				x	x
Irrigation management	x	x				x	x
No-till farming		x	x			x	x
Nutrient management	x	x					x
Soil sampling*	x						x
Terraces		x	x			x	x
Diversions		x	x			x	x
Contour farming*		x	x			x	x
Livestock							
Manure and Land Application Management	x	x		x			x

Practice	Practice Mode of Action			Pollutants Addressed			
	Avoid	Control	Trap	*E. coli*	Atrazine	Sediment	Nutrients
Reduced nutrients in feed*	x						x
Pasture management/ Prescribed grazing	x	x		x		x	x
Onsite waste water management system*	x	x	x	x		x	x
Onsite runoff management*		x	x	x		x	x
Livestock Exclusion	x			x		x	x
Other							
Riparian buffer		x	x	x	x	x	x
Saturated buffers		x	x	x	x	x	x
Soil Health Management	x			x		x	x

*Source: ACT criteria not reported in Nebraska State Nonpoint Source Management Plan

Crop to Grass Conversion

Crop to grass conversion is a highly effective practice to avoid pollutants from entering waterbodies. Significant environmental gains can be achieved by converting row crop back into grass including: decreased soil erosion, reductions in pollutant loading, reduced greenhouse gas emissions, reduced fertilizer usage, wildlife habitat, and many others. Since 2009, commodity prices have dropped significantly and many producers are again considering a non-row crop option such as the Conservation Reserve Program (CRP). Since 2009, over 160,000 acres have been converted into row crop from either grasslands or pasture in the Basin. This conversion was driven mainly by a desire to increase crop production during a time when agricultural markets were very strong. In 2016, commodity prices were very low and rates for CRP contracts are more attractive to producers.

Cover Crops

Cover crops are an important tool for promoting healthy soils and trapping pollutants. They are designed to naturally absorb excess nutrients after crop harvest and to prevent erosion when the field would otherwise be fallow, therefore improving water quality be reducing nutrients and sediment in agricultural runoff. Cover crops are typically planted in the late-fall and increase infiltration of rainfall and snowmelt. A cover crop is not typically harvested, but is grown to benefit the topsoil and or other crops. If the length of the growing season permits, however, it can be harvested prior to planting a summer crop. Crops such as turnips, radishes, and collards are the most common cover crop in NE. Other cover crops include cereal rye, oats, sweet clover, winter barley, and winter wheat are planted to temporarily protect the soil from wind and water erosion during times when cropland is not adequately protected. Cover crops also increase the organic matter and improve soil health, and are also referred to as green manure. STEPL reports pollutant reduction of 70 percent for sediment. According to the Pennsylvania Department of Environmental Protection (PA DEP), cereal cover crops provide between 30 and 45 percent load reduction for nitrogen (2006). PA DEP also reports phosphorous efficiencies at 15 percent for early-application and 7 percent for late-application when conventional-till methods are used. When conservation-till methods are used, PA DEP reports efficiencies of 0 percent phosphorous efficiency for both early and late-applications. The USEPA (2014) reported that combined soil conservation practices that included cover crops reduced *E. coli* runoff concentrations up to 46 percent. A more conservative *E. coli* efficiency is assumed for cover crops as a sole practice or in combination with no-till practices that are common in the study area. For the purposes of this study, load reductions were estimated at 70 percent for sediment, 15 percent for phosphorous, 37.5 percent for nitrogen, and 33 percent for *E. coli*.

Irrigation Management

Irrigation management techniques can prevent excessive runoff of pollutants by avoiding the over application of irrigation water. Irrigation scheduling is a practice that can reduce total water use and results in less nitrogen leaching from the root zone. Funding assistance through the P-MRNRD for data loggers, evapotranspiration gages, watermark sensors, and irrigation water flow meters represent valuable tools for optimal irrigation strategies.

Pivot irrigation is considered more efficient than furrow irrigation and can reduce leaching of nitrates by applying water in a more timely manner. Replacing furrow irrigation with a pivot irrigation system decreases water consumption and reduces infiltration of nutrients to groundwater.

Application of fertilizer through a pivot, referred to as both chemigation and fertigation, can help ensure that nitrogen is utilized by the plant. This practice encourages the use chemigation for a portion of their crop's fertilizer needs, thus reducing pre-plant applications that are more prone to runoff or infiltration to groundwater.

Variable Rate Irrigation (VRI) is a newer technology designed to control irrigation water application depths and rates. VRI takes into account soil types, topography, fertility levels, soil texture and quality, and past yields. VRI has multiple benefits, including reduced pumping costs, water conservation, and reduced infiltration, thus limiting nitrogen leaching.

No-Till Farming

No-till farming can reduce soil erosion by 90 to 95 percent compared to conventional tillage practices, and continuous no-till can make the soil more resistant to erosion over time. Phosphorus naturally binds to sediment, therefore, a reduction in sediment loading equates to a reduction in phosphorus loading. In fact, Baker and Laflen (1983) documented a 97 percent reduction in sediment loss in a no-till system as compared with conventional tillage practices. Fawcett et al. (1994) summarized natural rainfall studies covering more than 32 site-years of data and found that, on average, no-till resulted in 70 percent less herbicide runoff, 93 percent less erosion and 69 percent less water runoff than moldboard plowing, in which the soil is completely inverted. STEPL lists reduction of 75 percent for sediment, 45 percent for phosphorous, and 55 percent for nitrogen (Tetra Tech 2011). *E. coli* reductions are estimated at 33 percent.

Nutrient Management

Nutrient management is an avoiding practice for the management of the amount, method, and timing of application of fertilizer, manure, and other soil amendments. This practice is one of the most effective ways to improve water quality. Nutrient loss can be reduced by implementing general nutrient application guidelines that have been developed for voluntary or regulatory use (Miller et al. 2012). The Pennsylvania Department of Environmental Protection (2006) indicates an 18 percent reduction in nitrogen and a 22 percent reduction of phosphorous. A compilation of guidelines recommended in Nebraska and surrounding states can be used to direct voluntary efforts. General fertilizer application guidelines can include:

- Apply nutrients during the spring to avoid fall and winter runoff
- Apply nutrients in split applications
- Always apply nutrients at agronomic rates
- Maintain soil phosphorus concentrations at peak production levels
- Do not apply nutrients directly to surface water
- Do not apply nutrients to saturated ground
- Do not apply nutrients to ground that is frequently flooded or when flooding is expected
- Do not apply nutrients to frozen or snow covered soils

Split nitrogen applications consist of applying nitrogen in two batches at two different times rather than one. This is a common practice when total fertilizer recommendations exceed 100 lbs. Sidedressing or chemigation is common for the final application.

Nitrogen inhibitors are chemicals that reduce the rate at which ammonium is converted to nitrate by killing or interfering with the metabolism of *Nitrosomonas* bacteria. The loss of nitrogen from the root zone can be minimized by maintaining applied nitrogen in the ammonium form during periods of excess rainfall prior to rapid nitrogen uptake by crops. Data has shown that fields with only spring application of fertilizer show less nitrogen below the root zone. This is due to the differences in application timing, leaching rates, and crop utilization rates.

Record keeping is a non-structural BMP where producers that keep track of agronomic applications to ensure good crop production and protect water from leaching or runoff. Typical records include field based information such as residual soil nitrogen, nitrates in irrigation water, applied fertilizers, water applied, yield goals, and actual goals. Producers who more closely manage nitrogen applications typically apply less than those who do not.

<u>Soil Sampling</u>

Soil testing can be considered the basis for all nutrient management plans and should be practiced regularly by all producers. By following recommendations of an agronomist, fertilizer is applied at an agronomic rate based upon what exists in the soil, so the total quantity of fertilizer needed can be reduced in most cases, leading to improvement in groundwater and surface water quality. As commodity prices drop, managing input costs becomes an increasing concern to producers, making nutrient management even more important.

Soil sampling is a practice that may save a producer a considerable amount of money by reducing fertilizer inputs, yet maintaining a strong yield, without economic incentives to encourage implementation.

Terraces

Terraces are a controlling practice that consist of an earthen embankment, channel, or a combined ridge and channel built across the slope of the field and are generally used in moderate to steep sloping land. Terraces intercept and store surface runoff, trapping sediments and pollutants. In some types of terraces, underground drainage outlets are used to collect soluble nutrient and pesticide leachates, reducing the risk of movement of pollutants into the groundwater, and improving field drainage. However, the waterbody receiving runoff directly via tile drains can be impacted by high pesticide and dissolved nutrient concentrations. They may reduce the sediment load and content of associated pollutants in surface water runoff. STEPL lists pollutant reductions as 85 percent for sediment, 70 percent for phosphorus, and 20 percent for nitrogen (Tetra Tech 2011). *E. coli* load reductions are estimated at 25 percent.

Diversions

A diversion is very similar to a terrace, but its purpose is to direct or divert surface water runoff away from an area, or to collect and direct water to a pond. Filter strips should be installed above the diversion channel to trap sediment and protect the diversion. Similarly, vegetative cover should be maintained in the diversion ridge. Any associated outlets should be kept clear of debris. STEPL reports pollutant reduction using diversions at 35 percent for sediment, 30 percent for phosphorus, and 10 percent for nitrogen (Tetra Tech 2011).

Contour Farming

Contour farming includes tillage, planting, and other farming operations performed with the rows on or along the contour of the field slope. It helps to reduce sheet and rill erosion and the resulting transport of sediment and other waterborne contaminants (TetraTech 2011). STEPL reports pollutant reductions for contour farming at 41 percent for sediment, 55 percent for phosphorous, and 49 percent for nitrogen.

Manure and Land Application Management

Land application of animal manure helps to recycle nutrients in the soil and adds organic matter to improve soil structure, tilth, and water holding capacity. One major concern about this practice is that unintended runoff to surface water and buildup of phosphorus in soils results in nutrient delivery to downstream water resources. Manure management includes methods such as applying manure at agronomic rates, using methods that limit runoff (such as knifing) and applying manure outside of priority area sub-watersheds. Using STEPL, Pollutant load reductions were estimated by reducing the number of months manure applied to fields by 1/3. This resulted in reductions of 5 percent for phosphorous, 6 percent for nitrogen, and 33 percent for *E. coli* (Tetra Tech 2011).

Reduced Nutrients in Feed

Geographic areas with intense livestock production often import more nutrients in the form of feed than is exported in livestock or crop products. When manure is applied intensely to these areas over long periods of time, phosphorus tends to increase in the soils unless the manure is exported. Phosphorus inputs not only include the natural content of feed, but mineral supplements. Careful balancing of livestock rations may allow reductions in added phosphorus, thereby reducing the phosphorus content of manure. Studies have estimated that balancing supplemental phosphorus to dietary intake requirements could reduce phosphorus use by 15 percent (Fawcett 2009). Providing education to producers to promote feed ration optimization as a means to improve profits is a key component to this practice.

Pasture Management - Prescribed Grazing

Rotational grazing, also called prescribed or managed grazing, is a management-intensive system of raising livestock on subdivided pastures called paddocks. Livestock are regularly rotated to fresh paddocks at the right time to prevent overgrazing and optimize grass growth (Miller et al. 2012). The research portion of the economic, environmental and social analysis by the Land Stewardship Project documented significant water quality benefits when a managed year-round cover scenario (including rotational grazing) is used on working farms to replace intensive row cropping. A scenario identified expected water quality improvements of a 49 percent reduction in sediment, a 75 percent reduction in phosphorus, and a 62 percent reduction in nitrogen (Miller et al. 2012).

Onsite Waste Water Management

Animal waste management systems comprise a variety of best management practices (BMPs) or combination of BMPs used at concentrated animal feeding operations (CAFOs) and farms to manage animal waste and related animal by-products. These systems include engineered facilities and management practices for the efficient collection, proper storage, necessary treatment, transportation, and distribution of waste. The BMPs are designed to reduce the discharge of nitrogen, phosphorus, pathogens, organic matter, heavy metals (such as zinc, copper, and occasionally arsenic, which are present in many animal rations), and odors. Example facilities and management methods are holding ponds, waste treatment ponds, composting, and manure management and land application (TetraTech 2011). The Pennsylvania Department of Environmental Protection (2006) cites that waste management systems on feedlots can reduce phosphorous 75 percent and can reduce nitrogen by 75 percent. *E. coli* reduction is assumed to be similar to other pollutant reductions, also at 75 percent.

Onsite Runoff Management System

A runoff management system controls excess runoff caused by construction operations at development sites, changes in land use, or other land disturbances like feedlot operations (TetraTech 2011). In 2011, the Minnesota Department of Agriculture (Miller et al. 2012) reported that runoff management systems can reduce sediment and phosphorous by 75 percent. Nitrogen reduction was estimated at 65 percent and *E. coli* reduction was 50 percent.

Livestock Exclusion

Livestock producers who restrict or eliminate access to streams and/or farm ponds and convert to an alternative water source can expect increased productivity and improvements in riparian vegetation and in-stream water quality (Zeckoski et al. 2007). Key practice components include providing off-stream watering, livestock comfort, streamside fencing, stream crossings, and buffer strips. Not only does it decrease disturbance, this practice also reduces sediments being stirred up and eliminates livestock from defecating directly in the stream which helps with nutrients and bacteria. Pollutant reduction by livestock exclusion are: 86 percent for sediment, 65 percent for phosphorus, 27 percent for nitrogen, and 70 percent for *E. coli*. These figures mimic the behavior of the riparian buffers description provided within this chapter.

Riparian Buffer

Riparian buffers, vegetated buffers or filter strips, are planted between fields and surface waters to reduce sediment, organics, nutrients, pesticides pathogens, and other contaminants in runoff. The use of vegetated buffers along streams, and vegetated filter strips in uplands, can provide significant reductions of pollutants to waterbodies by reducing sediment to waterways, which equates to less sediment bound phosphorus being discharged to waterbodies. Nitrogen and dissolved contaminant reductions are more associated more with infiltration in the buffer. Pollutant removal rates largely depend on buffer width, vegetative make up, and pollutant type. A study for Stevens Creek near Lincoln, NE found that the baseline buffer width recommended for both water quality maintenance and basic habitat is 50 ft (15 m) per side. This number may be modified based on other factors such as slope, soil particle size, adjacent land use, the presence of certain wildlife communities, stream size, and stream order (Bray 2010). Pollutant load reduction estimates noted in the Agriculture BMP Handbook for Minnesota list reductions as: 86 percent for sediment, 65 percent for phosphorus, 27 percent for nitrogen, and 58 percent for atrazine (MDA 2012). *E. coli* reductions considered to be 70 percent based on the findings of Koelsch et al. (2006) and Wagner (2010).

Saturated Buffer

Nutrient loss through subsurface drainage systems is a major concern throughout the Midwest. By hydrologically reconnecting a subsurface drainage outlet with an edge-of-field buffer this practice takes advantage of both the denitrification and plant nutrient uptake opportunities that are known to exist in buffers with perennial vegetation as a way to remove nutrients from the drainage water. Nitrate reduction have been proven at 60 to 95 percent, while studies have shown that there were no consistent trends that indicated that dissolved phosphorus in the tile water was removed by the saturated buffers (Utt 2015).

Soil Health Management

Management of soil health has generated increased interest in recent years. Improvements to soil health can include increasing organic matter and increasing microbial activity. This results in increase water retention and improves nutrient cycling, which reduces the need for chemical fertilizer application, increases drought resiliency, etc., and ultimately reduces runoff and the associated pollutant loads. Chapter 8, Section 8.2 introduces the Nation Corn Growers – Soil Health Partnership that is working to establish demonstration farms to improve soil health. This would be a highly beneficial to bring into the Basin.

7.5 URBAN CONSERVATION PRACTICES

Many communities promote urban conservation practices to protect water quality and reduce runoff. Like agricultural practices, urban practices require a program to build awareness and promote behavioral change that will result in improvement and protection of water resources. In many cases, urban conservation practices can be utilized in public places (e.g., parks, public facilities, private lots, street right of ways, etc.) and serve as demonstration sites. Table 7-4 displays several conservation practices commonly used within municipalities that follow the ACT approach.

Table 7-4. Urban Structural ACT/Pollutants

Practice	Practice Mode of Action			Pollutants Addressed			
	Avoid	Control	Trap	*E. coli*	Atrazine	Sediment	Nutrients
Urban							
Bioswales		x	x	x		x	x
Urban soil quality restoration	x	x	x			x	x
Rain garden/bioretention		x	x	x	x	x	x
Bioinfiltration systems		x	x	x		x	x
Rain water harvesting	x	x		x		x	x
Native landscaping	x				x	x	x
No/low -Phosphorus Fertilizer*	x						x
Pet waste management	x	x		x			x
Low impact development	x				x	x	x
Green roofs*		x	x				x
Soil Health Management	x			x		x	x

*Source: ACT criteria not reported in Nebraska State Nonpoint Source Management Plan

Bioswales

Bioswales control and trap pollutants using deep rooted native vegetated drainage courses designed to increase infiltration and strip sediment and other pollutants from storm runoff. They are often installed as an alternative to underground storm sewers and are located within urban drainage ways. The bioswale is engineered so that runoff from frequent, small rains infiltrate into the soil below. When larger storms occur, bioswales slow the flow of runoff while using above ground vegetation to filter and clean the runoff before it ends up in a lake or stream. Bioswales can be a cost effective, low-maintenance replacement for low flow concrete liners in need of expensive repairs. Reduction estimates are 81 percent for sediment, 34 percent for phosphorus, and 84 percent for nitrogen (Winer 2000).

Urban Soil Quality Restoration

Healthy soil is the key to preventing polluted runoff and can avoid, control, and trap pollutants. As buildings and houses are built, top soil is removed and the remaining sub-soil is compacted by grading and construction activity. The owner is left with heavily compacted subsoil, usually with high clay content and little organic matter. Soil quality restoration is simple - start by reducing soil compaction and increasing organic matter content with the addition of compost. Soil quality restoration can be completed on any existing yard, making this one of the easiest and least expensive water quality conservation practices to implement. Reduction estimates for this practice were not widely reported.

Rain Gardens

Small-scale bioretention features, often referred to as 'rain gardens', are a structural conservation practice commonly used for stormwater quality improvement and reduction of stormwater runoff in urban areas. Rain gardens reduce runoff and allow stormwater to soak into the ground as opposed to flow into storm drains and surface waters which causes erosion, water pollution, flooding, and diminishes groundwater quality. When properly designed for specific soil types and climate, and well maintained, they can offer highly efficient reduction of phosphorus, as well as other pollutants, and are highly aesthetic. Pollutant reduction estimates for rain gardens vary and in some cases nutrient loads may increase. STEPL reports pollutant reduction using rain gardens at 81 percent for phosphorus, and 43 percent for nitrogen. *E. coli* reduction is estimated at 70 percent based on median concentration influent/effluent values reported in the International Stormwater BMP Database 2012 Pollutant Category Summary Addendum (Wright Water Engineers and Geosyntec 2012).

Bioinfiltration Systems

Bioinfiltration systems are shallow, landscaped depressions used to promote absorption and infiltration of stormwater runoff. This management practice is effective at removing pollutants and reducing the volume of runoff. Stormwater ponds in the depression and infiltrates into the soil bed. The filtered runoff infiltrates into surrounding soils through an absorption basin or trenches. These systems are typically designed to treat runoff from relatively small storms (1-2 yr events). STEPL reports pollutant reduction using bioinfiltration at 90 percent for sediment, 65 percent for phosphorus, and 50 percent for nitrogen. Bioinfiltration features reduced *E. coli* 20 to 95 percent according to median concentration influent/effluent values provided in the International Stormwater BMP Database 2012 Pollutant Category Summary Addendum (Wright Water Engineers and Geosyntec 2012). For this study, *E. coli* reduction efficiency for bioinfiltration systems is assumed at the mean performance, 58 percent.

Rain Water Harvesting

Rain barrels are a very simple method for collecting roof runoff for beneficial uses such as irrigation of landscaping and gardens. Residential rain barrels typically hold 55 gallons and are connected to a downspout with a faucet and overflow pipe. Rain water is naturally soft, oxygenated, and free of chemicals used to treat most sources of publically supplied water.

Native Landscaping

Native vegetation enhances a landscape's ability to manage stormwater, and also requires less water to survive by encouraging the growth of plants native to the surrounding area. The goal of low impact landscaping is to use techniques that infiltrate, store, evaporate, and detain runoff close to its source. A diversified habitat with native vegetation encourages use by birds, butterflies, and other wildlife. In most cases, native vegetation doesn't require fertilizer or pesticides for survival. Native landscaping and turf can replace bluegrass and other non-native water sensitive species commonly used in communities.

No/Low-Phosphorus Fertilizers

Nutrients are essential for plant growth, especially nitrogen, phosphorus, and potassium. Fertilizers, pesticides, and animal waste commonly include phosphorus. Excessive phosphorus loading is a leading contributor to algae growth, which lowers water quality and causes several issues in community lakes. No-phosphorus fertilizers (i.e. 30-0-3) are recommended to be used on established lawns, as most soils in Nebraska contain enough natural phosphorus to support a healthy lawn. Similar to Nutrient Management, reductions with this practice are 18 percent reduction in nitrogen and a 22 percent reduction of phosphorous.

Pet Waste Management

Pet waste, like livestock manure, contain nutrients and bacteria that can contribute pollution in runoff. Immediate removal and proper disposal of pet waste can help reduce pollutants and bacteria from reaching surface and ground waters. Pollutant load reductions were estimated by using similar values to the manure management practices previously identified in this chapter wherein adjusting the number of application months by 1/3 in the STEPL model provided an efficiency estimate (Tetra Tech 2011). The load reductions used were: 5 percent for phosphorous, 6 percent for nitrogen, and 33 percent for *E. coli*.

Low Impact Development

Numerous projects in Nebraska have focused on introducing urban stormwater management practices to citizens, community leaders and practitioners in the construction and land maintenance industries. Larger communities have relaxed mandatory curb and gutter standards to allow alternative street designs. Curb cuts draining runoff to rain gardens or bioswales and low-maintenance landscapes are now being encouraged in streetscape designs. Architects and engineers are gaining more experience with roof gardens, low input landscaping and green space as design options for public and private buildings. Permeable pavement is accepted as a common design option for low traffic areas such as parking spaces, trails and walkways. Low/no-phosphate fertilizer is now available through most garden centers and lawn maintenance companies. Landscape designers now promote rain barrels, rain gardens and native plants requiring less water and nutrients. Installation and evaluation of demonstration sites and extensive communication and training for private citizens, community leaders and industry professionals was instrumental in gaining acceptance and creating a market for low impact development practices in Nebraska.

Green Roofs

Green roofs or vegetated roof covers are a thin layer of growing plants on top of a roof. These systems store water in engineered soil, where water is taken up by the plant and transpired into the atmosphere. This results in a decrease in stormwater runoff from the roof and associated pollutants.

Soil Health Management

Soil health management in urban areas is an effort to reduce soil compaction and increase organic matter content with the addition of compost. Lawns with good soil quality reduce the need for watering, and minimize the need for fertilizers and pesticides. Yards with poor, compacted soil contribute to water quality problems due to their inability to infiltrate and absorb water, which increases runoff and the associated pollutant loads.

7.6 STREAM PRACTICES

Stream-based practices serve to enhance and restore existing resources by filtering pollutants, increasing aquatic habitat, stabilizing stream banks, recharging groundwater, and reducing sedimentation of downstream waterbodies. Table 7-5 displays the stream practices as part of the ACT approach from the 2015 State NPS Plan.

Table 7-5. Stream Based ACT/Pollutants Addressed

Practice	Practice Mode of Action			Pollutants Addressed			
	Avoid	Control	Trap	*E. coli*	Atrazine	Sediment	Nutrients
Stream Stabilization							
Stream Restoration		x		x		x	x
Grade control structure		x				x	
In-stream wetlands		x	x	x		x	x
In-stream weirs		x	x	x	x	x	x
Habitat Improvement							
Aquatic habitat development	x	x		x		x	x
Floodplain reconnection*		x	x	x		x	x
*Source: ACT criteria not reported in Nebraska State Nonpoint Source Management Plan							

Stream Restoration

Stream restorations will vastly improve stream stability and the ability to provide aquatic habitat. Designs would stabilize stream grades to reduce streambed incision that leads to bank failure and stream widening, as well as to promote pool and riffle formation. Bank slopes would be stabilized and regraded to allow increased vegetation cover, improved plant species and promote overhanging vegetation. Degrading streams can be a major contributor of sediment and other pollutants to rivers, lakes, and streams. Increased slopes occur due to the straightening of streams, which increases the energy of the flow. This causes the channel bed to incise, resulting in bank failure and channel widening. Erosion occurs in natural streams that have vegetated banks, however, land use changes or natural disturbances can cause the frequency and magnitude of water forces to increase. Loss of streamside vegetation leads to reduced resistance, making streambanks more susceptible to erosion. STEPL reports pollutant reduction using streambank stabilization at 75 percent for sediment, 75 percent for phosphorus, and 75 percent for nitrogen. *E. coli* reductions are estimated to be similar to other reductions at 75 percent.

Grade Control Structures

Grade control structures reduce erosion by stabilizing the banks and bed of a stream system by reducing stream slope and flow velocity. Grade control structures are built using rock, broken concrete, steel, or other similar materials. Grade control riffles spaced at regular intervals may help curb areas of minor incision in sections of streams by changing their profile from an erosive, steep incline to a stable stair-step pattern with hardened beds at each step. They allow stream elevation to drop in a controlled setting, while preventing further degradation. Grade control structures also create shallow pools by impeding the flow. The pools allow sediments and associated nutrients to settle from the water column and increase the biological processing of nutrients. The structures can also enhance biological communities by creating and protecting aquatic habitat. Load reductions associated with grade controls structures are highly specific to each site and design. Preventing degradation will reduce sediment loads as well as the load reduction associated with any pollutant attached to the sediment (nutrients and/or bacteria).

In-Stream Wetlands

In-stream wetlands can be created on small streams by impounding or adding a control structure to the stream. Mitsch (1993) observed that creation of in-stream wetlands is a reasonable alternative only in lower-order streams. Construction or restoration of created in-stream wetlands provides an opportunity to control nonpoint source pollution, regulate water storage, and provide habitat for both aquatic and non-aquatic species. Sediment, nutrient, and bacterial reduction efficiency of in-stream wetlands is assumed to be comparable to those discussed in the constructed wetland section previously discussed in this chapter.

Aquatic Habitat Development

Aquatic habitat restoration includes improving the conditions or enhancing stream ecology to support desired fish and other aquatic species. Actions vary depending upon the goals, but may include increasing overhanging riparian vegetation, providing structural habitat, and removing trash and other man-made products. Aquatic habitat improvement is often a component or result of other interventions, such as streambank stabilization, buffering, and riparian zone renovation. Common structural alternatives include restoring natural flow cycles such as reconnection to an oxbow or floodplain, riverine wetland restoration, native vegetation, and wetland enhancement. Load reductions could be experienced with activities implemented to improve habitat, but the primary focus of this practice would not likely be load reductions. The focus is to implement measures that address the aquatic community impairments that are not tied to a known pollutant source.

Floodplain Reconnection

Floodplains are reconnected to the stream by diverting excess water during high flow events onto the historic floodplain to reestablish natural stream processes. Benefits include wetland creation/enhancement, pollutant filtration, flood storage, groundwater infiltration, and enhanced aquatic and wildlife habitat. Load reductions could be experienced with activities implemented to improve habitat, but the primary focus of this practice would not likely be load reductions. The focus is to implement measures that address the aquatic community impairments that are not tied to a known pollutant source.

7.7 LAKE AND RESERVOIR PRACTICES

Working in a partnership with NGPC is a key element in managing lakes and reservoirs. NGPC has funding through the Aquatic Habitat Program that supports several of the management practices listed in this section. Several in-lake improvement alternatives have been identified that improve water quality and restore aquatic habitat. The ACT approach in-lake practices applicable to this Basin are listed in Table 7-6.

Table 7-6. Lake ACT/Pollutants Addressed

Practice	Practice Mode of Action			Pollutants Addressed			
	Avoid	Control	Trap	*E. coli*	Atrazine	Sediment	Nutrients
Lake and Reservoirs							
Wetland Enhancement*		x	x	x		x	x
Sediment Removal		x				x	x
In-Lake Forebays*	x		x	x		x	x
Nutrient Inactivation		x	x				x
Aeration*		x					x
Shoreline Stabilization		x				x	x
Fish Renovation*	x						x

*Source: ACT criteria not reported in Nebraska State Nonpoint Source Management Plan

<u>Wetland Enhancement</u>

Wetland benefits and functionality have been previously documented in this chapter. Opportunities are available to enhance existing wetlands, especially in the inlet area of several basin reservoirs. Wetland enhancements can benefit water clarity by removing nutrients and sediments, and reducing bacteria through attenuation. Phosphorus reductions are a priority, and water quality benefits can improve fisheries. In addition, the inlet area of reservoirs provides a location for bird watching, fishing, and hiking. Secondary benefits of wetland enhancements include aesthetics, wildlife habitat creation, groundwater recharge, and restoration of the ecosystem's natural functionality. Sediment, nutrient, and bacterial reduction efficiency is assumed to be comparable to those discussed in the constructed wetland section previously discussed in this chapter.

<u>Sediment Removal</u>

Sediment removal is a pollutant control technique in reservoirs and is a complex and expensive undertaking no matter which technique is used. More attention must be focused on the upkeep of reservoirs before sedimentation renders them useless. Increased sedimentation not only increases the amount of nutrients entering the reservoir but it also lessens the reservoir's ability to attenuate the nutrients within. In addition to removing sediment attached phosphorus from the system sediment removal to increase depth in shallow areas also reduces sediment re-suspension and increases water clarity. Targeted removal is likely to improve fish habitat, thereby increasing the water quality benefits associated with fishery renovation.

Load reductions associated with sediment removal are highly specific to each site and design. Regaining lost storage capacity is often necessary to achieve an acceptable level of water quality and maintain reservoir benefits. A number of different methods can be used to accomplish the removal of deposited sediment including sluicing, dredging, and dry excavation. While all options should be evaluated for each site, dredging and dry excavation have been the two most commonly used on reservoirs in the Basin. When conditions are suitable, dry excavation has proven to be the most cost effective.

In-Lake Sediment Forebays

Utilizing a portion of an existing reservoir, adding additional reservoir area above the existing reservoir, or a combination of both as a sediment/water quality basin is another means of minimizing the potential for materials to enter the main basin of a lake. Forebays, which serve as a trap for sediment and other pollutants, are commonly created at the headwaters of the reservoir or stormwater outlets. Forebays are multi-beneficial and can be comprised of soil or rock which can serve additional purposes (e.g., fishing jetty). In-lake sediment forebays can reduce sedimentation to the reservoir, capture nutrients, and promote establishment of wetlands as a natural filter. The layout of forebays allows for easier access of equipment to remove sediment when excavation efforts are necessary. Sediment, nutrient, and bacterial reduction efficiency are a function of the size of the designed structure and storage capacity, but it can assumed to be comparable to those discussed in sediment control basin section, since they function in the same manner.

Nutrient Inactivation

Phosphorus precipitation and inactivation are techniques used to control algal blooms by reducing the availability of phosphorus that fuels the growth of algae. Chemical complexes, typically salts of aluminum, calcium or iron compounds, are applied to bind with soluble phosphorus and make it unavailable for biological uptake by algae. Aluminum sulfate (alum) is frequently used because it retains its phosphorus-sorbing ability over a relatively wide range of environmental conditions.

For reservoirs, inactivation can be accomplished through topical treatments. These treatments should be used in conjunction with an extensive watershed management effort in order to reduce the external load of phosphorus to the waterbody. Nutrient inactivation can provide benefits in two ways;

- Phosphorus precipitation uses a relatively low dose of alum to provide temporary control of unbound phosphorus molecules within the water column. Phosphorus in the water bonds to aluminum as it falls to the bottom of the reservoir making it unavailable for algal uptake. The longevity of this benefit is greatly influenced by the amount of phosphorus entering the reservoir from the watershed.
- Phosphorus inactivation aims to achieve long-term control of phosphorus released from lake bottom sediments. As phosphorus is released from these sediments, it is bound by aluminum and retained on the bottom. Inactivation should be considered when internal loads are determined to be a significant contributor to degraded water quality.

Phosphorus inactivation can be used on streams entering a lake by injecting liquid alum on a flow-weighted basis during rain events. Alum-drip systems have reportedly resulted in immediate and substantial improvements in water quality in some lakes across the U.S. In specific applications, alum treatment of stormwater runoff has achieved a 90 percent reduction in total phosphorus, 50-70 percent reduction in total nitrogen, 50-90 percent reduction in heavy metals, and >99 percent reduction in fecal coliform (Harper 1992). The use of an alum-drip system is a potential alternative to be used in conjunction with watershed conservation practices, structural practices such as in-lake forebays, and detention structures.

The introduction of alum into the lake may require a Water Quality Standards Variance Request through the NDEQ dependent on the application method and potential temporary impacts on water quality parameters. Long term application of alum via injection of stream flows entering the lake can create a localized accumulation of the flocculent near the location of application. A forebay should be considered to trap the flocculant and enhance the ability to remove accumulated flocculant.

<u>Aeration</u>

Lake aeration can be accomplished by pumping oxygen (or air) into the deep, often nutrient-enriched, oxygen-depleted layer that forms in deeper lakes called the hypolimnion. The goal of hypolimnetic aeration is to maintain oxygen in this layer to limit phosphorus release from sediments without causing the water layers to mix (de-stratify). Phosphorus load reductions associated with aerations systems are highly specific to each lake and the size/design of the system.

<u>Shoreline Stabilization</u>

As reservoirs age, they lose depth due to sediment deposition from the watershed. Shoreline/bank erosion processes can add additional sediment and pollutants to the reservoir while affecting the depth and habitat diversity of shorelines. Physical factors, such as bank height, prevailing winds, fetch, and the amount of vegetation on the banks and in the water, can dictate the extent of shoreline erosion. Bank stabilization practices should be recommended based on a reconnaissance survey of each waterbody. A combination of rip rap (hard armor) and tall grass management or tall grass buffers are common for stabilization of shoreline. Stable vegetated shorelines have increased capacity to attenuate pollutants. Operation and maintenance changes can also support a more stable shoreline by limiting mowing and allowing a healthy stand of vegetation to support the banks along shorelines. Load reductions associated with shoreline stabilization are a function specific to the erosion rate and the pollutant content of the soils at that particular location.

<u>Fishery Renovation</u>

Fisheries renovation and the restoration and enhancement of in-lake fish habitat can help decrease sediment and nutrient re-suspension. It will also restore healthy ecosystem functions by increasing the quality of habitat for all trophic levels. Fishery renovation oftentimes involves removing rough fish such as common carp. The foraging behavior of these fish leads to a severe decrease in vegetation as well as the suspension of phosphorus laden sediment. The reestablishment of riparian and littoral vegetation will provide both forage and shelter habitat. It will also provide competition to algae for available phosphorus. Potential in-lake restoration components might include shoreline stabilization, shoals, scallops, spawning beds, etc. Because each lake is unique, the most appropriate combinations of habitat improvement techniques should be employed. Load reductions associated with fishery renovations is are highly specific to each lake and the rough fish population density.

7.8 GROUNDWATER PRACTICES

Groundwater practices are primarily focused on reducing nitrate contamination by decreasing nutrient loading to aquifers. Depending on the particular practice, other benefits may include conservation to reduce total consumption of groundwater, reduced pollutant loading to surface waters, and reduction of infiltration below the root zone. Table 7-8 displays the ACT approach benefits of groundwater practices.

The following techniques are listed as possible management actions for cost-share or other incentive based programs and many are related to management practices for surface water quality improvement. Other conservation practices not listed, that could be beneficial, may be considered by project sponsors. Many of these practices were previously described within this chapter.

Table 7-7. Groundwater Conservation Practice ACT/Pollutants Addressed

Practice	Practice Mode of Action			Pollutants Addressed			
	Avoid	Control	Trap	*E. coli*	Atrazine	Sediment	Nutrients
Groundwater							
Irrigation Management	x	x		x	x		x
Cropping Techniques*	x	x		x	x		x
Nutrient Management	x	x					x

*Source: ACT criteria not reported in Nebraska State Nonpoint Source Management Plan

<u>Irrigation Management</u>
Irrigation management practices previously described, including irrigation scheduling, furrow to pivot conversion, and VRI, are all practices that would be beneficial to reducing infiltration of nutrients to groundwater. Irrigation management is a multi-beneficial practice for surface water and groundwater.

<u>Cropping Techniques</u>
Practices previously listed, including crop to grass/CRP, cover crop, irrigation management, no-till, nutrient management, soil sampling, terraces, and diversions, have significant benefits for groundwater. These practices were previously defined within this chapter.

<u>Nutrient Management</u>
Nutrient practices previously listed, including split nitrogen applications, nitrate inhibitors, soil sampling, side dressing, record keeping, and chemigation, are all applicable beneficial practices to reducing nitrate loading to groundwater. Many nutrient management practices are multi-beneficial for reducing pollutant loading to groundwater and surface water.

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8 TECHNICAL AND FINANCIAL RESOURCES

8.1 INTRODUCTION

The purpose of this chapter is to describe the technical and financial resources and authorities that will be relied upon to implement the Plan. While P-MRNRD, the City of Omaha and the other municipalities in the District have taxing authorities that they use to support a variety of public needs, additional support from local, state, and federal funding is essential to accomplish a broad range of water quality management responsibilities. Funding through outside sources is neither consistent nor guaranteed, however, they will be relevant in implementing different aspects of this Plan, specifically project planning, implementation, monitoring, and education.

The P-MRNRD and its communities have a multitude of local, state, and federal experts available for technical input and assistance. Information provided below is focused on technical and financial resources that are deemed most critical to meet primary water quality management challenges in the district. Estimated cost for programs, projects, and activities that are planned for the first five years on a project level are provided within each individual watershed chapter, as well as being summarized in the Basin Summary chapter.

8.2 TECHNICAL RESOURCES

This Plan was prepared with input from numerous technical partners. Implementation of the management strategies will also require technical input and involvement. Technical partnerships or specific assistance will be pursued on a project-by-project basis to accommodate specific expertise needs. Several entities routinely provide technical assistance and support during the planning and implementation of water quality projects in the Basin (Table 8-1). Communities involved in water quality management efforts have the same technical partnering opportunities as the P-MRNRD and in most cases, communities and the P-MRNRD will work jointly on projects.

Given the large amount of privately-owned ground in the Basin used for agricultural purposes, one-on-one assistance to landowners/producers will be essential to successfully implement this Plan. Technical staff from the P-MRNRD and USDA-NRCS will provide landowner/producer assistance basin-wide with focused efforts in targeted areas. All assistance options, new research, and changes in conservation technologies will be made available to landowners and producers through technical and educational outlets provided by P-MRNRD and other partner agencies.

Table 8-1. Critical Technical Partners for Water Quality Management

Agency	Technical Capabilities
NDEQ	Regulatory and non-regulatory programs pertaining to water quality and nonpoint source pollution, monitoring, data assessment and reporting.
USDA-NRCS	Producer assistance for USDA programs. Design, installation, and evaluation of conservation practices,

Agency	Technical Capabilities
NDNR/Natural Resources Commission	Funding for monitoring, research, and project implementation through the Water Sustainability Fund.
NGPC	Technical assistance with aquatic habitat renovation, fisheries, and wetlands management.
UNL Extension	Environmental education, outreach, and stakeholder involvement.
UNL Institute of Agriculture and Natural Resources	Technical leadership, biological monitoring, environmental education, research studies, GIS data, and a library of research.
Nebraska Forest Service/ Statewide Arboretum	Collaboration and assistance for landscapes and vegetation selection for projects, as well as funding assistance.
UNL Water Center	Monitoring and laboratory analyses.
Local Universities and Colleges	Education and technical leadership.

8.2.1 Specialized Assistance

Several unique and specialized assistance programs are available through local and national agencies to address water quality issues in the Basin.

NDEQ- On-Site Wastewater System Upgrade Practice
Adoption of new regulations and new design standards for on-site wastewater systems occurred in 2004 and offered an opportunity to address this potential source of bacterial and nutrient contamination of streams. The On-Site Wastewater System Upgrade practice for Section 319 projects was created to support inspection of on-site wastewater systems and to upgrade systems installed before 2004. This practice is restricted to projects implementing an approved 9-element watershed management plan in which this practice has been identified.

USDA - Conservation Consultant Practice
Structural conservation practices generally are easily understood and permanently maintained by land managers. Applying non-structural management practices (such as no-till and cover crops) may require applying new skills and developing confidence over several years that management practices will yield the desired benefits. The conservation consultant practice was created as a complement to other management practices to assist land managers in successfully implementing new management practices such as no-till or nutrient and irrigation management by applying the professional assistance from a crop consultant. Successful implementation and understanding of conservation management practices by land managers is critical to long-term continuance of those practices.

Midwest Row Crop Collaborative (MRCC)
The MRCC, established in September 2016, is a diverse coalition working to expand agricultural solutions that protect air and water quality and enhance soil health while remaining committed to producing enough food to feed the growing global population. The participating companies and conservation groups are all committed to building a broad partnership in three pilot states: Illinois,

Iowa, and Nebraska. This group will measure and deliver improved environmental outcomes through cross-sector collaboration and continuous improvement at a meaningful scale throughout the Upper Mississippi River Basin. The MRCC is interested in forging partnerships with local partners and working with farmers, environmental groups, and state and local agencies to achieve nutrient and water loss reduction goals. The Nature Conservancy is a partner in the MRCC and would be the local resource in determining how to incorporate the activities of the MRCC into the Basin.

National Corn Growers - Soil Health Partnership (SHP) Demonstration Farms
The SHP is a farmer led initiative that brings together diverse partner organizations including federal agencies, universities and environmental groups to work toward the common goal of improving soil health. On their demonstration farms, they assist in identifying, testing and measuring management practices to improve soil health and benefit farmers' operations. They work with their demonstration farms to provide technical assistance that will help growers and their advisors make decisions that will result in positive changes for the profitability of their operation and the sustainability of the soil. Currently they have 65 demonstration farms enrolled and would like to expand this to 100 by 2017.

8.3 FINANCIAL NEEDS AND POTENTIAL RESOURCES

8.3.1 Financial Needs

Estimated funding needs for the first five years of Plan implementation are based on priorities identified during the planning process. Although Plan implementation costs are based on the first five year period, the P-MRNRD, City of Omaha and other communities within the District will conduct comprehensive budget planning on an annual basis as part of their regular budgeting process. In doing so, the jurisdictions will determine resource needs for planning, implementation, education, monitoring and assessment, and staffing for upcoming budget periods. These needs will be prioritized and balanced against available funding for that time period.

The estimated five year implementation costs are provided in the Basin Summary chapter. Costs are based on the following categories:

- *Planning*: Planning efforts related to project development including data assessment, the preparation of project plans, development of monitoring strategies, and the development of funding strategies and applications.
- *Land Conservation Measures*: The P-MRNRD is responsible for administering several district-wide programs related directly to water management. Many of these programs are focused on implementing conservation measures targeted at improving soil health and stream corridor conditions providing water quality and recharge benefits. Complementary to these programs are state and federally funded efforts that involve cost-share and incentives for conservation measures that address soil health and improve surface and groundwater quality.
- *Cost of Targeted Projects and Activities*: Targeted projects and activities include those that are focused in a priority or special priority area to address a specific resource concern. These

projects and activities were determined as priority management efforts by the Steering Committees. Targeted efforts will be aimed at improvements in surface and groundwater quality, groundwater recharge, or surface storage. For the purposes of this budget, targeted project costs will pertain to costs associated with surveys, design/engineering, and construction. Cost estimates were derived from the best available information and may change significantly as planning progresses.

- *Monitoring Costs*: Annual costs of physical, chemical, and biological monitoring were determined for expanded efforts that are planned for the next five years. Cost estimates are associated with purchasing or installing sampling equipment, equipment maintenance, and scientific/analytical services. Routine activities could include surface water and groundwater monitoring.

8.3.2 Financial Resources

The P-MRNRD, City of Omaha and other communities within the District are funded by a variety of sources including: property taxes, sale of conservation trees and services, assessment projects (self-supporting rural water systems), state and federal cost-sharing for projects and programs, and various grant programs. It is essential that funding is maximized by leveraging local funds against outside funding sources. While all available sources of funding will be evaluated and pursued for the implementation of this Plan, a few funding sources will be critical for the P-MRNRD and its communities to complete water management activities and projects. Match requirements vary per program and are discussed where applicable below.

<u>USDA - Environmental Quality Incentives Program (EQIP)</u>
EQIP is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air, and related natural resources on agricultural land and non-industrial private forestland. EQIP may also help producers meet federal, state, tribal, and local environmental regulations.

<u>USDA - Conservation Innovation Grants (CIG)</u>
CIGs are competitive grants that stimulate the development and adoption of innovative approaches and technologies for conservation on agricultural lands. CIG uses EQIP funds to award competitive grants to non-Federal governmental or nongovernmental organizations, American Indian Tribes, or individuals. Through CIG, NRCS partners with public and private entities to accelerate technology transfer and adopt promising technologies. These new technologies and approaches address some of the Nation's most pressing natural resources concerns. CIG benefits agricultural producers by providing more options for environmental enhancement and compliance with Federal, State, and local regulations.

<u>USDA – Regional Conservation Partnership Program (RCPP)</u>
RCPP promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS provides assistance to producers through partnership agreements and through program contracts or easement agreements. RCPP encourages partners to join in efforts

with producers to increase the restoration and sustainable use of soil, water, wildlife and related natural resources on regional or watershed scales. Through RCPP, NRCS and its partners help producers install and maintain conservation activities in selected project areas. Partners leverage RCPP funding in project areas and report on the benefits achieved.

USDA - Conservation Stewardship Program (CSP)
CSP helps farmers build on their existing conservation efforts while strengthening their operation on working lands. It is the largest conservation program in the United States with 70 million acres of productive agricultural and forest land enrolled in CSP. Thousands of farmers that have voluntarily enroll in the program because it helps enhance natural resources and improve their business operation. Through CSP, the NRCS will custom design a plan helps farmers build their business while implementing conservation practices that help ensure the sustainability of the entire operation. The plan will promote land stewardship that not only conserves the natural resources on the farm, but also benefits the water and air quality and wildlife habitat.

USDA - Conservation Reserve Program (CRP)
The CRP pays a yearly rental payment in exchange for producers removing environmentally sensitive land from agricultural production and planting species that will improve environmental quality. The long term goal of the program is to reestablish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat. A typical CRP contract is 10 years.

USDA -Conservation Reserve Enhancement Program (CREP)
The CREP is an offshoot of the CRP. CREP targets high-priority conservation issues identified by local, state, or tribal governments or non-governmental organizations. In exchange for removing environmentally sensitive land from production and introducing conservation practices, farmers, ranchers, and agricultural land owners are paid an annual rental rate. Participation is voluntary, and the contract period is typically 10–15 years, along with other federal and state incentives as applicable per each CREP agreement.

USDA - Emergency Conservation Program (ECP)
The ECP helps farmers and ranchers to repair damage to farmlands caused by natural disasters and to help put practices in place for water conservation during severe drought. The ECP does this by giving ranchers and farmers funding and assistance to repair the damaged farmland or to install methods for water conservation.

USDA - Farmable Wetlands Program (FWP)
The FWP is designed to restore previously farmed wetlands and wetland buffers to improve both vegetation and water flow. The FWP is a voluntary program to restore up to one million acres of farmable wetlands and associated buffers. Participants must agree to restore the wetlands, establish plant cover, and to not use enrolled land for commercial purposes for a 10 to 15 year period. Plant cover may include plants that are partially submerged or specific types of trees. Restoring farmable wetlands improves groundwater quality, helps track and break down pollutants, prevents soil erosion, reduces downstream flood damage, and provides habitat for waterfowl and wildlife. The rental rate is based on the weighted average dryland cash rent.

USDA - Transition Incentives Program (TIP)

The TIP offers assistance for retired or retiring land owners and operators, as well as opportunities for beginning and socially disadvantaged farmers and ranchers. It provides the retired/retiring land owners or operators with two additional annual rental payments on land enrolled in expiring Conservation Reserve Program (CRP) contracts, on the condition they sell or rent this land to a beginning farmer or rancher or to a socially disadvantaged group. Up to two additional annual CRP payments can be obtained through TIP. New land owners or renters must return the land to production using sustainable grazing or farming methods.

P-MRNRD – Urban Drainageway Program

For agencies other than the P-MRNRD as the project sponsor, the P-MRNRD offers assistance in the form of match funding for projects that control erosion and/or flooding along major drainageways in its jurisdiction. The goal is to encourage implementation of restoration approaches that maximize the natural functions of the stream channel. They provide varying levels of cost share from 40-75 percent and the local sponsor is responsible for the remaining percentage.

P-MRNRD – Urban Conservation Assistance Program

For agencies other than the P-MRNRD as the project sponsor, the P-MRNRD provides technical and financial assistance to units of government (sponsors) and citizen groups to help prevent or control erosion, flooding, and related resource concerns in urbanized areas.

P-MRNRD – Streambed Stabilization Program

For agencies other than the P-MRNRD as the project sponsor, the P-MRNRD provides technical and financial assistance on eligible grade stabilization projects to encourage and assist governmental agencies to incorporate conservation features in stream channels for the purpose of reducing soil erosion, sedimentation and related resource problems.

National Fish and Wildlife Foundation (NFWF) – Five Star and Urban Waters Grant Program

The NFWF seeks to develop nationwide community stewardships of local natural resources, preserving these resources for future generations and enhancing habitat for local wildlife. Projects seek to address water quality issues, such as erosion due to unstable streambank, pollution from stormwater runoff and degraded shorelines caused by development.

National Association of Conservation Districts (NACD) – Urban Agriculture Conservation Grant

The NACD is advancing conservation in developed urban areas. Water quality and quantity, air quality, non-native species, habitat degradation and reduction in opens space are natural resources challenges the NACD focuses on. While this grant focuses on urban agriculture conservation, it appears they also consider urban conservation type projects.

UNL Extension - Livestock Producer Assistance

The UNL Extension is leading an effort to develop and demonstrate alternative runoff control systems and solutions for small open lot feeding areas. The UNL Extension-sponsored Livestock Producer Environmental Assistance Project (LPEAP) is the only one of its kind in the United States. The primary focus of this program is the development of voluntary environmental risk reduction practices for water quality protection and a sustainable environment such as vegetative treatment systems (VTS) for open feedlots. The LPEAP approach is to provide livestock producers with a program to fund good stewardship activities. For those producers who want to practice good stewardship, this program provides a simple, timely means to obtain assistance.

NRC/NDNR - Water Sustainability Fund

The Water Sustainability Fund is administered through the Nebraska Department of Natural Resources (NDNR) and provides funding appropriated by the legislature each year, starting in 2015 at a rate of $11 million per year, for programs, projects, or activities that improve Nebraska water resources, including water quality and groundwater plan implementation. Applications are due in July annually. WSF will cover 60 percent of the net remaining expenses after other funding sources are taken into consideration. The local sponsor is responsible for the remaining 40 percent.

NDNR – Small Watersheds Flood Control Fund

The Small Watersheds Flood Control Fund financially aids local sponsors with the acquisition of necessary land rights for flood reduction projects.

NDNR - Nebraska Soil and Water Conservation Fund

The Soil and Water Conservation Fund was created in 1977 to provide financial assistance to private landowners for installation of soil and water conservation practices. Various conservation practices are eligible for cost-share assistance of up to 75 percent. The Natural Resources Commission determines the list of eligible practices, establishes operating procedures, and annually allocates the funds among the NRDs. The USDA NRCS provides technical assistance needed in planning and installing the conservation measures. NRDs are responsible for the administration of the program at the local level (NRC 2016).

NDNR – Natural Resources Water Quality Fund

The Natural Resources Water Quality Fund provides tax dollars to the NRDs for water quality projects. The districts match three local dollars for every two fund dollars.

Tribal Wildlife Grants

Provide a competitive funding opportunity for federally recognized Tribal governments to develop and implement programs for the benefit of wildlife and their habitat. The grants are used to provide technical and financial assistance to Tribes for the development and implementation of programs that benefit fish and wildlife resources and their habitat. Activities may include, but are not limited to, planning for wildlife and habitat conservation, fish and wildlife conservation and management actions, fish and wildlife related laboratory and field research, natural history studies, habitat mapping, field surveys and population monitoring, habitat preservation, conservation easements, and public education that is relevant to the project. The funds may be used for salaries, equipment, consultant services, subcontracts, acquisitions and travel.

Nebraska Environmental Trust Grants

The Nebraska Environmental Trust (NET) was established in 1992 to conserve, enhance and restore the natural environment of Nebraska. The NET seeks projects that bring public and private partners together to implement high-quality, cost-effective projects. Applicants for NET grants must meet tightly drawn criteria for eligibility to assure public benefit and substantial environmental gains.

Applications are due in September annually. There is not a match requirement for NET, however, at least a 10 percent local match is common.

NDEQ - Source Water Protection Grants

The EPA provides NDEQ with funding for political subdivisions that operate a groundwater-based public water system and that have a population of less than 10,000. Projects that provide long-term benefits to drinking water quality, quantity, and/or education are eligible. Project activities include: contaminant source identification, contaminant pathway removal, contaminant source management, establishment of a Drinking Water Protection Plan, and education and information sharing. The application period varies but occurs once a year and is announced on NDEQ's website. A minimum of a 10 percent local match is required.

NDEQ - Nonpoint Source Management Program

Section 319 of the federal Clean Water Act provides funding to states to implement Nonpoint Source Management Programs. This program, administered by the NDEQ, provides financial assistance for the prevention and abatement of nonpoint source water pollution. In general, eligible activities include those pertaining to management practice implementation, monitoring, and information/education. Funding could potentially support the implementation of activities, projects, and programs identified in this Plan. This fund requires a 40 percent non-federal match, which can be satisfied through local funds, dedicated state funds, or non-federal grant funds, such as those provided by the NET. Applications are due annually in September.

Pheasants Forever – Corners for Wildlife

Corners for Wildlife is a program unique to Nebraska that establishes permanent wildlife habitat on center pivot irrigation corners. This program is driven by funding and commitment from local Pheasants Forever chapters, NET, NGPC, and NRDs. As of 2016, this program has been awarded grants from the NET totaling $3,727,000.

Landowners enrolling in the program receive 75 percent cost-share assistance from Pheasants and Quail Forever chapters for the cost of seed and wildlife shrubs and a 5-year rental payment of up to $100 per acre each year, depending on the cover practice selected. NET and NGPC funds are applied solely to pay for landowner rental payments. The participating NRD plants the trees for free when the landowner selects 400 or more trees or shrubs for the project.

NGPC – Aquatic Habitat Program

The NGPC has established an Aquatic Habitat Plan to guide efforts to maintain, restore, or enhance the capacity of a waterbody to sustain a fish population. Funding is provided through the purchase of Aquatic Habitat Stamp required for everyone obtaining a fishing license in Nebraska. The NGPC is responsible for drafting a proposal for each project and is responsible for selecting eligible projects.

Property Owners

Landowners/operators will contribute both time and resources for implementing conservation measures. The cost of conservation measure implementation to landowners/operators will vary by practice type and by the extent of funding from other sources. Financial assistance through cost-share and incentives are necessary for many conservation measures, particularly for smaller producers that may not be able to afford to install more costly measures.

Local Communities

Communities within the Basin will contribute financial resources to match federal and state funding sources. Funding provided through local stormwater management programs could be utilized to implement actions within the Plan that support community goals for water quality improvement.

9 BLACKBIRD CREEK WATERSHED PLAN

The Blackbird-Soldier Creek (100230001) HUC 8 and a small portion of the Lewis and Clark Lake HUC 8 (10170101) within the Basin were combined to create what will be referred to in this Plan as the Blackbird Creek Watershed. The Blackbird Creek Watershed contains 602,560 acres in portions of Washington, Burt, Thurston, Dakota and Dixon Counties that drain to the east through a series of tributaries that discharge into the Missouri River.

Figure 9-1. Blackbird Creek Watershed

9.1 WATERSHED INVENTORY

9.1.1 Conditions

The Blackbird Creek Watershed is primarily a rural demographic. Land use is agricultural cropland and pasture with local farmsteads spread throughout the watershed, and a few concentrated areas of development within small towns (Figure 9-2). South Sioux City and the City of Blair are larger cities located in the northern and southern regions of the watershed respectively. Figure 9-3 depicts the slopes in the watershed, with drastic differences from the river valley up to the bluffs. Farming practices (irrigation and conservation) vary dependent upon the topographic region. Wells registered for irrigation use are highly concentrated in the valley, whereas wells in the uplands bluffs region are primarily registered as drinking wells. Due to the gentle slopes in the valley, there are very few structural conservation practices implemented. Several structural conservation practices were identified in the steep topographic regions, such has terraces, contour buffers and grassed waterways. Riparian buffers are present along some stream segments, but do not appear to be a highly common practice.

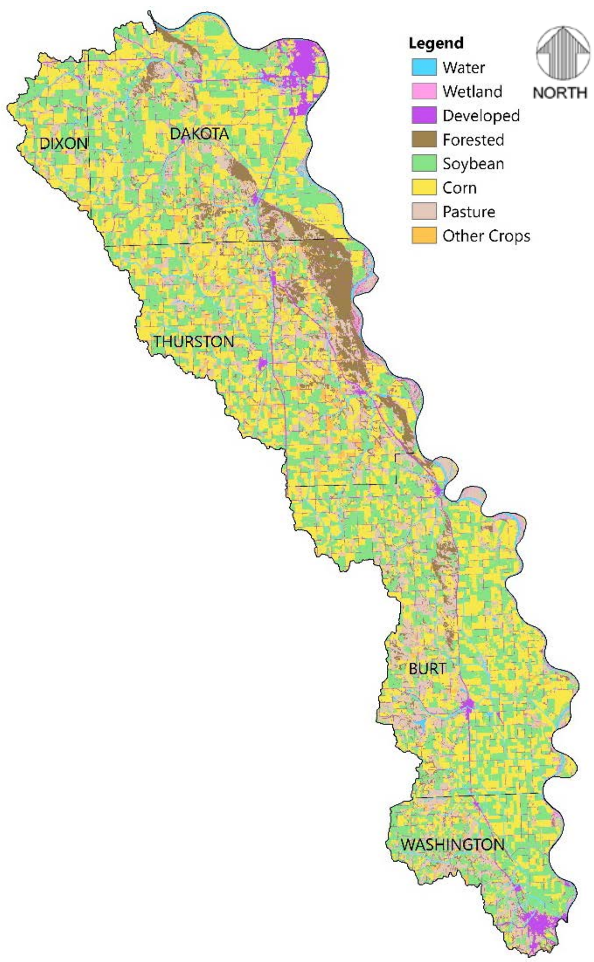

Figure 9-2. Land Use

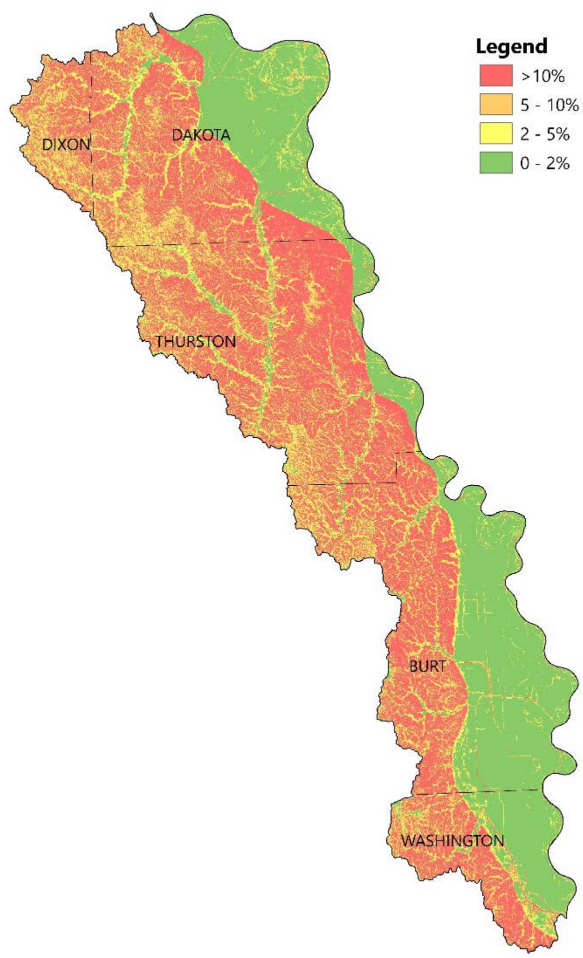

Figure 9-3. Watershed Slopes

The erosion potential of soils in the watershed is a characteristic that impacts water quality. In the soil data provided by the USDA, the "K factor" represents the soil erosion potential based on the susceptibility of soil to erosion (detachment) and the rate of runoff. Values from 0-0.15 are considered to have low potential for soil erosion, values from 0.2 to 0.35 are moderately susceptible to detachment and produce moderate runoff, and values 0.35 and greater have the greatest erosion potential. As depicted in Figure 4, the K factor in the bluffs region of the watershed indicate moderate to high erosion potential, which is reflected by the sedimentation and stream bank erosion experienced in the watershed. Input collected during public open houses and from local drainage districts indicate the continued interest for sediment control, primarily in valley areas where landowners are most impacted from the sediment. The drainage districts are continually faced with reduced carrying capacity and increased flood potential in the lowlands due to sediment received from the watershed.

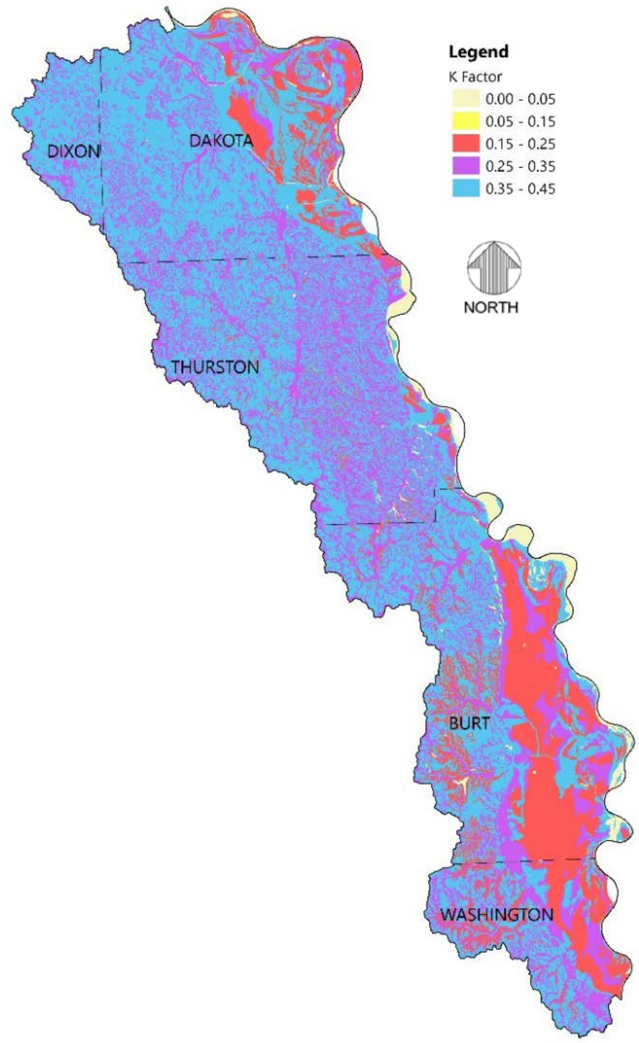

Figure 9-4. Soil Erosion Potential, K-Factor

9.1.2 Past and Current Management

The P-MRNRD has actively managed the erosion and sedimentation issues in the watershed since they have the largest impacts on farming, flooding and conveyance capacity of the irrigation canals. Several sediment and erosion control plans have been developed targeting individual stream systems, which include the Silver Creek, Tekamah-Mud Creek and Pigeon-Jones Creek plans. These plans consist of a combination of agricultural conservation practices (terraces, buffer strips, CRP enrollment, sediment basins and small grade control structures) as well as large erosion and grade control structures. The Silver Creek and Tekamah-Mud plans are no longer active, however the P-MRNRD is continuing to implement structures in the Pigeon-Jones watershed (Table 9-1).

Table 9-1. Large Erosion and Grade Control Structure Status

Watershed	Totals Planned Structures	Implemented Structures*	Planned for Future Implementation
Silver Creek	30	23	0
Tekamah-Mud Creek	Unknown	14	0
Pigeon-Jones Creek	20	11	10

*Includes additional sites/alternative locations from original plan upon further investigation and landowner cooperation

Two structures are scheduled for implementation in 2018 and 2019 and the remaining will be completed as land rights are acquired and funding is available. The P-MRNRD also offers additional cost sharing for conservation practices in these watersheds on top of USDA assistance programs, providing up to 90% cost share to establish new practices. To date, in the Pigeon-Jones watershed, the P-MRNRD has assisted in implementing 6 terrace systems (approximately 12,400 ft), 44 contracts of CRP (891 acres) and 9 small water and sediment control structures. These efforts are not currently eligible for 319 funding since the classification of Pigeon Creek (Jones is not a Title 117 stream segment) is IR Category 2 (insufficient information to determine if all uses are met) and not listed as an impaired waterbody. Below is a summary of the large erosion and grade control structures for each plan.

Pigeon-Jones Site 15 (renamed Kramper Lake, MT1-L0185) is a large recreation site for which a 9-element nonpoint source plan was completed in 2009 using a Community Based Planning process (PMRNRD 2009) to protect the water quality in the new lake. While conservation measures have been implemented on approximately 80 percent of the drainage area, opportunities still exist to implement practices that will provide additional protection to the lake. This plan has since expired and project implementation is no longer eligible for 319 funds. Further protection practices of MT1-L0185 are not in the scope of this plan.

There is also work currently being done by the Winnebago Tribe on the Omaha Creek. The EPA has awarded them a tribal grant under Section 106 of the Clean Water Act (CWA) to operate a Water Quality Program. Currently their program focuses on detailed physical, chemical and biological monitories activities at 12 monitoring locations. They intend to apply for a tribal 319 grant for future planning and implementation. The Omadi Drainage District receives water from Omaha Creek and has a very large interest in reducing sedimentation in their canals to improve capacity and reduce flooding impacts. The P-MRNRD is committed to supporting the Winnebago Tribe's efforts, but does not want to duplicate work. The P-MRNRD will continue to coordinate with the tribe to determine the appropriate steps forward as the planning process proceeds.

9.2 WATER RESOURCES AND CURRENT CONDITIONS

The conditions of water resources in the Papio-Missouri River Basin are based on NDEQ's beneficial use support assessments, historic planning documents, water quality assessments conducted by NDEQ and watershed surveys. Additional information on water quality concerns have been provided through the Steering Committees and public outreach efforts.

Figure 9-5. Blackbird Creek Waterbodies

9.2.1 Streams

Nebraska's Water Quality Standards identifies 48 Title 117 stream segments in the Blackbird Watershed that total 318 miles (Table 9-2 and Figure 9-5). These are major perennial streams that range from 1.7-17.9 miles (Missouri River segment that follows east watershed boundary line not included). Three segments have a Warm Water A designation for the Aquatic Life use, with the remaining 45 segments being a Warm Water B designation. Warm Water A designations apply to segments of Blackbird (MT1-11900), Omaha (MT1-12000) and Elk (MT2-10100) creeks. Three stream segments are assigned the Recreation use, which are Blackbird (MT1-11900), Omaha (MT1-12000) and Elk (MT2-10100) Creeks.

Table 9-2. Streams in the Blackbird Creek Watershed

Stream Name	Segment	Length (miles)
Cameron Ditch	MT1-10900	5.6
Couble Creek	MT1-10910	3.0
South Creek	MT1-10920	4.9
North Creek	MT1-10930	3.6
Stuart Creek	MT1-10940	3.2
Cameron Ditch	MT1-11000	11.6
Hill Creek	MT1-11100	5.7
New York Creek	MT1-11110	13.4
Carr Creek	MT1-11120	2.9
Davis Creek	MT1-11121	4.1
Hill Creek	MT1-11200	3.1
Combination Ditch	MT1-11300	5.4
Combination Ditch	MT1-11400	12.0
Tekamah Creek	MT1-11500	5.8
Silver Creek	MT1-11510	12.4
Tekamah Creek	MT1-11600	10.3
Elm Creek	MT1-11700	9.0
Lone Tree Creek	MT1-11710	3.3
Wood Creek	MT1-11800	4.3
Blackbird Creek	MT1-11900	4.0
South Blackbird Creek	MT1-11910	17.9
South Blackbird Creek	MT1-11920	8.0
North Blackbird Creek	MT1-11930	2.6
Unnamed Creek	MT1-11931	4.0
North Blackbird Creek	MT1-11940	8.2
Omaha Creek	MT1-12000	4.0
Omaha Creek	MT1-12100	14.3
Fiddlers Creek	MT1-12110	4.6
Wigle Creek	MT1-12120	3.5
Turtle Creek	MT1-12130	2.7
Morgan Creek	MT1-12140	4.0
North Omaha Creek	MT1-12150	9.7

Stream Name	Segment	Length (miles)
Unnamed Creek	MT1-12151	3.4
Unnamed Creek	MT1-12152	3.9
North Omaha Creek	MT1-12160	8.2
South Omaha Creek	MT1-12170	3.6
Cow Creek	MT1-12171	11.9
South Omaha Creek	MT1-12180	5.0
Pigeon Creek	MT1-12200	9.7
Pigeon Creek	MT1-12300	7.5
Elk Creek	MT2-10100	4.5
Elk Creek	MT2-10200	10.0
Otter Creek	MT2-10210	1.7
Minnow Creek	MT2-10211	6.0
Otter Creek	MT2-10220	9.3
Elk Creek	MT2-10300	11.9
Pigeon Creek	MT2-10310	3.5
Elk Creek	MT2-10400	7.1

NDEQ's beneficial use support assessments for 15 of the 48 segments that were performed is summarized in Chapter 5. The details of the beneficial uses and impairment for the stream segments located in the Blackbird Creek Watershed are provided in Tables 9-3 and 9-4.

- 5 of the 48 streams in the Blackbird Creek Watershed and associated HUC 12s were reported as impaired in the 2016 Nebraska Integrated Report.
- Impaired segments represent 38 miles of the total 318 stream miles or 12 percent.
- The only 2 segments designated for Recreation use are impaired from *E.coli* bacteria.
- 3 impairments are to the Aquatic Life Use, which are due to poor biological communities on three streams.
- There are no pristine streams in the planning area

Table 9-3. Beneficial Use Support for Assessed Streams in the Blackbird Creek Watershed

Stream Name	Segment	Applicable Beneficial Uses				Overall Assessment
		PCR	AL	AWS	AE	
Silver Creek	MT1-11510		I	NA	NA	I
Tekamah Creek	MT1-11600		S	NA	S	S
Elm Creek	MT1-11700		S	NA	S	S
Wood Creek	MT1-11800		S	NA	S	S
Unnamed Creek	MT1-11931		S	NA	NA	S
Omaha Creek	MT1-12000	I	S	S	S	I
Omaha Creek	MT1-12100		S	S	S	S
North Omaha Creek	MT1-12150		I	NA	NA	I
Cow Creek	MT1-12171		S	NA	S	S

Stream Name	Segment	Applicable Beneficial Uses				Overall Assessment
		PCR	AL	AWS	AE	
Pigeon Creek	MT1-12200		S	NA	S	S
Pigeon Creek	MT1-12300		S	NA	S	S
Elk Creek	MT2-10100	I	S	S	S	I
Elk Creek	MT2-10200		S	NA	S	S
Elk Creek	MT2-10300		S	NA	S	S
Elk Creek	MT2-10400		I	NA	NA	I
Use Definition: PCR=Primary Contact Recreation, AL=Aquatic Life (WWA and WWB), AWS=Agricultural Water Supply, AE=Aesthetics Assessment Definition: NA = Not Assessed, S = Supporting the Beneficial Use, I = Impaired Beneficial Use						

9-4. Stream Impairment Causes in the Blackbird Creek Watershed

Stream Name	Segment ID	Impairment	Pollutant
Silver Creek	MT1-11510	Aquatic Life- Aquatic Community	Unknown
Omaha Creek	MT1-12000	Recreation - Bacteria	*E.coli*
North Omaha Creek	MT1-12150	Aquatic Life- Aquatic Community	Unknown
Elk Creek	MT2-10100	Recreation - Bacteria	*E.coli*
Elk Creek	MT2-10400	Aquatic Life- Aquatic Community	Unknown

Figure 9-6. Blackbird Creek Impaired Streams

No TMDLs have been developed for the impaired stream segments to date. In 2015, NDEQ and EPA created a new alternative to developing TMDLs for impaired waterbodies called a "5-Alt.". This alternative was created to address missing TMDLs in areas where project sponsors have targeted for restoration work. *E.coli* data and associated information was developed for the two stream segments impaired for bacteria in the Blackbird Creek Watershed.

Table 9-5. *E.coli* Impaired Stream Segments Addressed in the 5-Alt. Approach

Segment	**Waterbody Name**
MT1-12000	Omaha Creek
MT2-10100	Elk Creek

The stability of the streams were also assessed using available digital elevation models processed at a 2 meter resolution 500 ft along each side of the Title 117 stream segments. This high resolution data was converted into a slope raster that characterizes the bank slopes, see Figure 9-7 for an example.

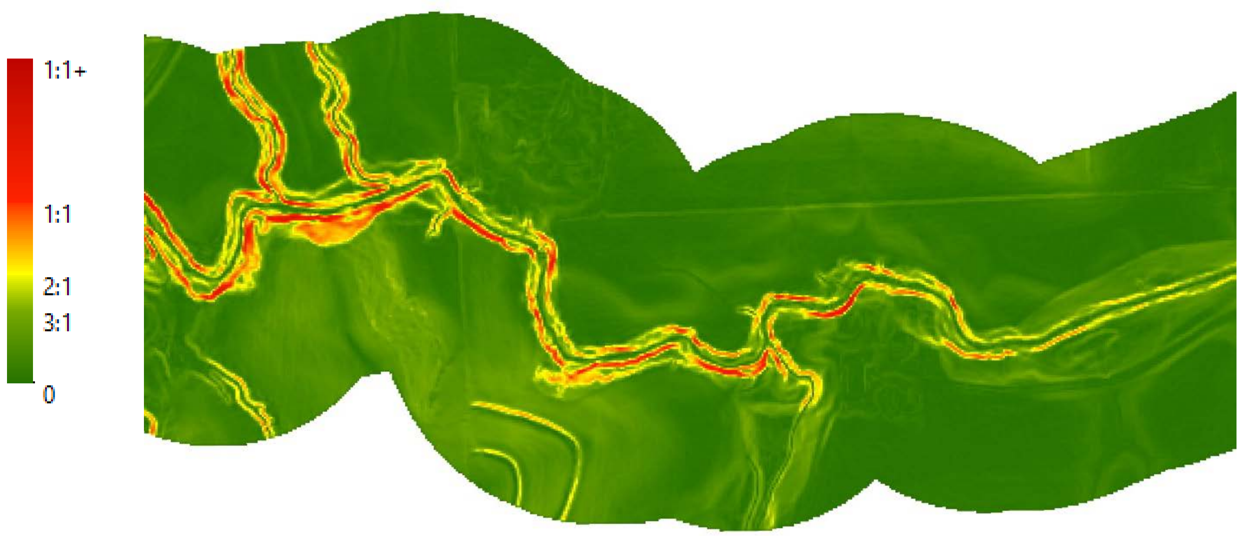

Figure 9-7. High Resolution Slope Raster

Results of this analysis were able to identify stream reaches with unstable banks (considered 1:1 slopes and greater) and are mapped on Figure 9-8. While this is not a direct representation of water quality, it identifies reaches with high erosion potential and also indicates regions where vegetation and aquatic life conditions could be impaired. As shown in Figure 9-8, thousands of linear feet of unstable slopes were identified in the higher topographic bluffs region of the watershed. This is consistent with the slope and soil erodibility potential data presented above. Stream bank erosion is a common problem with loss of agricultural ground, as well as impacts to local infrastructure.

Figure 9-8. Blackbird Watershed Unstable Slopes

9.2.2 Lakes

There are seven lakes in the Blackbird Creek Watershed that total 517 surface acres (Table 9-6 and Figure 9-5). Lakes range from 1 to 230 surface acres in size and include man-made impoundments, natural (oxbow) lakes along the Missouri River and man-made sandpits. The largest impoundment is Kramper Lake in Dakota County which comprises 230 surface acres.

Table 9-6. Lakes in the Blackbird Creek Watershed

Lake Name	Lake ID	Type	Area (acres)
Summit Lake	MT1-L0150	Reservoir	180.2
Mud Creek SCS Pond	MT1-L0160	Pond	38.7
Middle Decatur Bend Lake	MT1-L0170	Oxbow	1.0
Omadi Bend Lake	MT1-L0180	Oxbow	19.0
Kramper Lake	MT1-L0185	Reservoir	230
Gateway Lake	MT1-L0190	Sandpit	15.1
Crystal Cove Lake	MT1-L0200	Sandpit	32.5

All seven impoundments have the Warm Water A designation for the Aquatic Life use in addition to being protected for the Primary Contact Recreation, Agricultural Water Supply and Aesthetic uses. Water quality data was available for NDEQ to conduct beneficial use support assessments on three of the seven lakes in Blackbird Creek Watershed (Table 9-7), with impairments described in Table 9-8. A total of 228 acres have been assessed representing 44 percent of the surface acres in the area. A summary of the findings are:

- The PCR and AL uses for Summit Lake were determined to be impaired from *E.coli* bacteria, nutrients and chlorophyll.
- The PCR use was the only use assessed at Gateway Lake, which was determined to be fully supporting.
- While the PCR and Aesthetic uses are being fully supported at Crystal Lake, the AL use is impaired from contaminants that have bio-accumulated in the fish tissue and organs.
- There are no data indicating there are any pristine lakes in the watershed.

Table 9-7.Beneficial Use Support for Lakes in the Blackbird Creek Watershed

Lake Name	Lake ID	Applicable Beneficial Uses				
		PCR	AL	AWS	AE	Overall Assessment
Summit Lake	MT1-L0150	I	I	S	S	I
Gateway Lake	MT1-L0190	S	NA	NA	NA	S
Crystal Cove Lake	MT1-L0200	S	I	NA	S	I
Use Definition: PCR=Primary Contact Recreation, AL=Aquatic Life (WWA and WWB), AWS=Agricultural Water Supply, AE=Aesthetics Assessment Definition: NA = Not Assessed, S = Supporting the Beneficial Use, I = Impaired Beneficial Use						

Table 9-8. Lake Impairments in the Blackbird Creek Watershed

Lake Name	Waterbody ID	Impairment	Pollutant
Summit Lake	MT1-L0150	Recreation- Bacteria, Aquatic Life- Nutrients, Chlorophyll a	*E.coli*, Total Phosphorus, Total Nitrogen
Crystal Cove Lake	MT1-L0200	Aquatic Life- Fish Consumption Advisory	Hazard Index Compounds, Mercury

No TMDLs or 5-Alts have been developed for the impaired lakes to date.

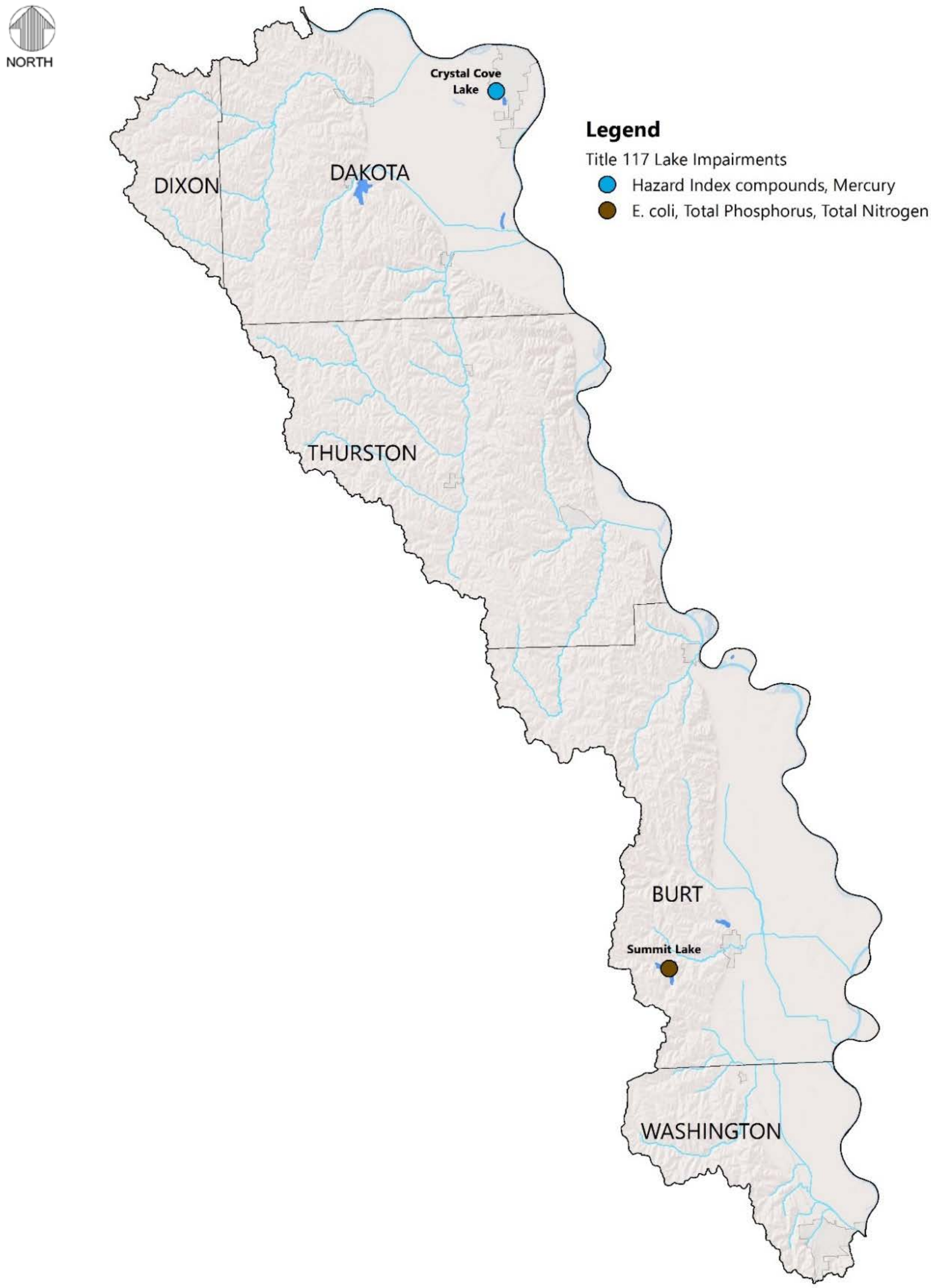

Figure 9-9. Blackbird Creek Watershed Impaired Lakes

9.2.3 Wetlands

No major wetland complexes outside the stream tributaries were identified on the NWI map in Chapter 3, however the low saturated hydraulic conductivity in the valleys of Washington and Burt Counties promote standing water and wetland development. Over 50 properties have been enrolled in the Wetland Reserve Program (WRP) in these two counties alone due to the wet conditions that were prohibitive to farming, creating additional wetland habitat in the watershed.

9.2.4 Groundwater

The local groundwater table is heavily tied to the Missouri River water level. During the barge season (early spring through late fall), the Missouri River upstream dams are operated to release more discharge which results in higher river levels. During these months, groundwater levels in the valley tend to range from 10 to 15 ft deep. High groundwater tables tend to be more susceptible to contamination from infiltration of contaminants, however the low to moderately low hydraulic conductivities reported in Chapter 3 (Figure 3-5) must prevent high rates of pollutant transport, as the nitrate data in the Basin watershed show most of the groundwater concentrations are in the low range of 0-5 ppm (Section 3.2.7). Wellhead protection areas (WPA) have been identified surrounding public drinking supplies (Section 3.2.6), with the Tekamah WPA as the only location measuring above the 0-5 ppm at 8.8 ppm. The P-MRNRD is the process of updating their Groundwater Rules and Regulations as part of their Groundwater Management Plan. Tekamah WPA has been identified as a Phase II Groundwater Quality Management Area (concentrations great that 5 ppm) that must abide by more stringent rules and regulations.

9.3 POLLUTANT SOURCES

The impairments described in section 9.2 indicate primary contributors to water quality degradation in the Blackbird Creek Watershed are tied to sediment, phosphorus, nitrogen and *E.coli* bacteria. The origin of these pollutant sources was assessed using land cover data, aerial imagery, watershed inventories, completed water quality plans and other available documentation.

9.3.1 General Watershed

Point source discharges have the potential to discharge wastewater to Waters of the State in the Blackbird Creek Watershed. Facility types include: municipal, commercial and industrial wastewater treatment facilities (WWTF). The 11 facilities that have been issued a National Pollutant Discharge Elimination System (NPDES) permit (according to EPA's Enforcement and Compliance History Online (ECHO) database) in the Blackbird Creek Watershed that are regulated for *E.coli* are listed in Table 9-9. Under Section 503 of the CWA, WWTFs may dispose of sewage sludge through land applications (EPA 1993). Sludge is land applied after proper stabilization and is incorporated into the soil at agronomic rates. Improper or over-application of sludge may potentially cause bacteria impairment to surface water. Nebraska is not a 503 authorized state, therefore administration of section 503 of the CWA falls within the authority of EPA's Bio Solids program.

Table 9-9. WWTF in the Blackbird Creek Watershed

Facility Name	NPDES Permit #	Receiving Stream
Blair WWTF	NE0021482	MT1-10000
OPPD Fort Calhoun Nuclear Station WWTF	NE0000418	MT1-10000
Tyson Fresh Meats	NE0001392	MT1-10000
Dakota City WWTF	NE0024236	MT1-10000
Homer WWTF	NE0025453	MT1-12100
Winnebago WWTF	NE0113212	MT1-12100
Walthill WWTF	NE0138932	MT1-12171
Macy WWTF	NE0061263	MT1-11900
Decatur WWTF	NE0049123	MT1-11700
Tekamah WWTF	NE0123072	MT1-11000
Waterbury WWTF	NE0122220	MT2-10220

Illicit connections and undetected discharges from wastewater pipes is a possible wastewater concern in the few community areas located within the watershed. The concerns regarding wastewater in the majority of the rural dominated Blackbird Creek Watershed are primarily related to straight pipes from septic tanks, failing septic systems or other failing onsite wastewater systems as a source for *E.coli* bacteria. Under Title 124, Chapter 3, NDEQ requires that any facility doing work associated with onsite wastewater systems to be certified by the State of Nebraska and requires systems constructed, reconstructed, altered, or modified to be registered with the state (NDEQ 2012). As of March 2016, a total of 339 onsite wastewater systems have been registered within Blackbird Creek Watershed. Systems installed prior to 2001 were not required to be registered, therefore the exact number of septic systems or failing septic systems is not possible to determine using existing data. Through aerial photography assessments, farmsteads that likely have private septic are grossly underrepresented by the actual number that are registered and mapped in Figure 9-10. According to the National Environmental Services Center it is estimated that 40 percent of

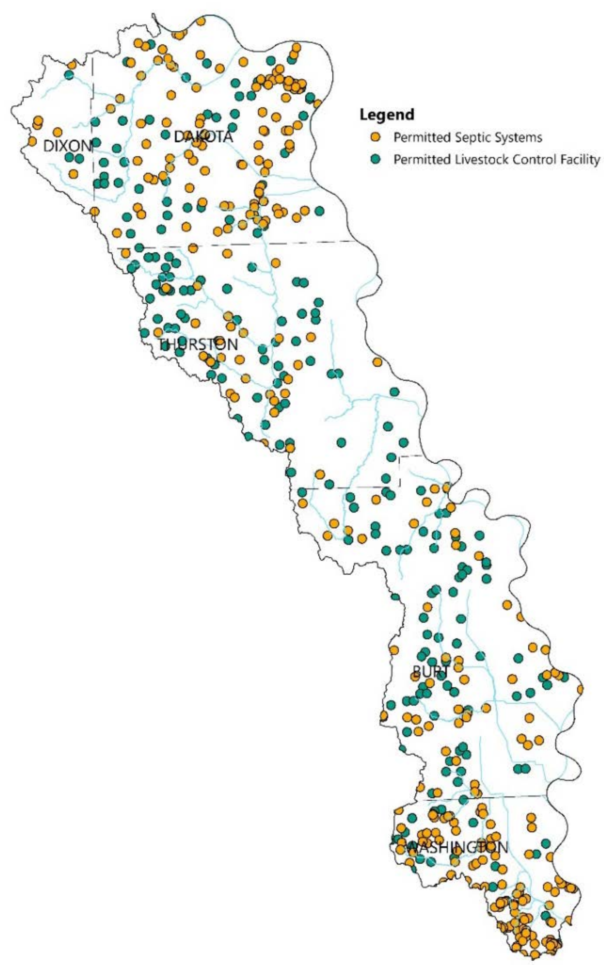

Figure 9-10. NDEQ Registered Facilities

all septic systems are presently failing and about 6 percent of systems are either repaired or replaced annually (NESC 2013).

AFOs are facilities that confine livestock in a limited feeding space for an extended period. The Nebraska Livestock Waste Management Act authorizes the Nebraska Department of Environmental Quality to regulate discharge of livestock waste from these operations. Nebraska's Livestock Waste Control Regulations (Title 130) classifies AFOs as small, medium or large operations based on the number and type of livestock confined in the facility. Title 130 also requires inspection of medium and large operations to assess the potential for waste discharge. Depending on the size of the operation and potential to discharge pollutants, the operation may be required to obtain a construction and operating permit for a livestock waste control facility (LWCF) from NDEQ. Each AFO may have more than one livestock waste control facility . These facilities are designed to contain any runoff that is generated by storm events that are less than or equal to a 25-year, 24-hour rainfall event. AFOs confining less than the equivalent of 300 beef cattle are considered administratively exempt from inspection and permitting unless they have a history or potential to discharge pollutants to Waters of the State. Figure 9-10 shows 225 LWCFs within the Blackbird Creek Watershed that have been entered into the NDEQ database as being inspected. Registered LWCFs are generally designed to function with high pollutant trapping efficiencies, therefore if managed correctly, the majority of the AFO pollutant load is contained.

Numerous small, unpermitted livestock facilities are present across the watershed. An inventory of the facilities not requiring a permit was not available. Cattle that can graze and access water from stream banks will trample vegetation, as well deposit manure direct in the stream with no filtration of runoff or infiltration potential. A common agricultural practice is also to remove the manure from AFOs and/or pasture and apply it as a natural fertilizer to cropland. Mismanagement of any of these facilities/activities can result in high bacteria loading to the stream from runoff. Identification of these operations would require a farm-by-farm inventory making it a difficult and expensive task for such a large assessment area. However, small operations can have a significant impact on water quality and should be included in any future detailed project planning efforts.

Contributions of bacteria from wildlife must also be considered. Due to high population densities in eastern Nebraska, the largest contributors are likely deer and waterfowl. The USFWS reports densities of deer in eastern Nebraska as 9-10 per square mile. Eastern Nebraska is a migratory path for Mississippi Flyway geese, but can also have resident geese year round. Because geese aggregate, large quantities of droppings can accumulate in nesting and foraging areas. One goose can produce up to three pounds of droppings each day, acting as a source of nutrients and *E.coli* to local waterbodies. Other wildlife that also contribute, although not as heavily in population density, are coyotes, rodents, deer, rabbits, racoons and opossums.

Sediment and nutrient loads in the Blackbird Creek Watershed are primarily a result of agricultural practices. Fertilization and soil management practices have a large impact on the loads produced from each field. Sedimentation occurs when precipitation runoff carries eroded soil particles into streams and lakes. Nutrient and bacteria are often attached to the soil particles and deposited into waterbodies along with the sediment. This provides dissolved nutrients in the water body which are available in the water column for uptake. Slope, geology and soil characteristics, and land uses with reduced vegetative cover increase runoff, create more erosion and increase sediment related impacts to streams and lakes. Erosion of stream beds and banks also contribute to the pollutant loads received by the local waterbodies. Sediment bound nutrients and bacteria, primarily in streams with sparse vegetation, can be disturbed and redistributed into the water column.

9.3.2 Impaired Waterbodies

A more detailed assessment of the watersheds for impaired lakes and streams was performed to identify the potential origin of the pollutant sources. NDEQ has identified impairments to Aquatic Life in several streams segments due to impaired aquatic community, opposed to a specific pollutant. Since this impairment is not tied to a specific pollutant, a more qualitative discussion on the cause is provided instead of a source assessment. Sources and causes were not investigated for contaminants causing fish consumption advisories given their widespread nature (e.g., mercury), historic use (e.g., PCBS) and complex transport mechanisms.

Omaha Creek (MT1-12000)

Impairment: E.coli

There are three WWTF discharges to Omaha Creek; Homer, Winnebago and Walthill. There are 56 permitted LWCFs in the Omaha Creek drainage area in addition to an unknown number of small unpermitted livestock operations. The subwatershed also includes a total of 48 registered onsite wastewater systems. Upon further aerial assessment of the stream system, there are 210 farmsteads within 150 yards of Omaha Creek and its tributaries, but only 26 of these farmsteads were registered. These are systems where potential failure would likely lead to bacteria loading to the local stream. Land use summarized in Table 9-10 indicate approximately 19% (grass/pasture plus hay/alfalfa) of the watershed is potentially utilized for frequent cattle grazing, and 65% (corn plus soybeans) of the watershed could have land application of manure and/or grazing when crops are not present.

Table 9-10. Land Use in the Omaha Creek Watershed

Land Use	Area (ac)	% Watershed
Corn	40,314	35%
Soybeans	34,655	30%
Grass/Pasture	15,138	13%
Hay/Alfalfa	7,169	6%
Water/Wetland	653	1%
Woodland	9,377	8%
Developed	5,682	5%
Other Crops	1,346	1%
Total	114,334	100%

Elk Creek (MT2-10100)

Impairment: E.coli

There is one *E.coli* regulated permitted discharge to Elk Creek; Waterbury WWTF. There are 21 permitted LWCF in the Elk Creek drainage area in addition to an unknown number of small unpermitted livestock operations. There is a total of 27 registered onsite wastewater systems in the watershed. Upon further aerial assessment of the stream system, there are 95 farmsteads within 150 yards of Elk Creek and its tributaries, but only 9 were registered. These are systems where potential failure would likely lead to bacteria loading to the local stream. Land use summarized in Table 9-11 indicates approximately 77% (grass/pasture plus hay/alfalfa) of the watershed is potentially utilized for frequent cattle grazing, and 65% (corn plus soybeans) of the watershed could have land application of manure and/or grazing when crops are not present.

Table 9-11. Land Use in the Elk Creek Watershed

Land Use	Area (ac)	% Watershed
Corn	37,463	45%
Soybeans	26,393	32%
Grass/Pasture	8,189	10%
Hay/Alfalfa	1,847	2%
Water/Wetland	560	1%
Woodland	5,655	7%
Developed	3,347	4%
Other Crops	176	0%
Total	83,630	100%

Summit Lake (MT1-L0150)

Impairments: E.coli, Nutrients, Chlorophyll

There are no permitted discharges within the Summit Lake watershed. There are 3 permitted LWCF in the sub-watershed in addition to an unknown number of small unpermitted livestock operations. There is a total of 5 registered onsite wastewater systems in the watershed. Upon further aerial assessment of the stream system, there are 18 within 150 yards of tributaries to Summit Lake, but only 2 were registered. These are systems where potential failure would likely lead to bacteria loading to the local stream. Land use summarized in Table 9-12 indicate approximately 38% (grass/pasture plus hay/alfalfa) of the watershed is potentially utilized for frequent cattle grazing, and 65% (corn plus soybeans) of the watershed could have land application of manure and/or grazing when crops are not present. Based on percent area of cropland, cropland is likely the largest contributor of sediment, phosphorus and nitrogen to the reservoir. While internal loads of phosphorus could be a significant portion of the overall load, they have not been quantified.

Table 9-12. Land Use in the Summit Lake Watershed

Land Use	Area (ac)	% Watershed
Corn	1,734	29%
Soybeans	1,243	21%
Grass/Pasture	2,185	36%
Hay/Alfalfa	112	2%
Water/Wetland	227	4%
Woodland	314	5%
Developed	234	4%
Total	6,048	100%

Elk Creek (MT2-10400)

Impairment: Aquatic Community

This Elk Creek segment is located in the headwaters of an agricultural watershed dominated by cropland. It is a sinuous stream with a relatively healthy riparian buffer averaging approximately 30 ft on each side. However, the slope analysis of the stream banks indicated highly unstable side slopes over 1:1. This is likely due to hydromodification in the watershed and a headcut working its way up the tributary. One creek segment appears to be much straighter than the rest, which could mean the creek has been straightened. This could lead to an increase in streambed slopes and eventually lead to stream incision and bank failure. This results in limited vegetation establishment on the banks and no connection with the floodplain and any associated habitat. The Nebraska Stream Biological Monitoring Program report (NDEQ, 2011), reported poor physical and habitat index metrics, poor fish index metrics and poor invertebrate community index metrics.

North Omaha Creek (MT2-12150)

Impairment: Aquatic Community

The North Omaha Creek stream segment has minimal riparian buffers which is limited to stream segments with trees. Most cropland is planted to the edge of the top of the streambank. The stream stability analysis did not show banks with unstable slopes, which allows for better vegetative cover along the stream banks. This is consistent with the good rating for physical and habitat index metrics that was reported in the biological monitoring report (NDEQ 2011). North Omaha Creek also has a good rating for invertebrate community index metrics, but is rated poor for fish index metrics.

Silver Creek (MT2-11510)

Impairment: Aquatic Community

The very downstream end of this impaired Silver Creek stream segment appears to have been straightened. The slope analysis indicates this has created stream incision resulting in steep side slopes, which has led to massive bank failure. Over time, the bank has appeared to have reestablished a bench with thick vegetation and tree cover. Most agricultural fields were planted to the top of the stream bank leaving no riparian buffer (with some exception). However, trees and vegetation are present within the channel, and the channel width is up to 200 ft. This is consistent with the good rating for physical and habitat index metrics that was reported in the biological monitoring report (NDEQ 2011). Silver Creek also has a good rating for invertebrate community index metrics, but rated poor for fish index metrics.

9.4 POLLUTANT LOADS

Pollutant loads have been assessed for Blackbird Creek Watershed on a subwatershed-size scale and also described more specifically for the impaired waterbodies. While ranges of pollutant loads were determined for subwatersheds, further quantification of pollutant loading and required load reductions for impaired waterbodies was not performed since there are no Priority Areas identified within this watershed. Loads (or lack of habitat) were not assessed for the aquatic community impairments since these are not tied to a specific pollutant.

9.4.1 General Watershed

USGS SPARROW data for phosphorus, nitrogen and sediment were used to provide a general understanding of the watershed loads. The SPARROW model relates in-stream water quality measurements to spatially referenced characteristics of subwatersheds to imperially estimated pollutant loads. This method provides perspective within the watershed as to where the loads are the highest for each constituent, and overlaying these results will show 'hot spots' that likely contribute the greatest overall load. See Figures 9-11 through 9-14 for 'hot spot' locations. Exact loading numbers from this methodology are not to be used for project level planning and a more detailed model should be developed at that time.

The USGS SPARROW model does not analyze *E.coli* data. A search of the available NDEQ and USACE sampling data reveal there is only *E.coli* data for Omaha Creek, Elk Creek and Summit Lake. These are impaired waterbodies that are discussed in more detail in section 9.4.2, however it was not enough information to perform a watershed-wide analysis of *E.coli* loading for the Blackbird Creek Watershed.

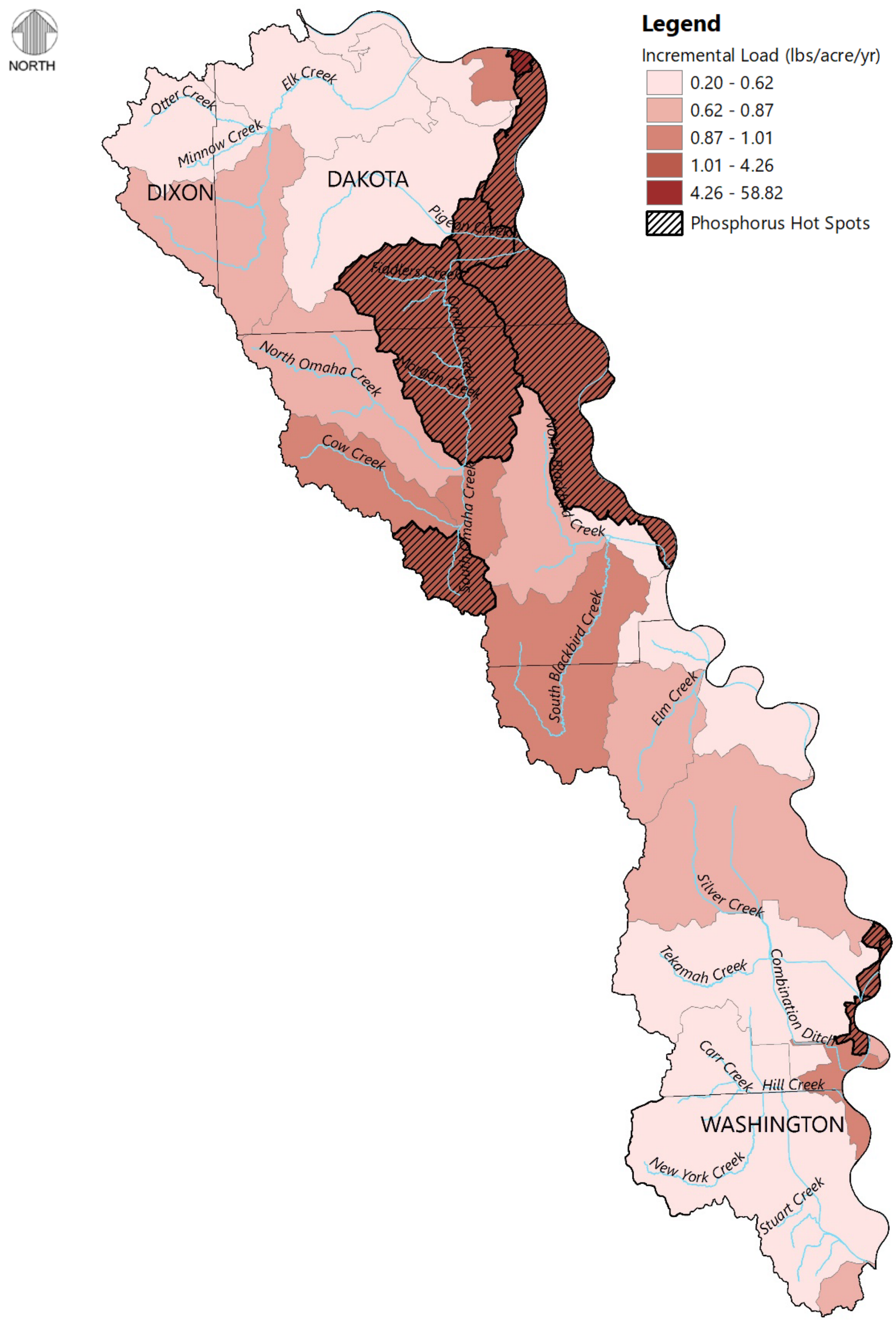

Figure 9-11. SPARROW Analysis- Phosphorus Results

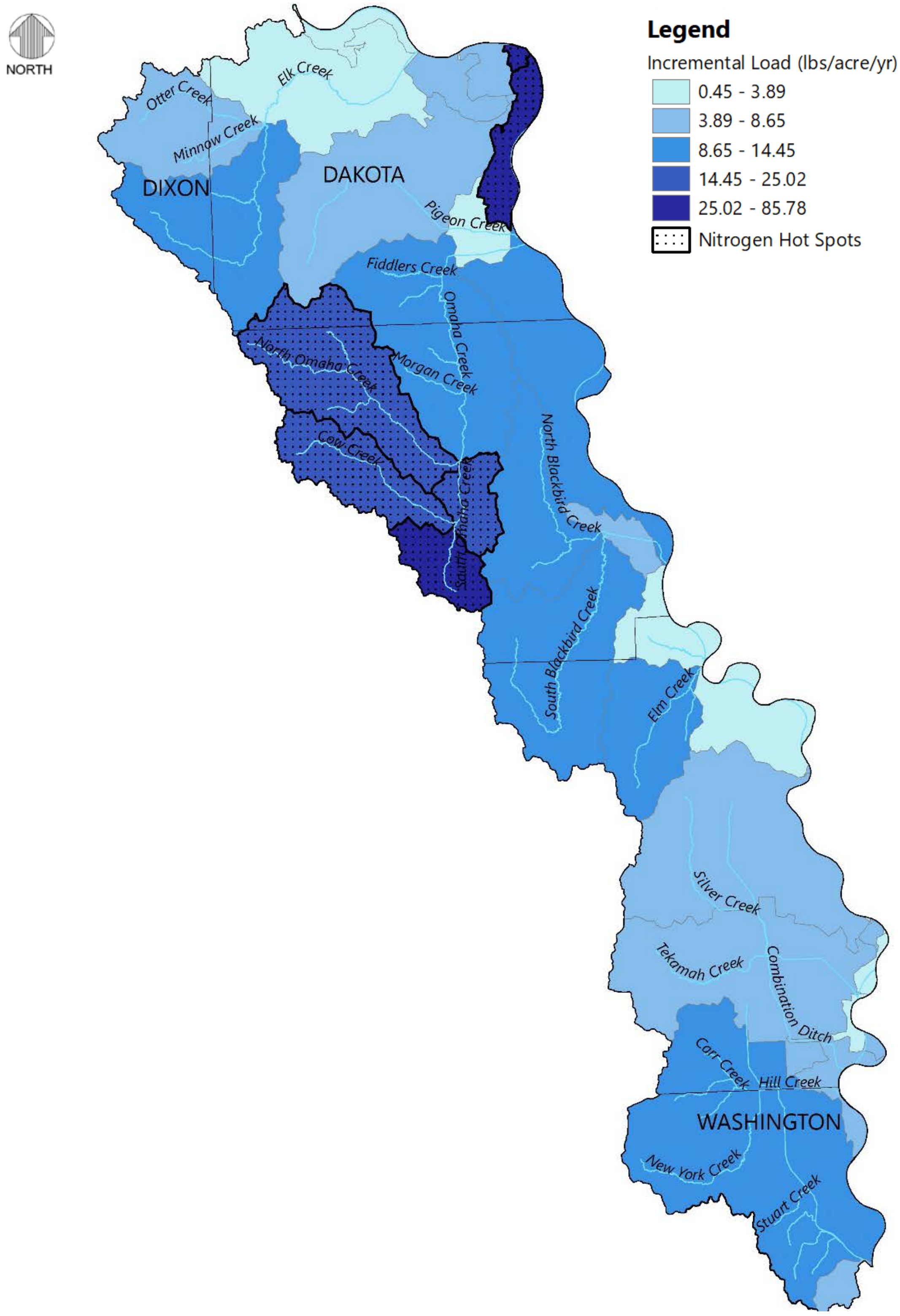

Figure 9-12. SPARROW Analysis- Nitrogen Results

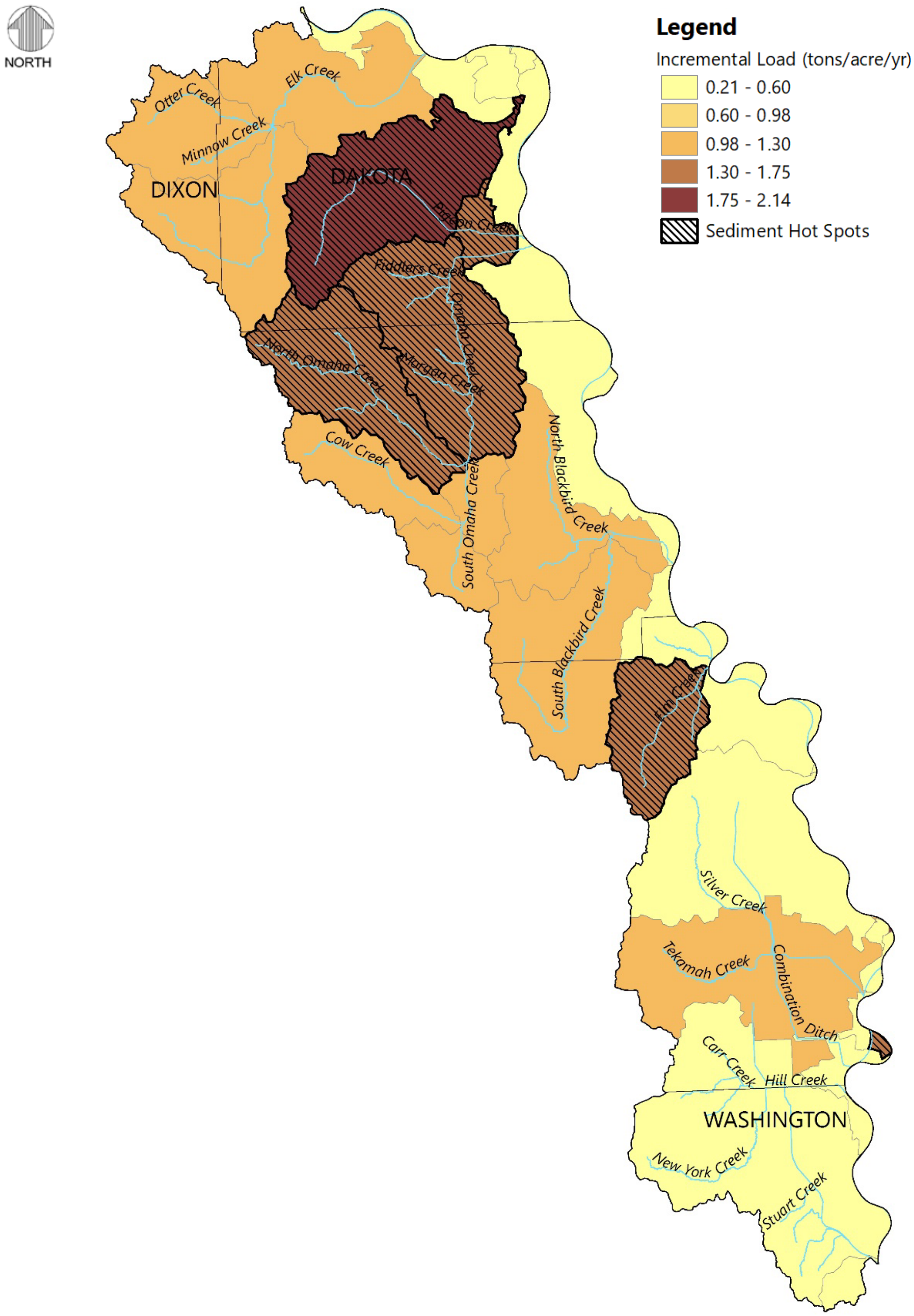

Figure 9-13. SPARROW Analysis- Sediment Results

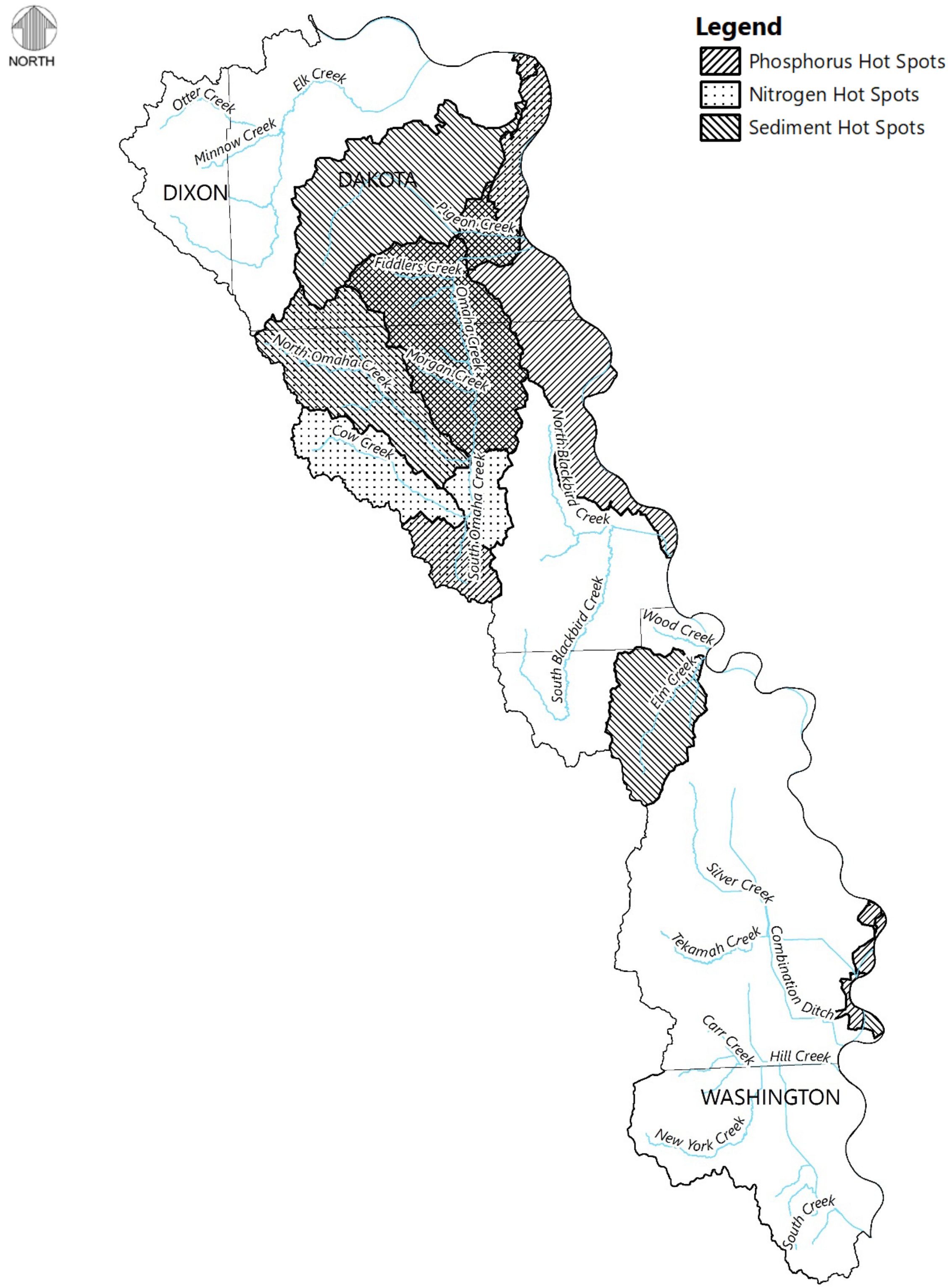

Figure 9-14. SPARROW Analysis- Hot Spots

The SPARROW modeling results identified hot spots in the northern portion of the watershed, primarily in the Pigeon and Omaha Creek watersheds. While the topography and soil types are not drastically different throughout the watershed, the model indicates higher loads reach the locations where the streams to the north are sampled. This is consistent with the locations of the sediment and erosion control projects that the P-MRNRD has implemented (as discussed in section 9.1.2). This highlights the need to continue to work in the Pigeon watershed, as well as emphasizes the need to focus on Omaha Creek.

9.4.2 Impaired Waterbodies

For impaired waterbodies, existing sample data and data analysis conducted by the NDEQ are discussed. The allocation of the load throughout the watershed was not modeled for these waterbodies since they are not currently Priority Areas in this Plan.

Omaha Creek (MT1-12000) and Elk Creek (MT2-10100)
Impairment: E.coli
NDEQ performed a TMDL-like analysis for *E.coli* bacteria for these two reaches within the Blackbird Creek Watershed, referred to as the 5-Alt. The data used by NDEQ to perform the 5-Alt is summarized in Table 9-13.

Table 9-13. 5-Alt Data

Data Sources	Flow Data				Location		Drainage Area at Gauge (sq mi)	Drainage Area of Segment	Flow Ratio
	Site	Range	Owner	Name	Lat	Long			
MT1-12000	6601000	1993-2014	USGS	Omaha Creek at Homer, NE	42.322	-96.488	174.0	186.8	1.07
MT2-10100	6601000	1993-2014	USGS	Omaha Creek at Homer, NE	42.322	-96.488	174.0	130.7	0.75

Table 9-14 reports the resulting seasonal geometric mean from the 5-Alt for the two stream segments that were analyzed. Since bacteria are living organisms, the “load” is based on concentrations rather than a mass per unit of time.

Table 9-14. *E.coli* Loads in Impaired Stream Segments in the Blackbird Creek Watershed

Segment	Waterbody Name	Seasonal Geometric Mean (col/100 ml)
MT1-12000	Omaha Creek	3,149
MT2-10100	Elk Creek	1,805

Summit Lake (MT1-L0150)

Impairments: E.coli, Nutrients, Chlorophyll

Several years of lake sampling data were available for nutrient and chlorophyll. A summary of the data is presented in Table 9-15 that represents the conditions of Summit Lake as a result of the pollutant load it receives from the watershed.

Table 9-15. Nutrient and Chlorophyll Concentrations for Summit Lake

	Data Period	Average Concentration
Total Phosphorus (µg/L)	1990-2013	130
Total Nitrogen(µg/L)	1990-2013	1,320
Chlorophyll *a* (mg/m^3)	1990-2013	75

Source: USEPA STORET

Phosphorus is a common pollutant used to model load reductions in TMDLs, however a TMDL has been developed that has calculated the loading to the lake. For this plan, the Canfield-Bachmann equation was applied to Summit Lake to estimate annual phosphorus loading. This lake response model calculated the load based on the average phosphorus concentration and the following data inputs in Table 9-16.

Table 9-16. Summit Lake Characteristics

Data Inputs	
Volume (ac-ft)	2,531.9
Mean Depth (ft)	14.1
Detention time (yrs)	0.72
Model Output	
Annual Load (lbs/yr)	7,548

While no stream *E.coli* concentrations for have been documented in the Summit Lake Watershed, beach sampling data (Station ID LMTSUMMIT04) for *E.coli* was provided for May through September in 2005 and 2010. While the lake is listed as impaired for *E.coli*, the data provided indicated that the geomean does not exceed the standard of 126 cfu/100 mL.

Table 9-17. Summit Lake E. coli Data Summary

Statistics	Value
# of Samples	38
Seasonal Geometric Mean (cfu/100 mL)	37.0
# Standard Violations	10
% Standard Violations	26.3%

9.5 POLLUTANT LOAD REDUCTIONS

Pollutant load reductions are typically calculated with the goal of meeting water quality standards for a given parameter. The State of Nebraska currently has no stream standards for sediment or nutrients, therefore, any reductions identified for stream segments are associated with reaching *E.coli* standards. No detailed watershed load modeling was performed since no Priority Areas were identified within the Blackbird Creek Watershed, therefore recommendations for BMPs to achieve load reductions were not developed as part of this Plan for this particular watershed.

9.5.1 General Watershed

While the south portion of the watershed does not have identified hot spots, there does continue to be sedimentation problems (as indicated by local landowners during public meetings) and the loading rates are still above desired conditions. Some of the hot spots in other parts of the watershed could be a potential indication of mismanaged feedlots or concentrated cattle in streams, as they are much higher than loads that would be expected from cropland. Conservation practices listed in Chapter 7 that would apply to agricultural land use should be pursued to reduce the loading rates throughout the watershed. Currently there is a concentrated effort on implementing these practices in the Pigeon Creek watershed. The P-MRNRD will continue to identify and focus work in sub-watersheds of the Blackbird Creek Watershed to help reduce pollutant loading to the receiving waterbodies.

9.5.2 Impaired Waterbodies

For impaired waterbodies, existing sample data and data analysis conducted by the NDEQ are discussed to provide load reduction goals. The quantification of BMPs required to reach these goals was not performed since they are not currently Priority Areas in the Plan for the Blackbird Creek watershed.

Omaha Creek (MT1-12000) and Elk Creek (MT2-10100)
Impairment: E.coli

The 5-Alt analysis indicates that reductions in the geometric mean concentration will be needed at both sites to meet water quality standards for *E.coli* (Table 9-18).

Table 9-18. E.coli Concentrations and Reductions for Stream Segments

Segment	Name	Data Period	Seasonal Geometric Mean (col/100 ml)	Required Reduction	Expected Geomean
MT1-12000	Omaha Creek	NDEQ 2010	3149	97%	94
MT2-10100	Elk Creek	NDEQ 2010	1805	94%	108

Conservation practices listed in Chapter 7, that target *E.coli* should be pursued in these watersheds. A more detailed analysis of the watershed to identify unpermitted cattle operations and potentially failing septic systems would be highly beneficial in these watersheds. A watershed loading model will be required at the project level if any projects are to be pursued and implemented according the 9 Element planning process.

Summit Lake (MT1-L0150)

Impairments: E.coli, Nutrients, Chlorophyll

The sampling data indicates that concentration reductions in phosphorus, nitrogen and chlorophyll are required to meet the water quality standards.

Table 9-19. Nutrient and Chlorophyll Concentrations for Summit Lake

	Average Concentration	Water Quality Standard	Required Reduction (µg/L)	Required Reduction
Total Phosphorus (µg/L)	130	50	80	62%
Total Nitrogen(µg/L)	1320	1000	320	24%
Chlorophyll *a* (mg/m^3)	75	10	65	87%

Source: USEPA STORET

The Canfield-Bachmann equation was also used to calculate the annual load reduction required to reduce the phosphorus concentration to the water quality standard of 50 µg/L.

Table 9-20. Annual Loading Summary

Condition	Value
Existing Load (lbs/yr)	7,548
Loading Goal (lbs/yr)	1,365
Reduction (lbs/yr)	6,182
Reduction (%)	82%

The results indicate a 6,182 lb/yr or 82% load reduction is required. If a project is pursued, this load should be partitioned into internal and external loading, and a detailed watershed model should be developed for the external load. Conservation practices listed in Chapter 7, Table 7-X that would apply to agricultural land use could be pursued to reduce the watershed load.

No *E.coli* reductions are required based on the sampling data provided. This should be investigated further if any future projects are pursued on Summit Lake.

9.6 COMMUNICATION AND OUTREACH

The P-MRNRD implements communication and education activities on a district wide and targeted basis. General approaches, delivery mechanisms and tools will be consistent across watersheds in the basin. In some cases, projects or problems may warrant a deviation from current approaches, however, none have been developed for this watershed. Refer to Chapter 6 for a description of communication and education approaches.

9.7 IMPLEMENTATION SCHEDULE

Watershed wide implementation to address sediment, nutrients and bacteria will continue for interested landowners utilizing the existing assistance programs administered by the P-MRNRD and USDA (See Chapter 8). The P-MNRND will continue implementing items from the soils and erosion control plan identified in table 9-1, with a specific timeline and budget for 2 new structures within 2018 and 2019. The Winnebago Tribe is working on their Water Quality Program, and the P-MRNRD intends to provide support to the tribe as needed throughout the process. These items may include but are not limited to:

- *E.coli* sampling throughout watershed,
- Inventory of unregistered livestock
- Detailed data collection of registered LWCF
- Inspection of septic systems
- Inventory of existing conservation practices in watershed
- Stream assessment/catalogue severity of streambank erosion

Dependent upon the results of the Winnebago Water Quality Program, the P-MRNRD will coordinate with the Winnebago Tribe and determine the best route forward with an improvement on Omaha Creek.

Table 9-21. Blackbird Creek Watershed Timeline

Waterbody	TIMELINE				
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Pigeon-Jones Creek	------------------------- Cost Share for Conservation Practices --------------------				
	2 Erosion and Sediment Control Structures			Pursue Remaining Structure Land Rights/Funds	
Omaha Creek	----------------------------- Assistance to Winnebago Tribe ------------------------				

9.8 MILESTONES FOR MEASURING IMPLEMENTATION PROGRESS

No milestones have been developed since there are no Priority Areas in the watershed and no 319 projects being pursued as part of this Plan.

9.9 EVALUATION CRITERIA

No evaluation criteria been developed since there are no Priority Areas in the watershed and no 319 projects being pursued for 319 funding.

9.10 MONITORING

No monitoring outside of the current monitoring networks identified in Chapter 4 will be performed since there are no Priority Areas in the watershed and no 319 projects being pursued as part of this Plan.

9.11 WATERSHED BUDGET

The P-MRNRD will continue to provide cost sharing assistance for conservation practices as requested from landowners (undetermined value), and continue to implement the large erosion and sediment control structures. The budget for the Pigeon-Jones efforts is $1,650,000 in FY18, $400,000 in FY19, $350,000 in FY20 and $350,000 in FY21. Assistance for to the Omaha Creek efforts will be determined upon requests from the Winnebago Tribe.

10 PAPILLION-BELL CREEK WATERSHED PLAN

The Big Papillion-Mosquito HUC 8 (100230006) and a small portion of the Lower Elkhorn HUC 8 (10220003) that contains Bell Creek within the Basin were combined to create what will be referred to in this Plan as the Papillion-Bell Creek Watershed (Figure 10-1). The Papillion-Bell Creek Watershed contains 434,180 acres in portions of Sarpy, Douglas and Washington Counties. There are three main drainage systems within this watershed (Figure 10-2). The northwest portion located in the Lower Elkhorn HUC 8 drains through Bell Creek to the Elkhorn River. Within the Big Papillion-Mosquito HUC 8, the majority of the area drains to Papillion Creek, with the very eastern portion draining to the Missouri River through a series of tributaries.

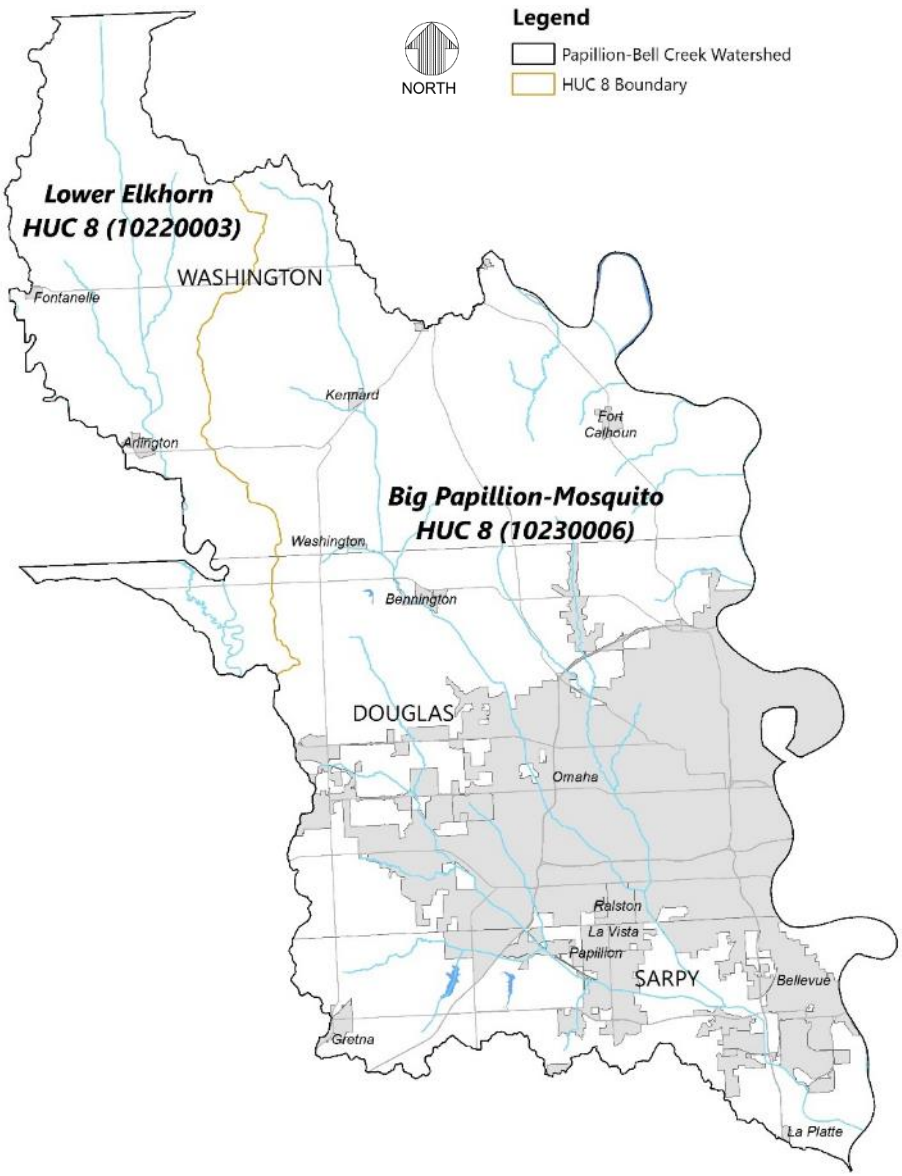

Figure 10-1. Papillion-Bell Creek Watershed

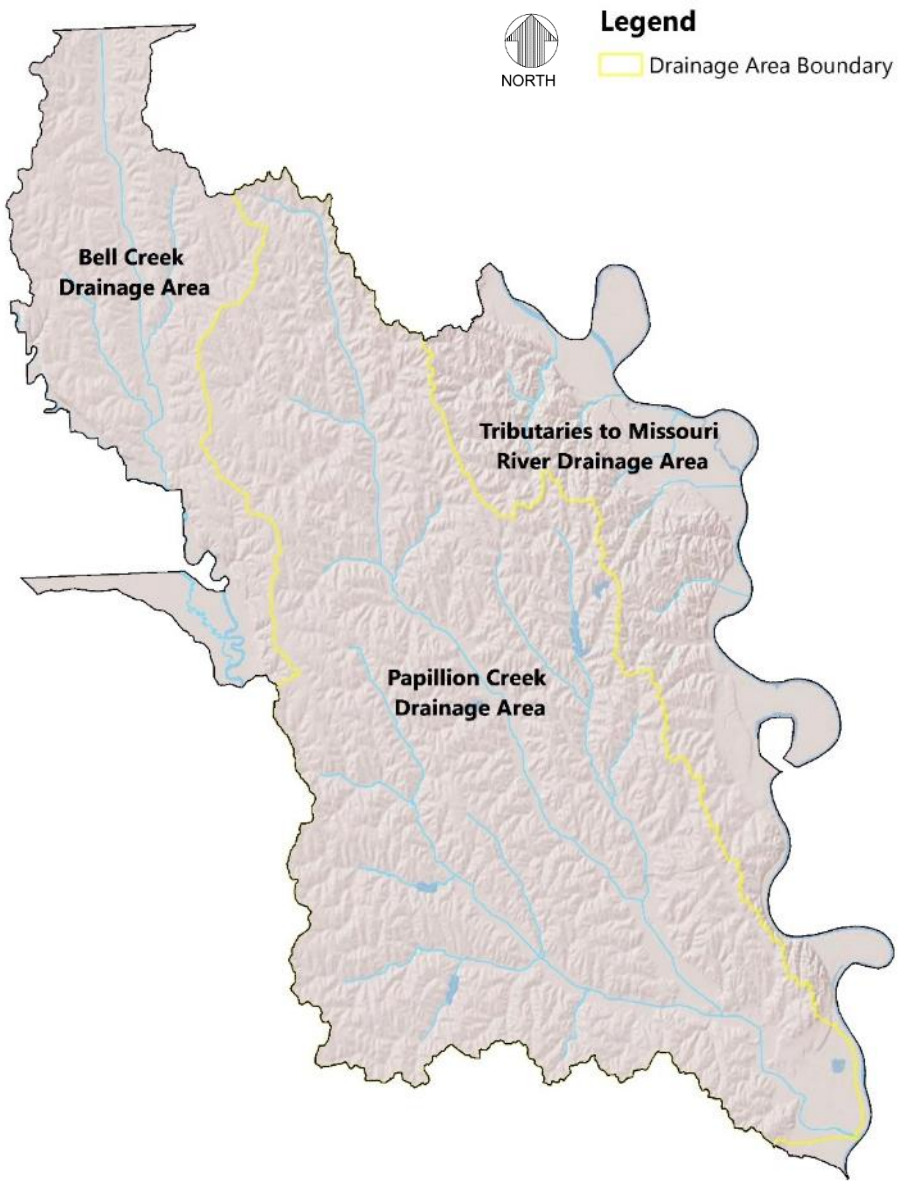

Figure 10-2. Papillion-Bell Creek Drainage Systems

10.1 WATERSHED INVENTORY

10.1.1 Conditions

The Papillion-Bell Creek Watershed has a very diverse demographic. As shown in Figure 10-3, the southern portion is the developed Omaha metropolitan area. The northern portion is primarily agricultural cropland and pasture with local farmsteads spread throughout the watershed. The slopes throughout the majority of the watershed generally consist of moderate to high slopes between 2%

and 10%, with steeper slopes in the bluffs to the east that flatten out to be very gentle in the Missouri River valley, as well as the Elkhorn River, Bell Creek and Papillion Creek valleys.

Farming practices in the northern part of the watershed (irrigation and conservation) vary dependent upon the topographic region. Wells registered for irrigation use are highly concentrated in the valley, whereas wells in the uplands bluffs region are primarily registered as drinking wells. The majority of row crops are located in the hilly uplands. No-till is very common and terraces and grassed waterways are implemented intermittently throughout the fields, however, there are still many fields that would benefit from the implementation of no-till, terraces or grassed waterways. Riparian buffers are present along some stream segments, but do not appear to be a common practice.

Urban area is a mix of residential, commercial and industrial zoning. Residential lots are generally medium to high density with few low impact development neighborhoods. Green infrastructure projects are becoming more popular throughout the metro area, however in a developed area, finding space is often the biggest challenge for implementation of best management practices.

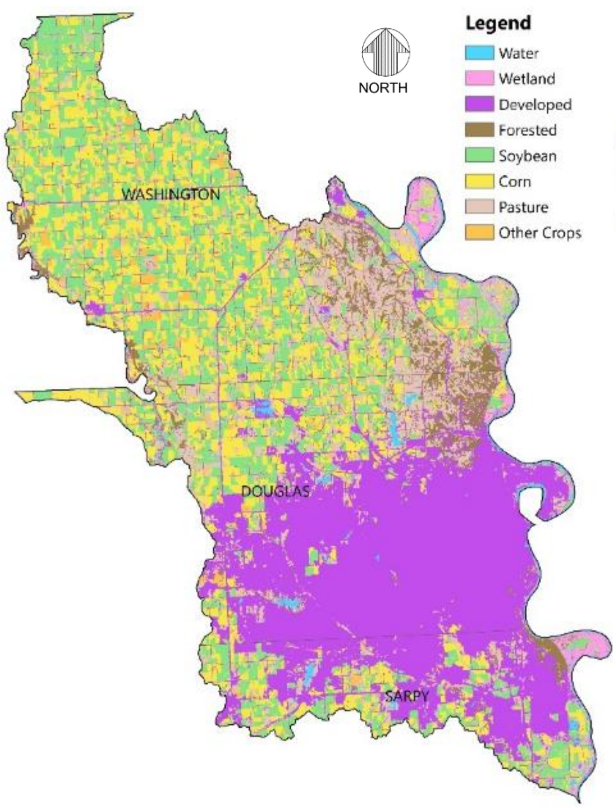

Figure 10-3. Land Use

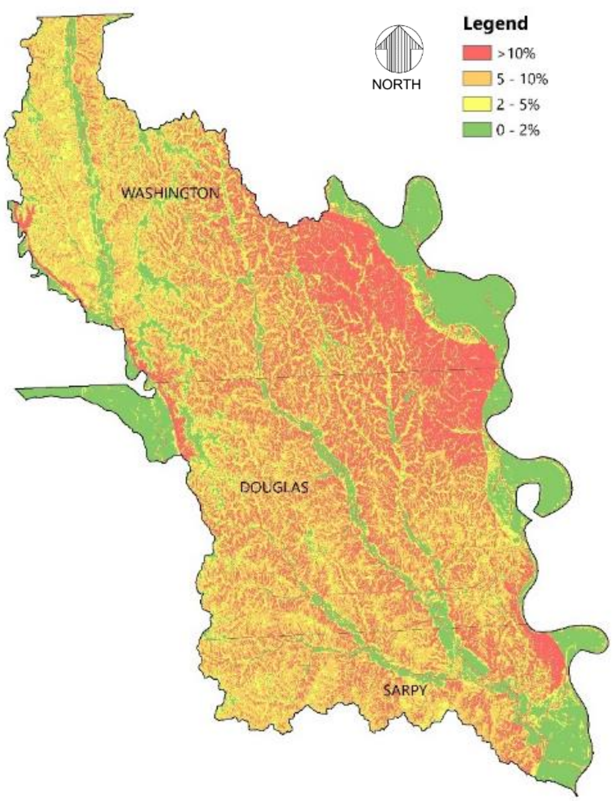

Figure 10-4. Watershed Slopes

The erosion potential of soils in the watershed is a characteristic that impacts water quality. In the soil data provided by the USDA, the "K factor" represents the soil erosion potential based on the susceptibility of soil to erosion (detachment) and the rate of runoff. Values from 0-0.15 are considered to have low potential for soil erosion, values from 0.2 to 0.35 are moderately susceptible to detachment and produce moderate runoff, and values 0.35 and greater have the greatest erosion potential. As depicted in Figure 10-5, the K factor throughout the majority of the undeveloped portion of the watershed indicates moderate to high erosion potential. This is consistent with the soil loss experienced in agricultural fields and gully formations seen throughout the watershed, especially in areas with increased runoff from agriculture or increased impervious area, as well as severe stream erosion through the main tributaries in urban areas.

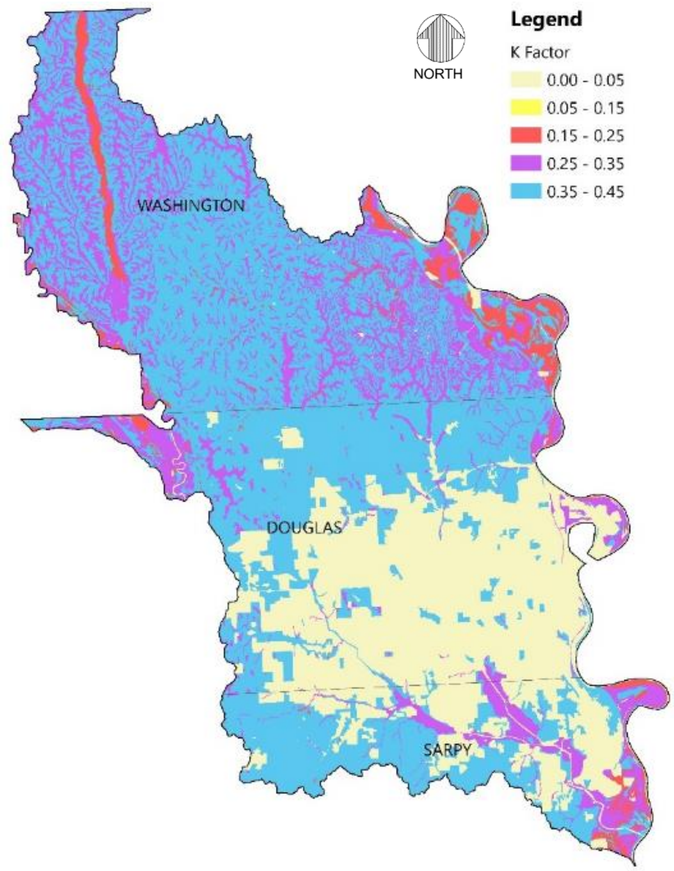

Figure 10-5. Soil Erosion Potential, K-Factor

10.1.2 Past and Current Management

Very large planning efforts have already taken place in the Papillion Creek watershed. Most notable is the formation of the Papillion Creek Watershed Partnership (PCWP) that was created in 2001 through an interlocal agreement between 9 local governments in the watershed. The purpose is to proactively address the water quality and quantity problems in the watershed. The guiding principles of the PCWP are cooperation, community participation and comprehensive watershed planning.

In 2009, the Papillion Creek Watershed Management Plan was finalized and developed a set of recommendations for water quality and flood control improvements. The primary recommendations for water quality included Water Quality Low Impact Development (WQ LID) throughout the entire watershed and several water quality basin structures. WQ LID includes capturing the first 0.5" of net runoff and providing no net increase in the 2-yr peak runoff volume for all new development and significant redevelopment. The WQ LID was implemented as an ordinance in all participating communities and is successfully managed by the City of Omaha Stormwater Department through their development permit requirements.

Several community based watershed management plans have been developed for lakes in the watershed, including Zorinsky Lake, Cunningham Lake and Carter Lake. These efforts resulted in implementation of several water quality basins and watershed practices, as well as complete lake restoration projects. These plans have since expired. Stream restoration projects are also common in the urban area. Many of the stream degradation sites were creating problems with the local infrastructure, and working to improve the stream system also resolved the infrastructure issues at hand. The City of Omaha Stormwater Department also implements green infrastructure projects at their facilities, parks and throughout the city where opportunities arise. They support efforts of local schools, universities and any other interested parties looking for stormwater solutions. See Chapter 6 for more information on their public outreach efforts.

10.2 WATER RESOURCES AND CURRENT CONDITIONS

The condition of water resources in the Papillion-Bell Creek are based on NDEQ's beneficial use support assessments, historic planning documents, water quality assessments conducted by NDEQ and watershed surveys. A figure of the waterbodies located in the watershed is presented on Figure 10-6. Additional information on water quality concerns have been provided through the Steering Committees and public outreach efforts.

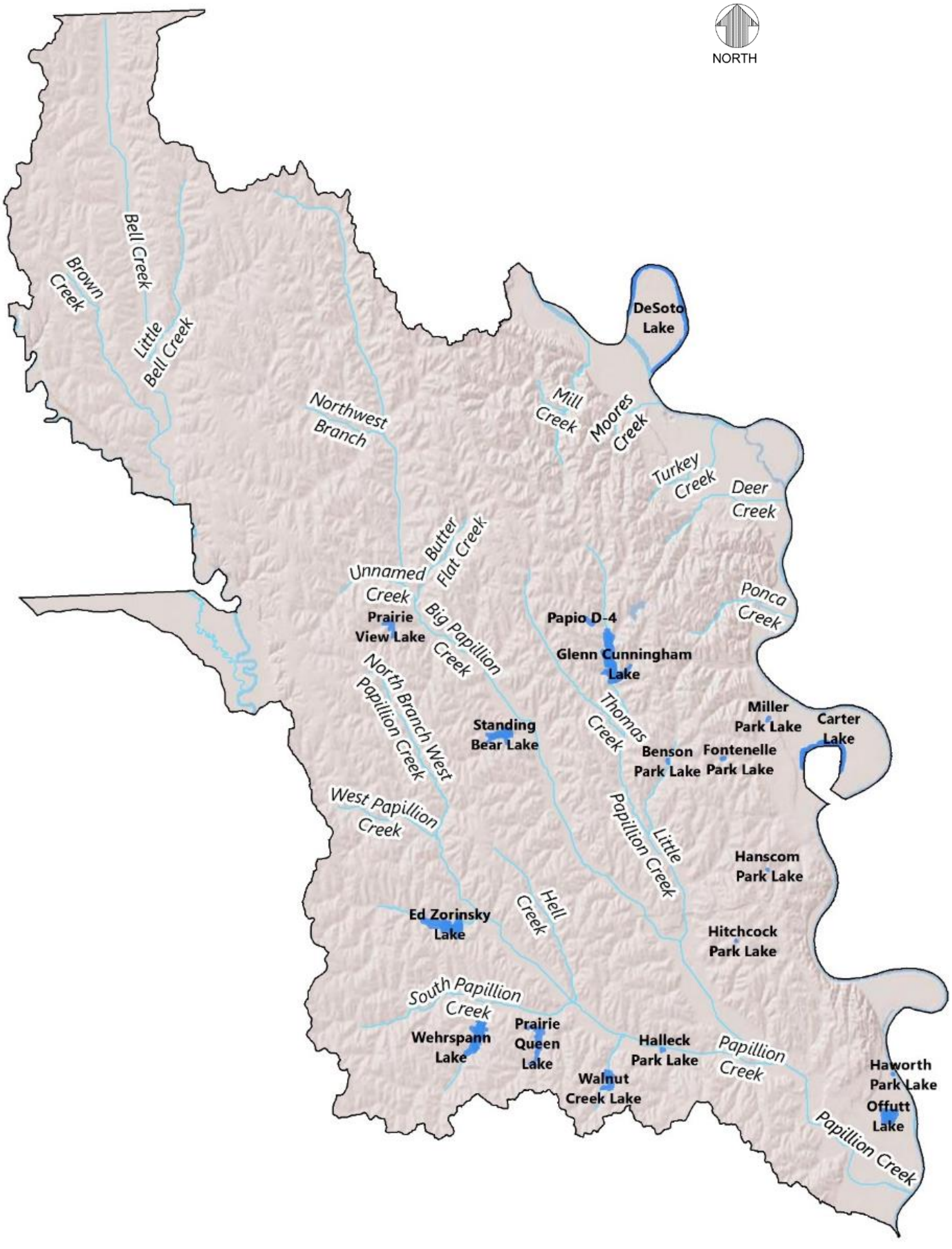

Figure 10-6. Papillion-Bell Creek Waterbodies

10.2.1 Streams

Nebraska's Water Quality Standards identifies 36 Title 117 stream segments in the Papillion-Bell Watershed that total 413 miles (Table 10-1 and Figure 10-6). These are major perennial streams that range from 2.1-137.6 miles. Eight segments have a Warm Water A designation for the Aquatic Life use, with the remaining 28 segments being a Warm Water B designation. Eight stream segments are assigned the Recreation designation, which includes segments of the Elkhorn and Missouri Rivers.

Table 10-1. Streams in the Papillion-Bell Creek Watershed

Stream Name	Segment	Length (miles)	Warm Water Designation	Recreation Designation
Elkhorn River	EL1-10000	52.4	A	PCR
Rawhide Creek	EL1-10300	13.5	A	none
Rawhide Creek	EL1-10400	5.7	B	none
Bell Creek	EL1-10600	19.6	A	none
Brown Creek	EL1-10610	8.2	B	none
Little Bell Creek	EL1-10620	7.5	B	none
Missouri River	MT1-10000	137.6	A	none
Papillion Creek	MT1-10100	8.2	A	PCR
Big Papillion Creek	MT1-10110	5.4	A	PCR
Little Papillion Creek	MT1-10111	8.3	B	PCR
Cole Creek	MT1-10111.1	4.0	B	PCR
Thomas Creek	MT1-10111.2	7.5	B	none
Little Papillion Creek	MT1-10112	7.8	B	none
Big Papillion Creek	MT1-10120	16.3	A	PCR
Butter Flat Creek	MT1-10121	3.8	B	none
Big Papillion Creek	MT1-10130	6.1	B	none
Unnamed Creek	MT1-10131	2.5	B	none
Northwest Branch	MT1-10132	3.2	B	none
Big Papillion Creek	MT1-10140	10.8	B	none
Papillion Creek	MT1-10200	7.3	A	PCR
Walnut Creek	MT1-10210	3.8	B	none
Hell Creek	MT1-10220	6.8	B	none
South Papillion Creek	MT1-10230	3.2	B	none
Unnamed Creek	MT1-10231	3.5	B	none
South Papillion Creek	MT1-10240	6.1	B	none
West Papillion Creek	MT1-10250	8.2	B	none
Boxelder Creek	MT1-10251	5.3	B	none
N. Branch West Papillion	MT1-10252	8.2	B	none
West Papillion Creek	MT1-10260	4.3	B	none
Ponca Creek	MT1-10300	5.1	B	none
Deer Creek	MT1-10400	5.3	B	none
Turkey Creek	MT1-10500	4.7	B	none

Stream Name	Segment	Length (miles)	Warm Water Designation	Recreation Designation
Moores Creek	MT1-10600	3.4	B	none
Long Creek	MT1-10700	4.9	B	none
Mill Creek	MT1-10710	2.1	B	none
Long Creek	MT1-10800	2.9	B	none

NDEQ's beneficial use support assessments for 21 of the 36 segments that were performed is summarized in Chapter 5. The details of the beneficial uses and impairments for the stream segments located in the Papillion-Bell Creek Watershed are provided in Tables 10-2 and 10-3.

- Fourteen of the 21 stream segments assessed in the Papillion-Bell Creek Watershed were reported as impaired in the 2016 Nebraska Integrated Report.
- Impaired segments represent 276 miles of the total 413 stream miles or 67 percent.
- All 8 segments designated for Recreation use are impaired from *E. coli* bacteria.
- Nine impairments are to the Aquatic Life use, which are due to aquatic community, selenium, dissolved oxygen and fish consumption.
- There are no pristine streams in the planning area.

Table 10-2. Beneficial Use Support for Assessed Streams in the Papillion-Bell Creek Watershed

Stream Name	Segment	Applicable Beneficial Uses						
		PCR	AL	DWS	AWS	IWS	AE	Overall
Elkhorn River	EL1-10000	I	I		S		S	I
Rawhide Creek	EL1-10400		S		NA		S	S
Bell Creek	EL1-10600		S		S		NA	S
Missouri River	MT1-10000	I	S	S	S	S	S	I
Papillion Creek	MT1-10100	I	I		S		S	I
Big Papillion Creek	MT1-10110	I	S		S		S	I
Little Papillion Creek	MT1-10111	I	S		S		S	I
Cole Creek	MT1-10111.1	I	I		S		S	I
Thomas Creek	MT1-10111.2		I		NA		NA	I
Little Papillion Creek	MT1-10112		S		S		S	S
Big Papillion Creek	MT1-10120	I	S		S		S	I
Big Papillion Creek	MT1-10140		S		NA		S	S
Papillion Creek	MT1-10200	I	NA		NA		NA	I
Walnut Creek	MT1-10210		I		S		S	I
Unnamed Creek	MT1-10231		S		S		S	S
South Papillion Creek	MT1-10240		I		NA		NA	I
West Papillion Creek	MT1-10250		I		NA		NA	I
Boxelder Creek	MT1-10251		S		S		S	S
N. Branch West Papillion	MT1-10252		I		NA		NA	I
Long Creek	MT1-10700		S		NA		S	S

Stream Name	Segment	Applicable Beneficial Uses						
		PCR	AL	DWS	AWS	IWS	AE	Overall
Long Creek	MT1-10800		I		NA		NA	I

Notes: PCR=Primary Contact Recreation, AL=Aquatic Life (WWA and WWB), DWS=Drinking Water Supply, AWS=Agricultural Water Supply, IWS= Industrial Water Supply, AE=Aesthetics, NA = Not Assessed, S = Supporting the Beneficial Use, I = Impaired Beneficial Use

Table 10-3. Stream Impairment Causes in the Papillion-Bell Creek Watershed

Stream Name	Segment ID	Impairment	Pollutant
Elkhorn River	EL1-10000	Recreation- Bacteria, Aquatic Life- Selenium	*E. coli*, natural Selenium
Missouri River	MT1-10000	Recreation- Bacteria	*E. coli*
Papillion Creek	MT1-10100	Recreation- Bacteria, Aquatic Life- Selenium	*E. coli*, natural Selenium
Big Papillion Creek	MT1-10110	Recreation- Bacteria	*E. coli*
Little Papillion Creek	MT1-10111	Recreation- Bacteria	*E. coli*
Cole Creek	MT1-10111.1	Recreation- Bacteria, Aquatic Life- Dissolved Oxygen	*E. coli*, Unknown
Thomas Creek	MT1-10111.2	Aquatic Life- Aquatic Community	Unknown
Big Papillion Creek	MT1-10120	Recreation- Bacteria	*E. coli*
Papillion Creek	MT1-10200	Recreation- Bacteria	*E. coli*
Walnut Creek	MT1-10210	Aquatic Life- Aquatic Community	Unknown
South Papillion Creek	MT1-10240	Aquatic Life- Aquatic Community	Unknown
West Papillion Creek	MT1-10250	Aquatic Life- Fish Consumption Advisory	Hazard Index Compounds
North Branch West Papillion Creek	MT1-10252	Aquatic Life- Aquatic Community	Unknown
Long Creek	MT1-10800	Aquatic Life- Aquatic Community	In-stream structures prevent fish passage

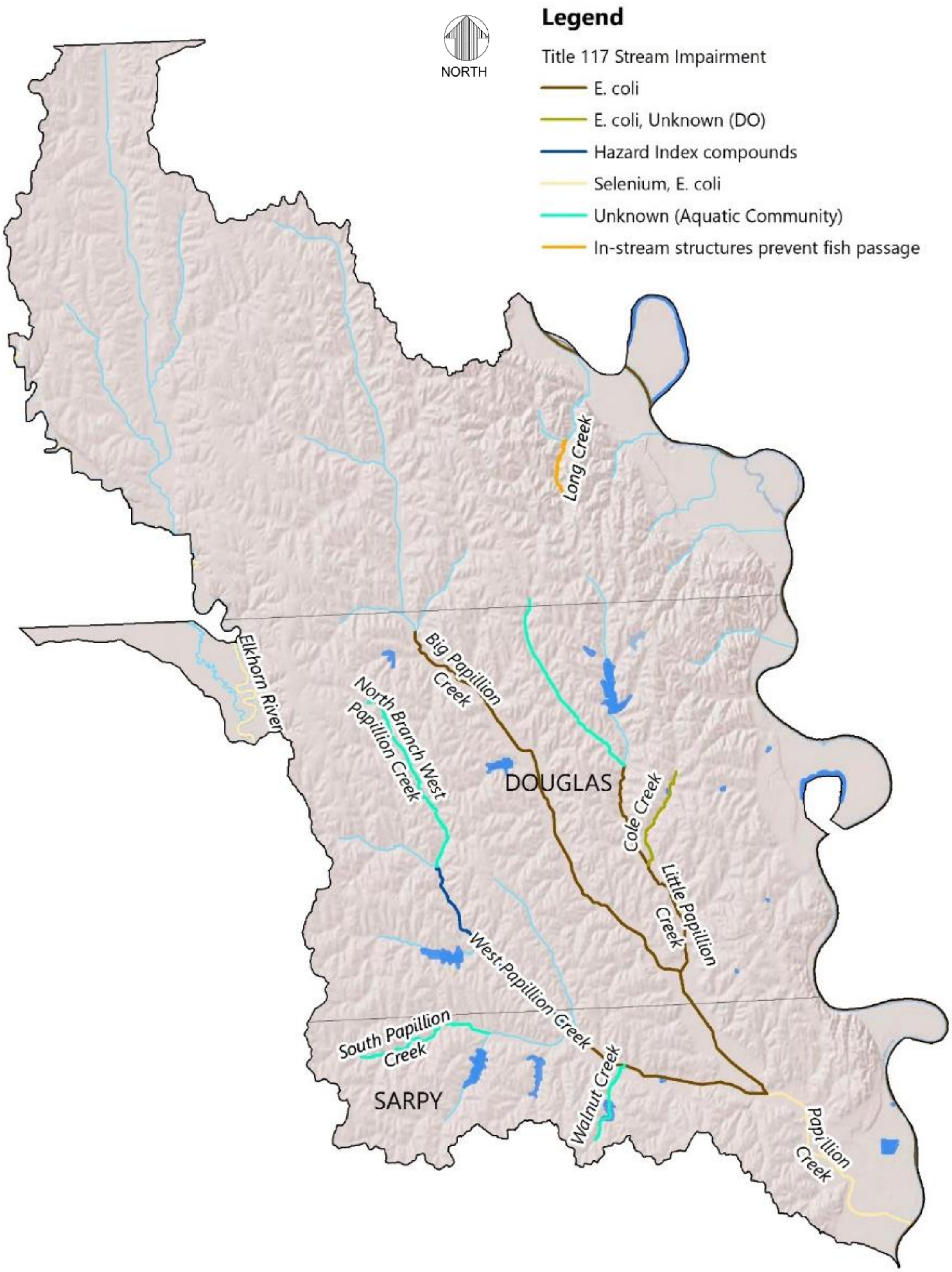

Figure 10-7. Papillion-Bell Creek Impaired Streams

In 2009, NDEQ developed TMDLs for six segments in the watershed. In 2015, NDEQ and EPA created a new alternative to developing TMDLs for impaired waterbodies called a "5-Alt.". This alternative was created to address missing TMDLs in areas that project sponsors have targeted for restoration work. *E. coli* data and associated information was developed for the one stream segment impaired for bacteria in the Papillion-Bell Creek Watershed.

Table 10-4. *E. coli* Impaired Stream Segments Addressed in TMDLs and 5-Alt

Waterbody Name	Segment	TMDL Data Period	5-Alt Data Period
Papillion Creek	MT1-10100	2005	2010
Big Papillion Creek	MT1-10110	2005	n/a
Little Papillion Creek	MT1-10111	2005	n/a
Cole Creek	MT1-10111.1	2005	n/a
Big Papillion Creek	MT1-10120	2005	n/a
Papillion Creek	MT1-10200	2005	n/a

The stability of the streams were also assessed using available digital elevation models processed at a 2 meter resolution 500 ft along each side of the Title 117 stream segments. This high resolution data was converted into a slope raster that characterizes the bank slopes, see Figure 10-8 for an example. The City of Omaha also performed an investigation of the stream systems to identify erosion and stormwater issues.

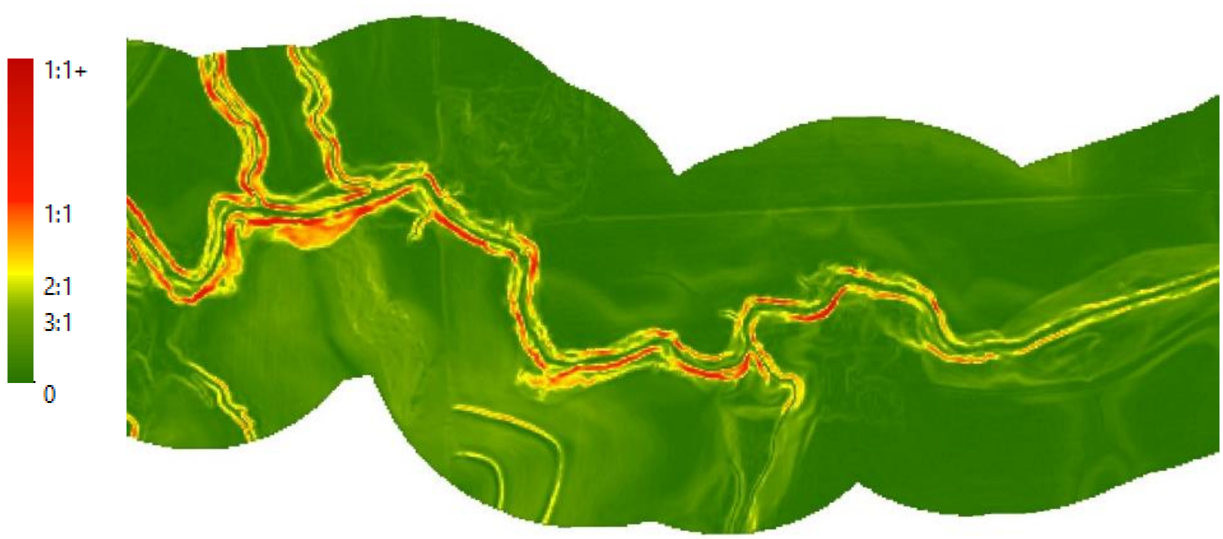

Figure 10-8. High Resolution Slope Raster

Results of this analysis were able to identify stream reaches with unstable banks (considered 1:1 slopes and greater) and locations where stream and stormwater issues were identified are mapped on Figure 10-9. While this is not a direct representation of water quality, it identifies reaches with high erosion potential and also indicates regions where vegetation and aquatic life conditions could be impaired. As shown in Figure 10-9, thousands of linear feet of unstable slopes were identified, as well as hundreds of site specific erosion and stormwater issues. This is consistent with the slope and soil erodibility potential data previously presented in this chapter. Stream bank erosion is a common problem with very frequent impacts to local infrastructure and personal property.

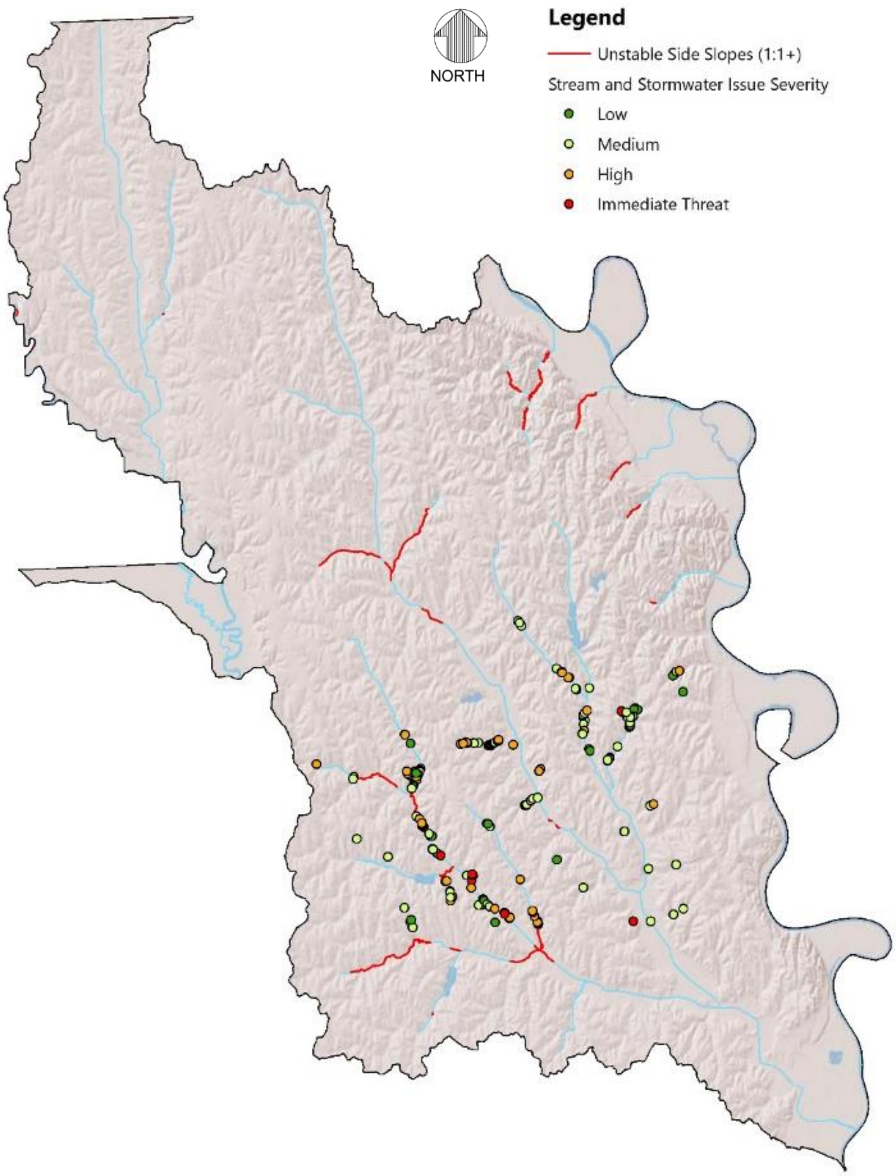

Figure 10-9. Papillion-Bell Watershed Unstable Slopes, Erosion and Stormwater Issues

10.2.2 Lakes

There are 18 lakes in the Papillion-Bell Creek Watershed that total 2,439 surface acres (Table 10-5 and Figure 10-6). Lakes range from 1 to 851 surface acres in size and include man-made impoundments, natural (oxbow) lakes along the Missouri River and man-made borrow pits. DeSoto Lake is considered a State Resource Water (SWR), which is a classification given to outstanding State or National resources, such as waters within national or state parks, national forests or wildlife refuges and waters of exceptional recreational or ecological significance. Offutt Lake is part of Offutt Air Force Base near Bellevue. While this is a public waterbody, access to the general public is not allowed. All lakes have the Warm Water A designation for the Aquatic Life use in addition to being protected for the Primary Contact Recreation, Agricultural Water Supply and Aesthetic uses. There are no pristine lakes in the planning area.

Table 10-5. Lakes in the Papillion-Bell Creek Watershed

Lake Name	Lake ID	Type	Area (acres)
Offutt Lake	MT1-L0010	Reservoir	122
Haworth Park Lake	MT1-L0020	Borrow Pit	2
Halleck Park Lake	MT1-L0023	Borrow Pit	4
Walnut Creek Lake	MT1-L0025	Reservoir	84
Prairie Queen	MT1-L0027	Reservoir	103
Wehrspann Lake	MT1-L0030	Reservoir	216
Hitchcock Park Lake	MT1-L0040	Borrow Pit	1
Ed Zorinsky Lake	MT1-L0050	Reservoir	235
Hanscom Park Lake	MT1-L0060	Borrow Pit	1
Fontenelle Park Lake	MT1-L0070	Borrow Pit	6
Benson Park Lake	MT1-L0080	Borrow Pit	4
Carter Lake (Omaha)	MT1-L0090	Oxbow	298
Standing Bear Lake	MT1-L0100	Reservoir	106
Miller Park Lake	MT1-L0110	Borrow Pit	5
Glenn Cunningham Lake	MT1-L0120	Reservoir	345
Papio D-4	MT1-L0130	Reservoir	22
Prairie View Lake	MT1-L0035	Reservoir	36
DeSoto Lake	MT1-L0140	Oxbow	851

Water quality data was available for NDEQ to conduct beneficial use support assessments on 15 of the 18 lakes in Papillion-Bell Creek Watershed (Table 10-6), with impairments described in Table 10-7. A total of 2,308 acres have been assessed representing 95 percent of the surface acres in the area. A summary of the findings are:

- Eleven of the 15 lakes assessed in the Papillion-Bell Creek Watershed were reported as impaired in the 2016 Nebraska Integrated Report (Figure 10-10).

- Impaired lakes represent 1,451 acres of the total 2,439 surface acres in the watershed or 59 percent.
- One lake designated for Recreation use is impaired from *E. coli* bacteria.
- All 11 lake have impairments to the Aquatic Life use, which are due to fish consumption, nutrients, chlorophyll a and pH.
- No lakes have impairments to the Agricultural Water Supply use.
- Two lakes have impairments to the Aesthetics use, which are due to algae blooms and sedimentation.
- There is no data indicating there are any pristine lakes in the watershed.

Table 10-6. Beneficial Use Support for Lakes in the Papillion-Bell Creek Watershed

Lake Name	Lake ID	Applicable Beneficial Uses				
		PCR	AL	AWS	AE	Overall Assessment
Offutt Lake	MT1-L0010	NA	I	NA	NA	I
Haworth Park Lake	MT1-L0020	S	S	S	NA	S
Halleck Park Lake	MT1-L0023	NA	I	NA	S	I
Walnut Creek Lake	MT1-L0025	I	I	S	S	I
Wehrspann Lake	MT1-L0030	S	I	S	S	I
Hitchcock Park Lake	MT1-L0040	S	I	S	S	I
Ed Zorinsky Lake	MT1-L0050	S	I	S	S	I
Hanscom Park Lake	MT1-L0060	NA	S	NA	NA	S
Benson Park Lake	MT1-L0080	S	NA	NA	NA	S
Carter Lake	MT1-L0090	S	I	S	I	I
Standing Bear Lake	MT1-L0100	S	I	S	I	I
Miller Park Lake	MT1-L0110	S	I	S	NA	I
Glenn Cunningham Lake	MT1-L0120	S	I	S	S	I
Prairie View Lake	MT1-L0035	NA	I	NA	NA	I
DeSoto Lake	MT1-L0140	NA	S	NA	NA	S

Table 10-7. Lake Impairments in the Papillion-Bell Creek Watershed

Lake Name	Waterbody ID	Impairment	Pollutant
Offutt Lake	MT1-L0010	Aquatic Life- Fish Consumption Advisory	Cancer Risk Compounds, Hazard Index Compounds
Halleck Park Lake	MT1-L0023	Aquatic Life- Fish Consumption Advisory	Hazard Index Compounds
Walnut Creek Lake	MT1-L0025	Aquatic Life- Nutrients, Chlorophyll a, Fish Consumption Advisory, Recreation- Bacteria	Total Phosphorus, Total Nitrogen, Hazard Index compounds, Mercury, *E. coli*
Wehrspann Lake	MT1-L0030	Aquatic Life- Nutrients, Chlorophyll a, Fish Consumption Advisory	Total Phosphorus, Total Nitrogen, Hazard Index compounds, Mercury
Hitchcock Park Lake	MT1-L0040	Aquatic Life- pH	Unknown
Ed Zorinsky Lake	MT1-L0050	Aquatic Life- Nutrients, Chlorophyll a, Fish Consumption Advisory	Total Phosphorus, Total Nitrogen, Hazard Index compounds, Mercury
Carter Lake	MT1-L0090	Aquatic Life- Nutrients, Chlorophyll a, Fish Consumption Advisory, Aesthetics- Algae Blooms	Total Phosphorus, Total Nitrogen, Hazard Index compounds, Mercury
Standing Bear Lake	MT1-L0100	Aquatic Life- Nutrients, Chlorophyll a, Fish Consumption Advisory, Aesthetics- Sedimentation	Total Phosphorus, Total Nitrogen, Hazard Index compounds, Mercury, Sediment
Miller Park Lake	MT1-L0110	Aquatic Life- pH	Unknown
Glenn Cunningham Lake	MT1-L0120	Aquatic Life- Nutrients, Chlorophyll a, pH	Total Phosphorus, Total Nitrogen
Prairie View Lake	MT1-L0035	Aquatic Life- Fish Consumption Advisory	Hazard Index Compounds, Mercury

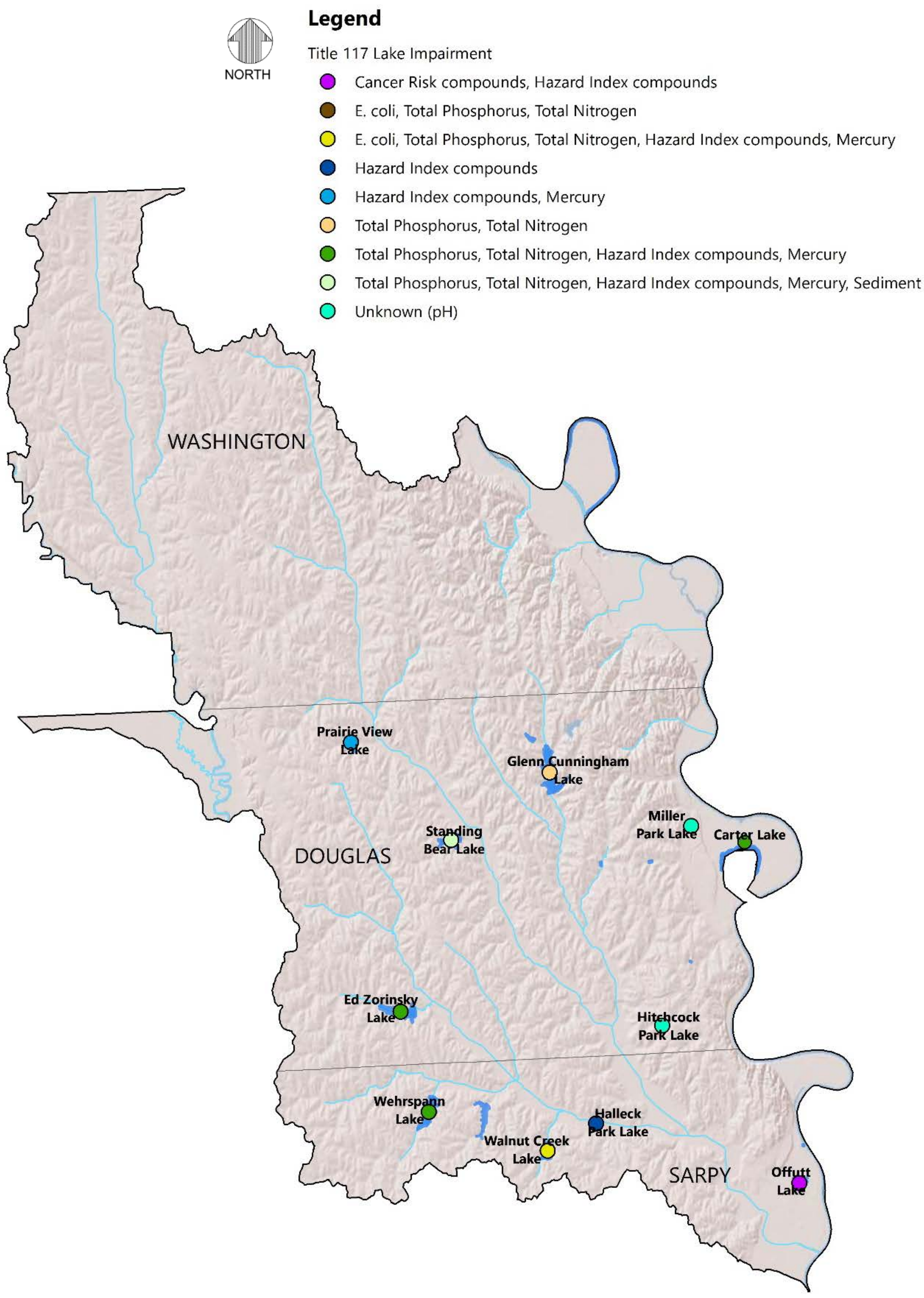

Figure 10-10. Papillion-Bell Creek Watershed Impaired Lakes

Three TMDLs have been developed for lakes in the Papillion-Bell Creek watershed.

Table 10-8. TMDLs in the Papillion-Bell Creek Watershed

Lake Name	Waterbody ID	Pollutant	Year Published
Standing Bear Lake	MT1-L0100	Sediment and Phosphorus	2003
Carter Lake	MT1-L0090	Algae and Turbidity	2007
Ed Zorinsky Lake	MT1-L0050	Sediment and Phosphorus	2002

Another concern in the watershed is Zebra mussels. In 2006, a federal wildlife specialist discovered a live adult Zebra mussel in Offutt Lake on Offutt Air Force Base near Bellevue. At that time a Zebra Mussel Work Group was formed which was comprised of state and federal officials. The Work Group prepared a workplan and in 2008 and 2009 the lake was treated with copper sulfate. Monitoring conducted in 2009 was negative for Zebra mussel larvae and adults, however, in 2010 adult mussels were detected. In 2010, a large infestation of mussels was also documented at Ed Zorinsky Lake in Omaha. A successful eradication of the mussels was achieved through a total lake draw-down and the lake was reopened in 2012. Since that time yearly testing has not found larvae or adult Zebra mussels.

10.2.3 Wetlands

In the steeper terrain of the headwaters in the western portion of the watershed there are no major wetland complexes outside the stream tributaries, as shown on the NWI map in Chapter 3. Conditions are more conducive to ponding on the eastern edge of the watershed along the Missouri River valley. The only major wetland area in the watershed is in the DeSoto National Wildlife Refuge where the large DeSoto Lake oxbow is surrounded by a wetland area that has been preserved and protected from cultivation.

10.2.4 Groundwater

The P-MRNRD is the process of updating their Groundwater Rules and Regulations as part of their Groundwater Management Plan (see 3.2.4-3.2.7). The local groundwater table is heavily tied to the Missouri River water level. During the barge season, early spring through late fall, the Missouri River upstream dams are operated to release more discharge which results in higher river levels. During these months, groundwater levels in the valley tend to range from 10 to 15 ft deep. High groundwater tables tend to be more susceptible to contamination from infiltration of contaminants, however the low to moderately low hydraulic conductivities reported in Chapter 3 (Figure 3-5) must prevent high rates of pollutant transport, as the nitrate data in the Basin watershed show groundwater concentrations are currently not a major concern (Section 3.2.7). The majority of the watershed is in the high topographic region that is generally disconnected from the water table.

10.3 POLLUTANT SOURCES

The impairments described in section 10.2 indicate primary contributors to water quality degradation in the Papillion-Bell Creek Watershed are tied to sediment, phosphorus, nitrogen and *E. coli* bacteria. The origin of these pollutant sources was assessed using land cover data, aerial imagery, watershed inventories, completed water quality plans and other available documentation. General sources for the entire watershed will be discussed and a very detailed analysis was performed on the Priority Area, which is the entire Papillion Creek watershed, as discussed in Chapter 5. The Papillion Creek and several of its tributaries are impaired for *E. coli*, however there are several waterbodies within the Papillion Creek watershed that have their own impairments, listed in Table 10-9. A detailed analysis of each of these impairments was not feasible for the scope of this Plan, however two of the waterbodies, Standing Bear Lake and Thomas Creek, have generated a high level of interest from local agencies for projects within the next five years. Therefore, a detailed investigation of these two waterbodies is included.

Table 10-9. All Impairments in the Papillion Creek (MT1-10100) Watershed

Stream Name	Segment ID	Impairment
Papillion Creek	MT1-10100	Recreation- Bacteria, Aquatic Life- Selenium
Big Papillion Creek	MT1-10110	Recreation- Bacteria
Little Papillion Creek	MT1-10111	Recreation- Bacteria
Cole Creek	MT1-10111.1	Recreation- Bacteria, Aquatic Life- Dissolved Oxygen
Thomas Creek	**MT1-10111.2**	**Aquatic Life- Aquatic Community**
Big Papillion Creek	MT1-10120	Recreation- Bacteria
Papillion Creek	MT1-10200	Recreation- Bacteria
Walnut Creek	MT1-10210	Aquatic Life- Aquatic Community
South Papillion Creek	MT1-10240	Aquatic Life- Aquatic Community
West Papillion Creek	MT1-10250	Aquatic Life- Fish Consumption Advisory
North Branch West Papillion Creek	MT1-10252	Aquatic Life- Aquatic Community
Halleck Park Lake	MT1-L0023	Aquatic Life- Fish Consumption Advisory
Walnut Creek Lake	MT1-L0025	Aquatic Life- Nutrients, Chlorophyll a, Fish Consumption Advisory, Recreation- Bacteria
Wehrspann Lake	MT1-L0030	Aquatic Life- Nutrients, Chlorophyll a, Fish Consumption Advisory
Hitchcock Park Lake	MT1-L0040	Aquatic Life- pH
Ed Zorinsky Lake	MT1-L0050	Aquatic Life- Nutrients, Chlorophyll a, Fish Consumption Advisory
Carter Lake	MT1-L0090	Aquatic Life- Nutrients, Chlorophyll a, Fish Consumption Advisory, Aesthetics- Algae Blooms

Standing Bear Lake	**MT1-L0100**	**Aquatic Life- Nutrients, Chlorophyll a, Fish Consumption Advisory, Aesthetics-Sedimentation**
Glenn Cunningham Lake	MT1-L0120	Aquatic Life- Nutrients, Chlorophyll a, pH
Prairie View Lake	MT1-L0035	Aquatic Life- Fish Consumption Advisory

10.3.1 General Watershed

Point source discharges have the potential to discharge wastewater to Waters of the State in the Papillion-Bell Creek Watershed. Facility types include: municipal, commercial and industrial wastewater treatment facilities (WWTF). The 5 facilities that have been issued a National Pollutant Discharge Elimination System (NPDES) permit (according to EPA's Enforcement and Compliance History Online (ECHO) database) in the Papillion-Bell Creek Watershed that are regulated for *E. coli* are listed in Table 10-10. Under Section 503 of the Clean Water Act (CWA), WWTFs may dispose of sewage sludge through land applications (EPA 1993). Sludge is land applied after proper stabilization and is incorporated into the soil at agronomic rates. Improper or over-application of sludge may potentially cause bacteria impairment to surface water. Nebraska is not a 503 authorized state, therefore administration of section 503 of the CWA falls within the authority of EPA's Bio Solids program.

Table 10-10. WWTF in the Papillion-Bell Creek Watershed

Facility Name	NPDES Permit #	Receiving Stream
Omaha Papillion Creek WWTF	NE0112810	MT1-10000
Omaha Missouri River WWTF	NE0036358	MT1-10000
Elkhorn WWTF	NE0040096	MT1-10260
Mt. Michael WWTF	NE0112216	MT1-10260
Douglas County SID # 128 - Twilight Hills	NE0113077	MT1-10300

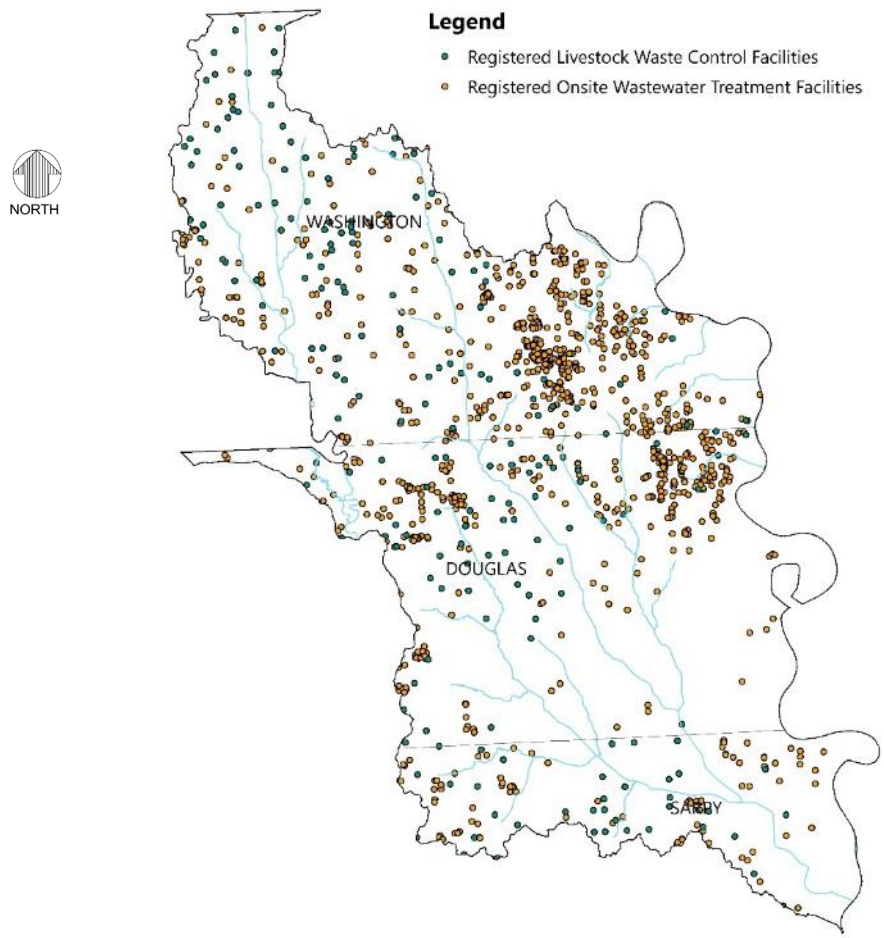

Figure 10-11. NDEQ Registered Facilities

Illicit connections, undetected discharges from wastewater pipes, straight pipes from septic tanks or failing septic systems or other failing onsite wastewater systems can also be a source for *E. coli* bacteria. Under Title 124, Chapter 3, NDEQ requires that any facility doing work associated with onsite wastewater systems to be certified by the State of Nebraska and requires systems constructed, reconstructed, altered, or modified to be registered with the state (NDEQ 2012). As of March 2016, a total of 1,198 onsite wastewater systems have been registered within Papillion-Bell Creek Watershed. Systems installed prior to 2001 were not required to be registered, therefore the exact number of septic systems or failing septic systems is not possible to determine. Through aerial photography assessments, farmsteads that likely have private septic are grossly underrepresented by the actual number that are registered and mapped in Figure 10-11. According to the National Environmental Services Center it is estimated that 40 percent of all septic systems are presently failing and about 6 percent of systems are either repaired or replaced annually (NESC 2013).

AFOs are facilities that confine livestock in a limited feeding space for an extended period. The Nebraska Livestock Waste Management Act authorizes the Nebraska Department of Environmental Quality to regulate discharge of livestock waste from these operations. Nebraska's Livestock Waste Control Regulations (Title 130) classifies AFOs as small, medium or large operations based on the number and type of livestock confined in the facility. Title 130 also requires inspection of medium and large operations to assess the potential for waste discharge. Depending on the size of the operation and potential to discharge pollutants, the operation may be required to obtain a construction and operating permit for a livestock waste control facility (LWCF) from NDEQ. Each AFO may have more than one livestock waste control facility (LWCF). These facilities are designed to contain any run off that is generated by storm events that are less than or equal to a 25-year, 24-hour rainfall event. AFOs confining less than the equivalent of 300 beef cattle are considered administratively exempt from inspection and permitting unless they have a history or potential to discharge pollutants to Waters of the State. Figure 10-11 shows 205 LWCFs within the Papillion-Bell Creek Watershed that have been entered into the NDEQ database as being inspected. Registered LWCF are generally designed to function with high pollutant trapping efficiencies, therefore if managed correctly, the majority of the AFO pollutant load is contained.

The City of Omaha has a combined sewer overflow system (CSO) that outlets into tributaries to the Missouri River and Papillion Creek. The CSO is a large contributor to *E. coli* loading in the watershed. In October 2002, the City of Omaha was issued an NPDES permit and outlined nine specific minimum controls and long-term control plan (LTCP) requirements. The plan focuses on the control of *E. coli* contributions to Papillion Creek from CSO events. Implementation began in 2009 and the City of Omaha is committed to completion by the LTCP by October 2027. Other urban source loads not regulated by permits include pet waste, any human generated waste that enters run-off and wildlife.

Numerous small unpermitted livestock facilities are present across the watershed. An inventory of the facilities not requiring a permit was not available. Cattle that can graze and access water from stream banks will trample vegetation, and their manure directly enters the stream with no filtration of runoff or infiltration potential. A common agricultural practice is also to remove manure from AFOs and/or pasture and apply it as a natural fertilizer to cropland. Mismanagement of any of these facilities/activities can result in high bacteria loading. Identification of these operations would require a farm-by-farm inventory making it a difficult and expensive task for such a large assessment area. However, small operations can have a significant impact on water quality and should be included in any future detailed project planning efforts.

Contributions of bacteria from wildlife must also be considered. Due to high population densities in eastern Nebraska, the largest contributors are likely deer and waterfowl. The USFWS reports densities of deer in eastern Nebraska as 9-10 per square mile. Eastern Nebraska is a migratory path for Mississippi Flyway geese, but can also have resident geese year round. Because geese aggregate, large quantities of droppings can accumulate in nesting and foraging areas. One goose can produce up to three pounds of droppings each day, acting as a source of nutrients and *E. coli* to local waterbodies. Other wildlife that also contribute, although not as heavily in population density, are coyotes, rodents, rabbits, raccoons and opossums.

Sediment and nutrient loads in the Papillion-Bell Creek Watershed are generated from both agricultural and urban areas. Fertilization and soil management practices have a large impact on the loads produced from each field in the agricultural areas. Sedimentation occurs when precipitation runoff carries eroded soil particles into streams and lakes. Nutrients often attached to the soil particles and deposited into waterbodies along with the sediment. Urban areas tend to have less sediment erosion in lawns, however the dissolved nutrient loads in the stormwater runoff are generally elevated due to fertilizer application. The dissolved nutrients in the waterbodies are available in the water column for uptake, often leading to algal blooms in the lakes. This is very prevalent throughout the watershed with all assessed lakes resulting in impairments.

Erosion of stream beds and banks also contribute to the pollutant loads received by the local waterbodies. Hydromodification from row crops and urban development create increases in runoff that cause major stream degradation and high erosion rates. Stream banks become near vertical and can lose connection with the floodplain, reducing the quality of aquatic habitat. Undeveloped and/or unfarmed space is limited along stream corridors and frequent issues with bank failure cause costly damages to local infrastructure and adjacent properties.

10.3.2 Priority Area - Papillion Creek

The Papillion Creek (MT1-10100) is impaired for *E. coli*. A detailed pollutant load model was developed to understand the sources and load allocations that contribute to the water quality impairment. The model utilizes concepts of the Simple Method (Schueler, 1987) and the Spreadsheet Tool for Estimating Pollutant Load (STEPL) (Tetra Tech, 2011). Both runoff and groundwater/baseflow contributions of pollutants will be predicted using simulated flow volumes. The ratio of surface to groundwater runoff was calibrated to match the baseflow index (BFI) for Papillion Creek, and pollutant concentrations based on land uses and flow pathways were applied. The Papillion Creek watershed is 257,283 total acres, and was broken into 10 subwatersheds on a HUC 12 basis for the purpose of pollutant load modeling (Figure 10-12).

Data collected and input into the model includes land-use, livestock numbers, septic systems, soil data (e.g., hydrologic soil group), rainfall depths, and existing conservation practices (identified via aerial photograph or discussions with the NRCS). Major inputs were downloaded from the STEPL data server (Tetra Tech, 2013) and refined using locally-available data. Stream bank erosion and gully information was input into the model based on a GIS analysis of stream bank slopes, soil information, and local knowledge of stream conditions.

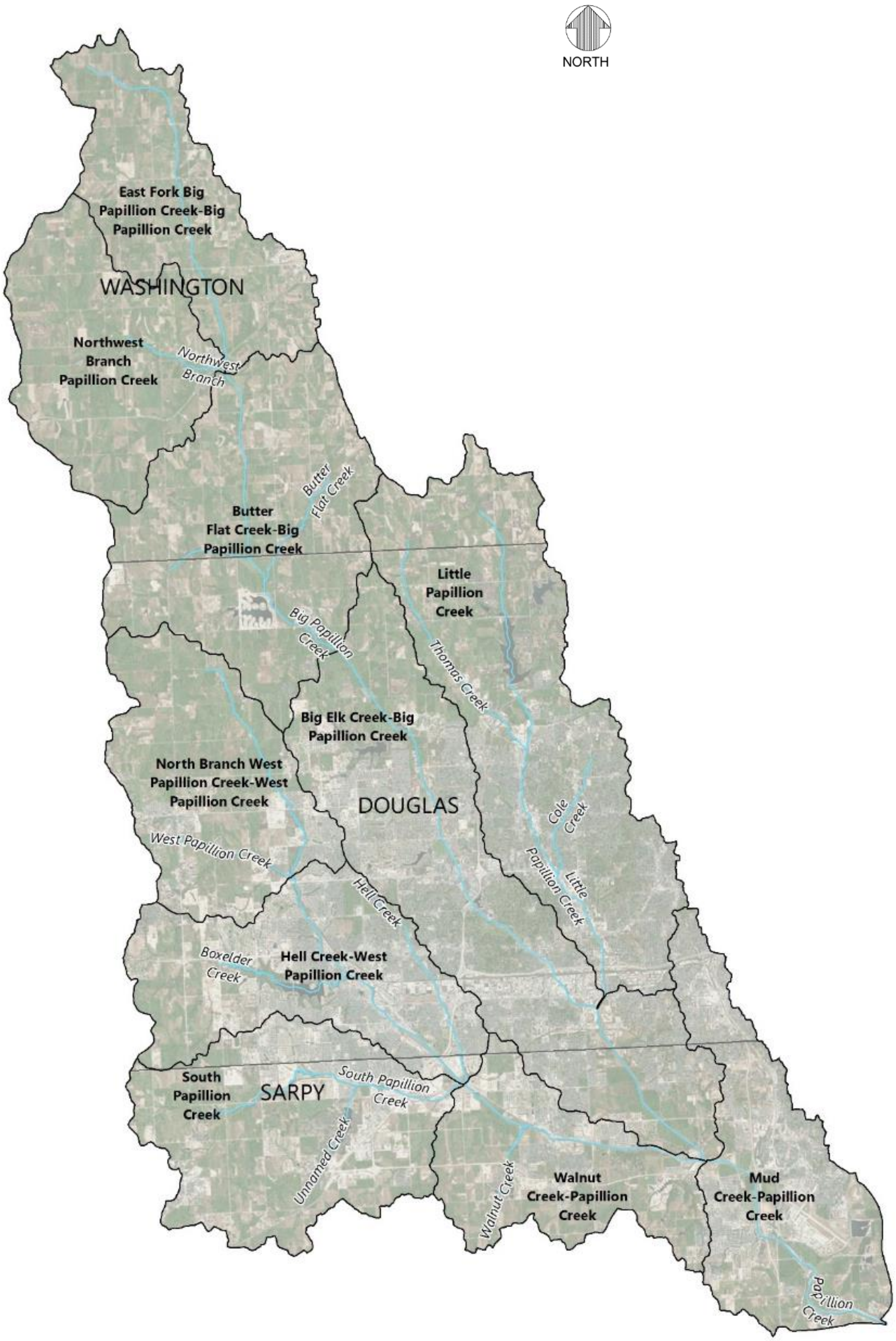

Figure 10-12. Papillion Creek Subwatersheds

Land use in the watershed is a near even split between urban and rural, as shown in Table 10-11.

Table 10-11. Land Use in the Papillion Creek Subwatersheds

Subwatershed	Urban (Acres)	Cropland (Acres)	Pasture (Acres)	Forest (Acres)	Feedlot (Acres)	Open Water (Acres)	Total (Acres)
North Branch West Papillion Creek	8,166	10,727	1,991	202	0	45	21,131
South Papillion Creek	12,654	10,710	1,504	151	0	237	25,256
Hell Creek-West Papillion Creek	17,536	3,416	1,256	268	0	320	22,796
Walnut Creek-Papillion Creek	8,068	6,431	1,889	345	0	146	16,880
Northwest Branch Papillion Creek	1,112	17,264	1,772	157	605	17	20,928
East Fork Big Papillion Creek-Big Papillion Creek	1,094	16,351	1,996	172	20	27	19,661
Butter Flat Creek-Big Papillion Creek	2,245	23,750	4,805	439	5	325	31,569
Little Papillion Creek	20,684	10,138	5,810	621	0	555	37,808
Big Elk Creek-Big Papillion Creek	29,012	7,100	2,974	485	1	253	39,825
Mud Creek-Papillion Creek	14,637	5,832	318	296	0	346	21,429
Subtotal Percent of Total	**115,209 (44.78%)**	**111,719 (43.42%)**	**24,314 (9.45%)**	**3,137 (1.22%)**	**631 (0.25%)**	**2,271 (0.88%)**	**257,283 (100%)**

Discussions with local NRCS staff were conducted to obtain understanding for the general practices in the watershed. Pastureland is limited to only 9.45% of the watershed and free range cattle grazing is not highly prevalent. Cropland dominates the rural setting covering 43% of the watershed, which receives land application of manure and/or grazing when crops are not present, which is the primary reason why runoff from cropland contributes to *E. coli* loading in the watershed.

There are less than 200 permitted LWCFs in the sub-watershed in addition to an unknown number of small unpermitted livestock operations. For a more accurate account of livestock in the pollutant load model, information was pulled from the USDA Census of Agriculture which reported 6,919 head of cattle within the Papillion Creek watershed.

Similarly, the NDEQ registered onsite wastewater systems are an underrepresentation of the actual number of farmsteads with septic systems, reporting less than one thousand in the watershed. More accurate information from the Environmental Services Center was gathered and used in the pollutant load model. This data estimates there are 7,840 septic systems in the Papillion Creek watershed where potential failure would likely lead to bacteria loading in the local stream.

There are two NPDES permitted discharges that are regulated for *E. coli* within the Papillion Creek watershed; Elkhorn WWTF and Mt. Michael WWTF. Urban sources not regulated by permits include pet waste, wildlife waste, and any human generated waste that enters runoff.

A portion of the City of Omaha CSO is located within the Papillion Creek watershed. Cole Creek and Little Papillion Creek receive CSO overflows from a system that drains approximately 5,600 acres and contains a population around 56,000 headcounts. The Big Papillion Creek and the main stem of Papillion Creek receive CSO overflows from a system that drains approximately 3,600 acres and contains a population around 55,000 headcounts.

The information described above was incorporated into the pollutant load model to estimate the existing E.coli load from the watershed. A summary of the modeled annual loading rates per source is provided in Table 10-12.

Table 10-12. Bacteria Sources and Annual Loading Rates

Source	Loading Rate	Units	Notes
Urban	7	billion cfu/ac	Runoff from urban and developed areas.
Cropland	45	billion cfu/ac	Runoff from row crop areas (both land receiving and not receiving manure application). This includes contributions from wildlife.
Pasture	4	billion cfu/ac	Includes both grazed and ungrazed grassland areas and includes contributions from wildlife.
Forest	3	billion cfu/ac	Timber and forest areas. Includes contributions from wildlife.
Feedlot	56	billion cfu/ac	Runoff from feedlot areas.
Onsite WW Treatment Systems	7	billion cfu/system	Failing or improperly functioning onsite wastewater treatment systems.
CSOs	51	billion cfu/ac	Combined sewer overflow contributions per acre of urban area in CSO watersheds.

10.3.3 Other Impairments in Priority Area

Standing Bear Lake (MT1-L0100)

Impairment: Total Phosphorus, Total Nitrogen, Hazard Index compounds, Mercury, Sediment

Standing Bear Lake is located on a tributary to the Big Papillion Creek in northwest Omaha with a 3,840 acre drainage area. The watershed has been transitioning from agricultural land use, when the dam was closed in 1977, to urban (Figure 10-13). The pollutant loads, especially sediment, generated during construction are elevated due to the disturbed and bare ground. Currently, the entire watershed is near full build out. The only development that is ongoing is one small 20 acre subdivision that has been graded but has not begun the construction of homes. There is only a small amount of pasture and/or undeveloped open space that could have any future development.

The current land use is summarized in Table 10-13. While the lake is impaired for sediment and it was receiving very high sediment loads, the transition to primarily urban area will create a drastic decrease in sediment loading. The nutrients produced from residential lots from fertilizers is now the most prevalent sources of phosphorus and nitrogen to the lake. Once a pollutant is introduced to the lake, it can settle to the bottom. If resuspended via wind or wave action, this can be reintroduced into the water column and is referred to as internal loading. Internal loading can also take place from plant or fish die-off and organic matter settling to the bottom and will release nutrients back into the water column over time. However, in reservoirs, these loads have the opportunity to pass through the principal spillway and out of the waterbody, opposed to oxbows or sandpits that generally do not have an outlet.

Figure 10-13. Standing Bear Lake Watershed

Table 10-13. Land Use in the Standing Bear Watershed

Land Use	Area (ac)	% Watershed
Urban	2,758	72%
Cropland	87	2%
Pasture	518	13%
Park and Lake	477	12%
Total	3,840	100%

Thomas Creek (MT2-101111.2)

Impairment: Aquatic Community

Thomas Creek is listed as impaired due to impaired aquatic community with an unknown pollutant of concern. NDEQ's Nebraska Stream Biological Monitoring Program (2004-2008) Technical Report (NDEQ, 2011) reports the results of Regional Environmental Monitoring and Assessment Program (R-EMAP) performed across the state of Nebraska. The R-EMAP provides ratings for each stream evaluated for the following metrics:

- Fish Index of Biotic Integrity (IBI)
- Invertebrate Community Index (ICI)
- Nebraska Habitat Index (NHI)

Thomas Creek received a "Poor" rating for ICI metrics and a "Fair" rating for NHI metrics, which placed it on the impaired list.

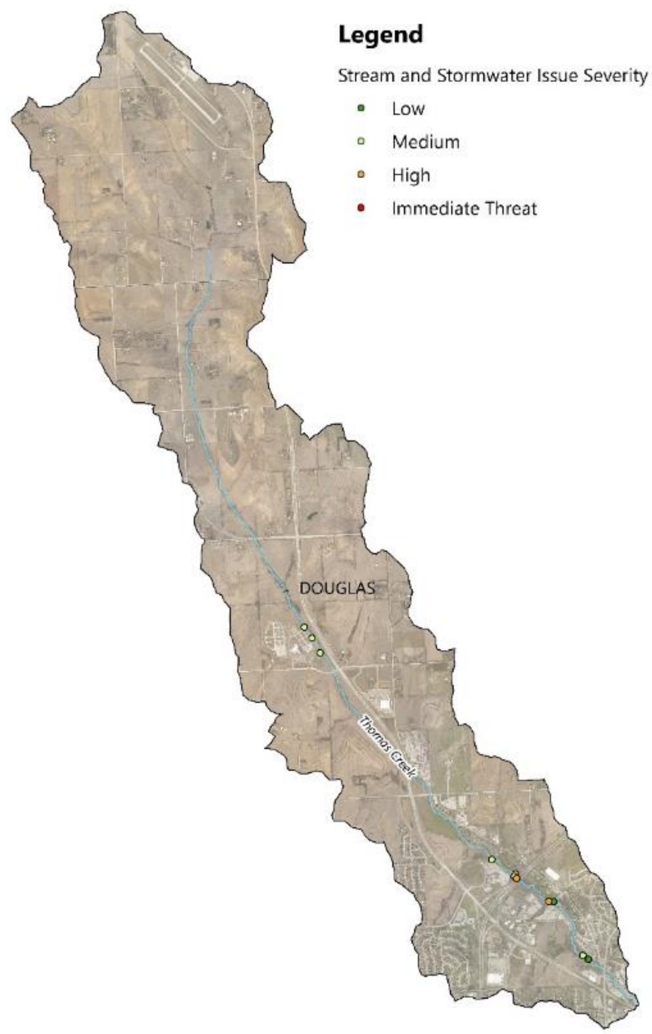

Figure 10-14. Thomas Creek Watershed

Since the aquatic community impairment is not tied to a specific pollutant, a more qualitative discussion on the cause is provided instead of a source assessment. The majority of Thomas Creek is located on the outskirts of Omaha with an agricultural watershed dominated by cropland. Thomas Creek enters into industrialized/urban area approximately three miles before the confluence with Little Papillion Creek, with a total drainage area of 6,895 acres. Thomas Creek is a fairly straight stream with very little sinuosity. There are very minimal riparian buffers; most vegetation is limited to the bank side slopes. There are very limited trees beyond the top of banks, and crops are generally planted right up to the edge of the bank. The stream stability analysis did not show banks with unstable slopes, which allows for better vegetative cover along the stream banks. However, the City of Omaha investigation identified locations of stream instability due to bank erosion/widening and channel incision in the lower reaches of the stream. The NDEQ findings from the biological monitoring information are consistent with these observations. It is clear there is not suitable habitat for a healthy aquatic community in the stream.

10.4 POLLUTANT LOADS

Pollutant loads were assessed for Papillion-Bell Creek Watershed on a watershed-size scale (10.4.1) and assessed in detail for the Papillion Creek (Priority Area, 10.4.2), and on the additional impairments within the watershed for Standing Bear Lake and Thomas Creek (10.4.3).

10.4.1 General Watershed

USGS SPARROW data for phosphorus, nitrogen and sediment were used to provide a general understanding of the watershed loads. The SPARROW model relates in-stream water quality measurements to spatially referenced characteristics of watersheds to imperially estimated pollutant loads. This method provides perspective within the watershed as to where the loads are the highest for each constituent, and overlaying these results will show 'hot spots' that likely contribute the greatest overall load. The hot spot analysis was performed on a Basin wide scale, and the results for the Papillion-Bell Creek watershed are presented on Figures 10-15 through 10-18. Exact loading numbers from this methodology were not used for Priority Area modeling, as a more detailed pollutant load model was developed.

The USGS SPARROW model does not analyze *E. coli* data. A search of the available NDEQ and USACE sampling data reveal there is only *E. coli* data for waterbodies within the Papillion Creek, which is the Priority Area, and is discussed in greater detail in 10.4.2. There was not enough available data to perform a watershed-wide analysis of *E. coli* loading for the Papillion-Bell Creek Watershed.

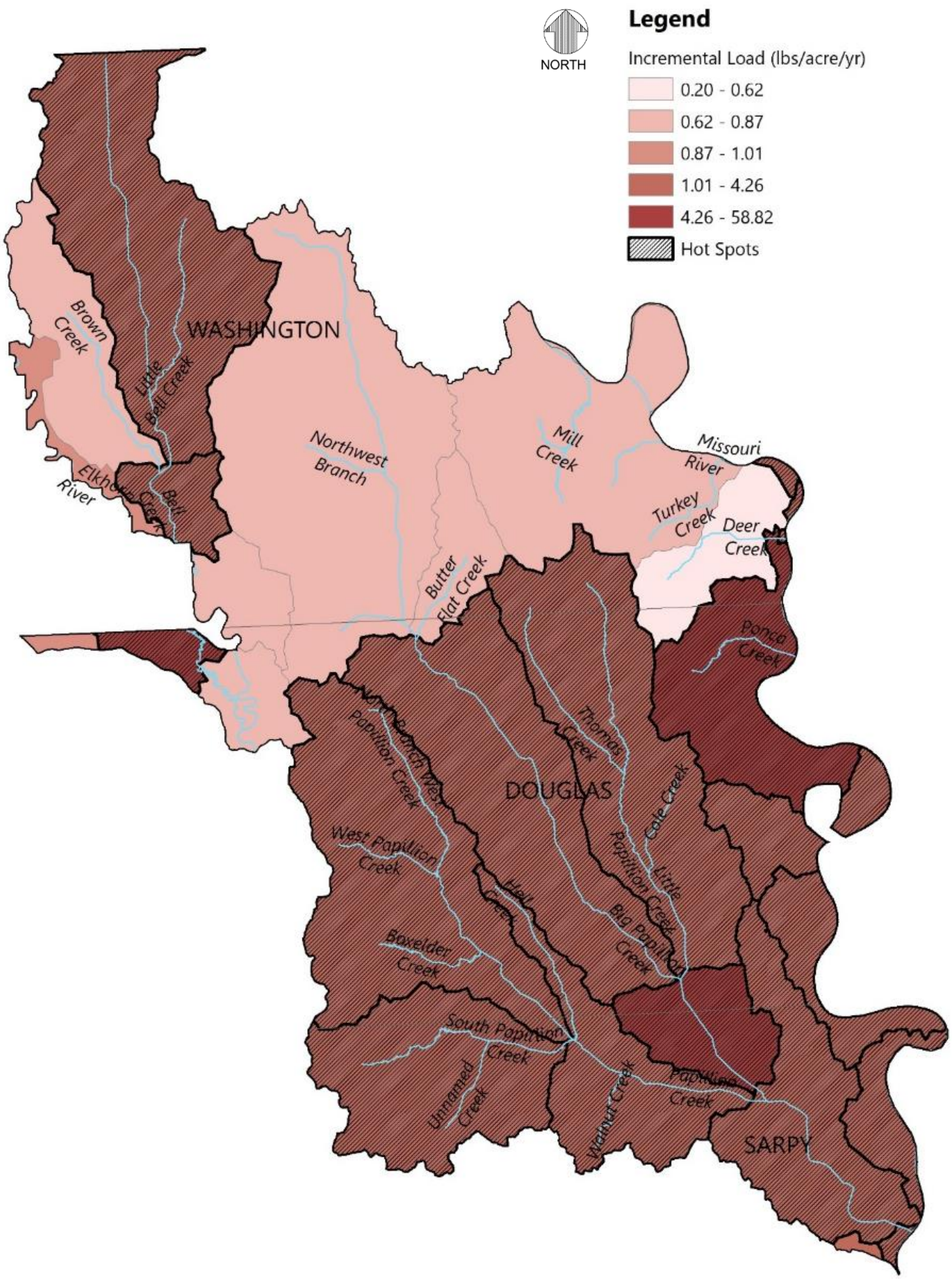

Figure 10-15. SPARROW Analysis- Phosphorus Results

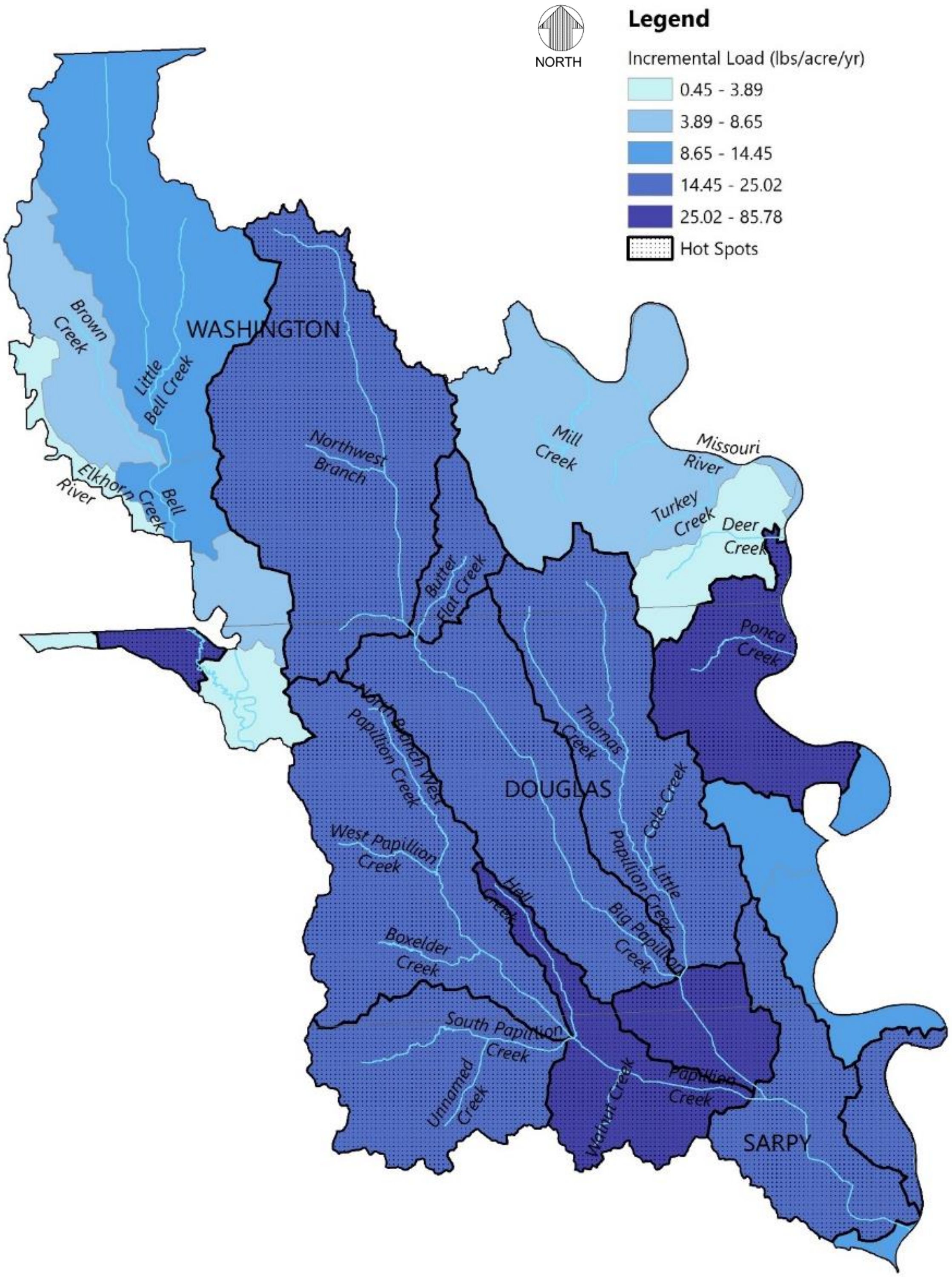

Figure 10-16. SPARROW Analysis- Nitrogen Results

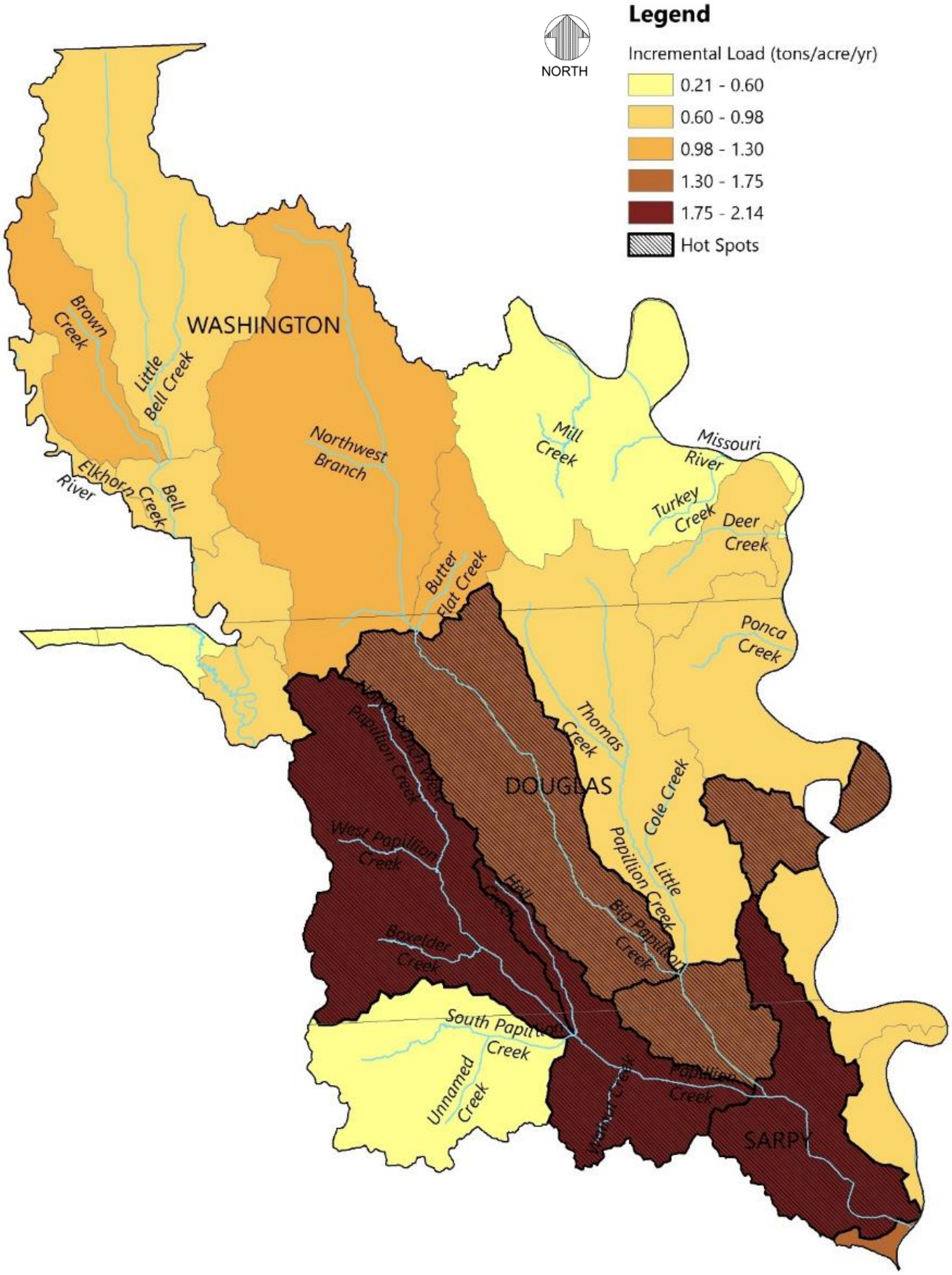

Figure 10-17. SPARROW Analysis- Sediment Results

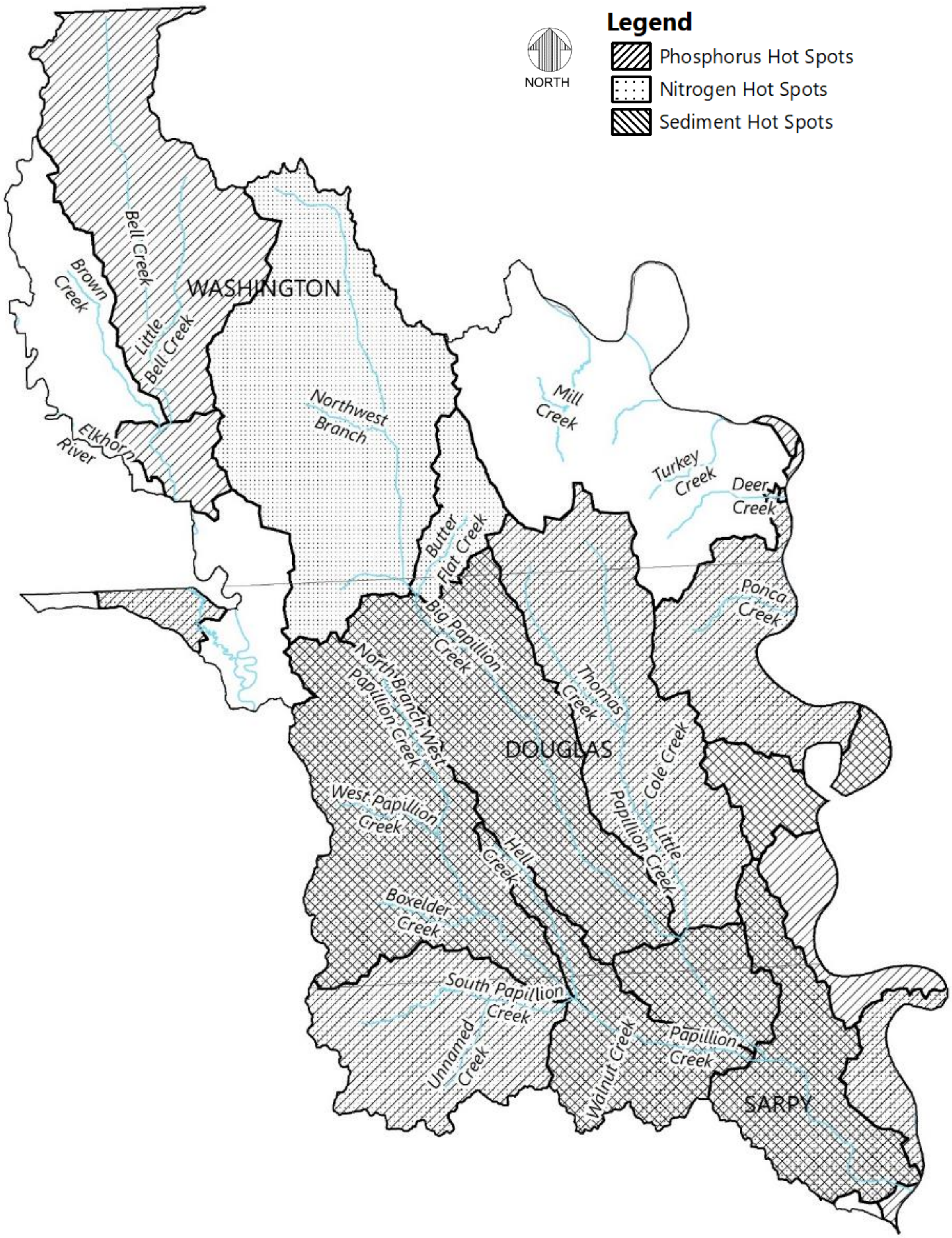

Figure 10-18. SPARROW Analysis- Hot Spots for Combination of Nitrogen, Phosphorous, Sediment

As shown in Figures 10-15 through 10-18, the SPARROW modeling results identified the majority of the Papillion-Bell Creek watershed as a hot spot for at least one pollutant. The Papillion Creek watershed has multiple hot spots overlaying each other, which was a prime reason that it was selected as the Priority Area for this Plan (see 5.5). This is consistent with the local observations and numerous impairments throughout the watershed.

10.4.2 Priority Area – Papillion Creek

The existing *E. coli* load was calculated for six segments in the Papillion Creek watershed during the development of the TMDL. NDEQ also performed a TMDL-like analysis for *E. coli* bacteria for the main stem of the Papillion Creek (MT1-10100), referred to as the 5-Alt. The data used by NDEQ to perform the 5-Alt is summarized in Table 10-14 to 10-15.

Table 10-14. 5-Alt Flow Data Source

Data Sources	Flow Data				Location		Drainage Area at Gauge (sq mi)	Drainage Area of Segment	Flow Ratio
	Site	Range	Owner	Name	Lat	Long			
USGS	6610795	2012-2015	USGS	Papillion Creek at Fork Crook Rd. Omaha, NE	41.118	-95.938	384.0	401.0	1.04

Table 10-15. 5-Alt Flow Water Quality Data Source

Data Sources	Water Quality Data				Location		
	Site	Range	Owner	Name	Lat	Long	WBID
NDEQ	SMT1PAPIO165	2010	NDEQ	Papillion Creek at Fork Crook in Omaha, NE	41.1178	-95.938	MT1-10100

Table 10-16 reports the resulting seasonal geometric mean from the TMDL and the 5-Alt for the stream segments analyzed in the Papillion Creek watershed. These analyses present the "load" in terms of concentrations rather than a mass per unit of time. However, there are total bacteria count loads that are associated with these concentrations that have been divided out by the total runoff volume.

Table 10-16. *E. coli* Impaired Stream Segments Addressed in TMDLs and 5-Alt

Waterbody Name	Segment	TMDL Seasonal Geometric Mean (col/100 mL)	5-Alt Seasonal Geometric Mean (col/100 mL)
Papillion Creek	MT1-10100	1,708	2,719
Big Papillion Creek	MT1-10110	1,705	n/a
Little Papillion Creek	MT1-10111	2,288	n/a
Cole Creek	MT1-10111.1	4,104	n/a
Big Papillion Creek	MT1-10120	1,605	n/a
Papillion Creek	MT1-10200	848	n/a

A pollutant load model was developed for the Papillion Creek. Once the initial conditions were input and the model output was observed, the model was refined to correspond to the 2005 TMDL results. Since the TMDL reports geometric means for six segments, this provided the opportunity to refine the model more accurately on a six subwatershed basis. Once TMDL refinement was completed, the model was calibrated again to correspond to the more current 5-Alt results. The process involved gathering spatially distributed precipitation data from 8 USGS and NOAA gaging stations in the study area and final model calibration utilized 2010 data. The model was also refined to better reflect load contributions from CSO in urban-residential land use areas, using the 2010 census data to estimate contributing population and CSO service area maps provided by the City of Omaha. Nutrient and *E.coli* concentrations in both urban and agricultural runoff were adjusted to correspond with literature approved values used in NDEQ/EPA approved plans. Wildlife load contributions were estimated based on information provided by the Nebraska Game and Parks Commission. BMP efficiencies were updated to reflect newer study results and research from sources such as the Pennsylvania Department of Environmental Protection and Massachusetts Department of Environmental Quality, as discussed and referenced in Chapter 7.

The *E. coli* load modeling results are presented in Tables 10-17 to 10-18 and Figures 10-19 to 10-21. The total annual bacteria count is presented in Table 10-17, as well as the corresponding seasonal geometric mean that is within 1.5% of the reported 5-Alt value of 2,719 col/100 mL.

Table 10-17. Modeled Existing *E. coli* Loads

Subwatershed	Annual Existing Bacteria Load (Billions of CFU)	Percent Total	Seasonal Geometric Mean (col/100 mL)
North Branch West Papillion Creek	357,149	4%	1,594
South Papillion Creek	527,323	6%	1,548
Hell Creek-West Papillion Creek	217,067	2%	916
Walnut Creek-Papillion Creek	322,168	3%	1,429
Northwest Branch Papillion Creek	970,728	10%	2,750
East Fork Big Papillion Creek-Big Papillion Creek	988,915	11%	2,679
Butter Flat Creek-Big Papillion Creek	1,450,164	16%	2,469
Little Papillion Creek	2,079,267	22%	5,295
Big Elk Creek-Big Papillion Creek	717,168	8%	1,731
Mud Creek-Papillion Creek	1,695,225	18%	5,878
Total	**9,325,174**	**100%**	**2,717**

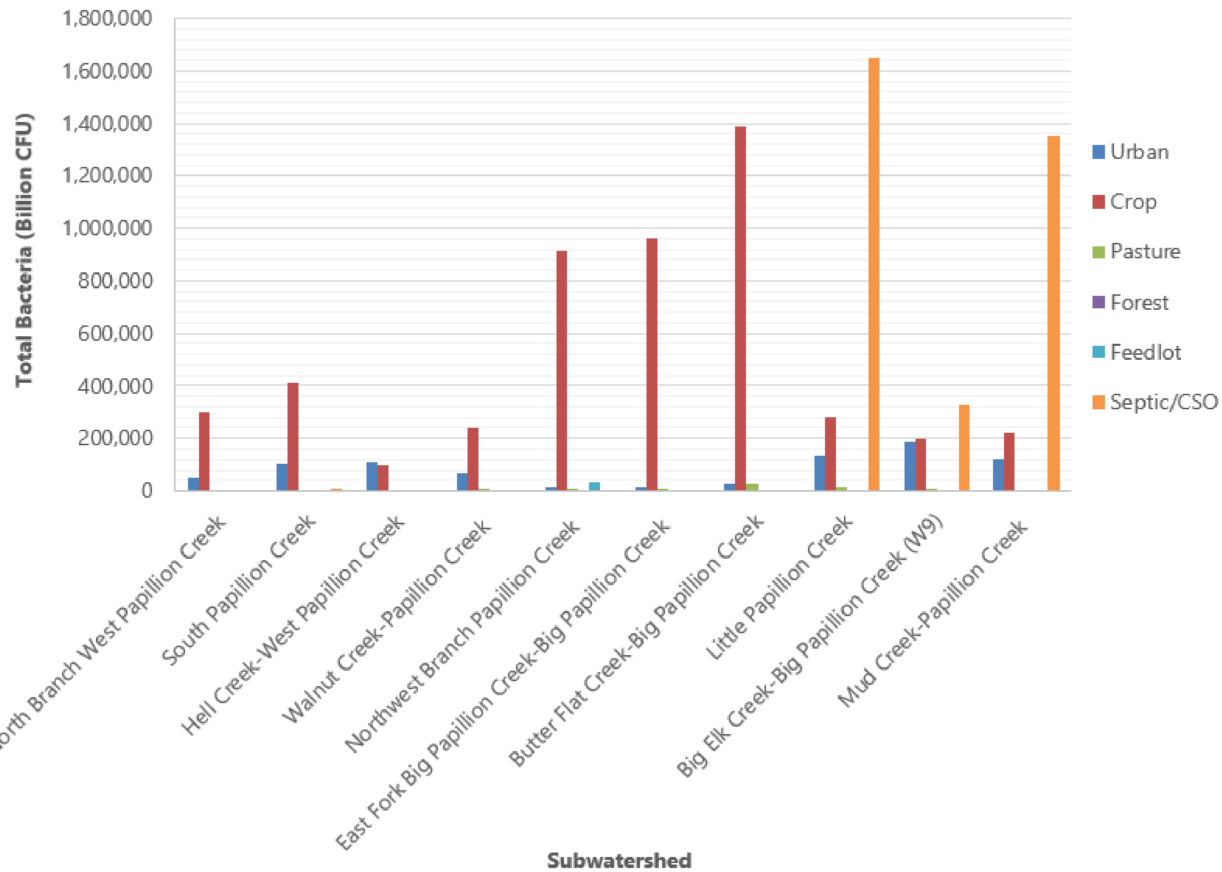

Figure 10-19. Modeled Existing E. coli Load Allocation

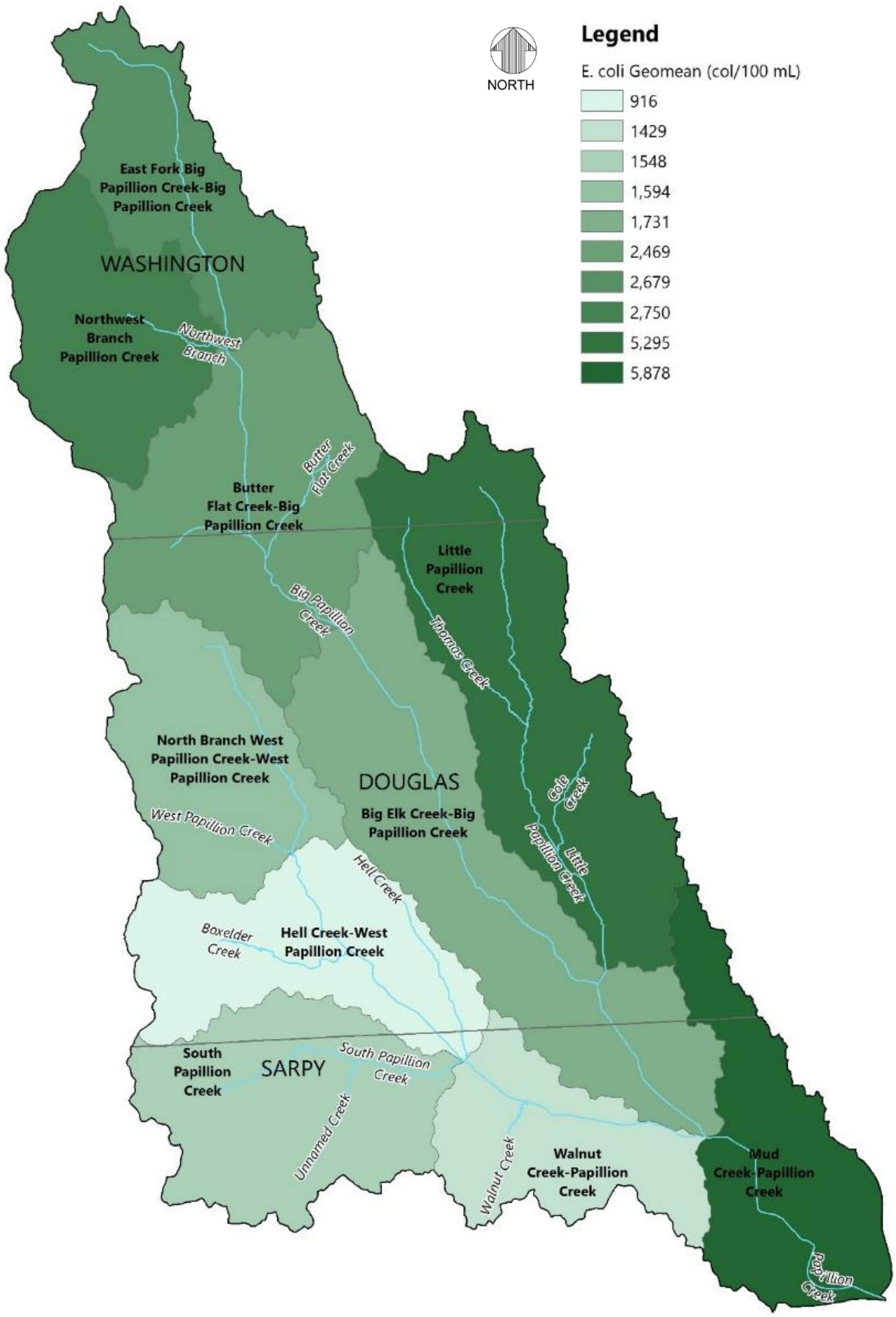

Figure 10-20. Subwatershed E.coli Seasonal Geometric Means

Table 10-18. *E. coli* Load Source Allocation

Source	Annual Existing Bacteria Load (Billions of CFU)	Percent Total
Urban	826,902	9%
Cropland	5,008,741	54%
Pastureland	93,035	1.00%
Forest	8,660	0.09%
Feedlots	35,463	0.38%
CSO	3,299,549	35%
Septic	52,825	0.6%
Total	**9,325,174**	**100%**

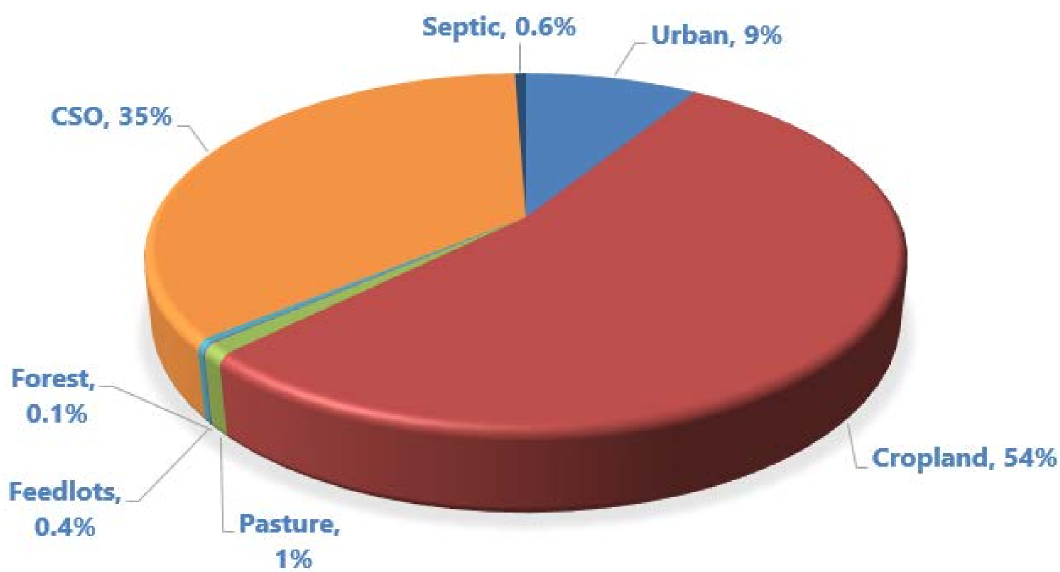

Figure 10-21. E. coli Load Source Allocation

While the Papillion Creek is not listed as impaired for nutrients and sediment, multiple benefits can be realized from best management practice implementation. Phosphorus, nitrogen and sediment were also included in the pollutant load modeling in order to track the reductions to all pollutant loads. Existing conditions for phosphorus, nitrogen and sediment are presented in Tables 10-19 to 10-21 and Figures 10-22 to 10-24 based on the Papillion Creek watershed mode results and are not the SPARROW values presented in previous sections. Nutrient loads include contributions from groundwater, see 10.3.2.

Table 10-19. Modeled Existing Phosphorus Loads

Subwatershed	Annual Total Phosphorus Load (lbs)	% Annual Total Phosphorus Load
North Branch West Papillion Creek	26,646	7%
South Papillion Creek	40,532	11%
Hell Creek-West Papillion Creek	38,430	10%
Walnut Creek-Papillion Creek	20,944	5%
Northwest Branch Papillion Creek	55,538	14%
East Fork Big Papillion Creek-Big Papillion Creek	40,447	11%
Butter Flat Creek-Big Papillion Creek	62,569	16%
Little Papillion Creek	31,641	8%
Big Elk Creek-Big Papillion Creek	37,329	10%
Mud Creek-Papillion Creek	29,984	8%
Total	**384,061**	**100%**

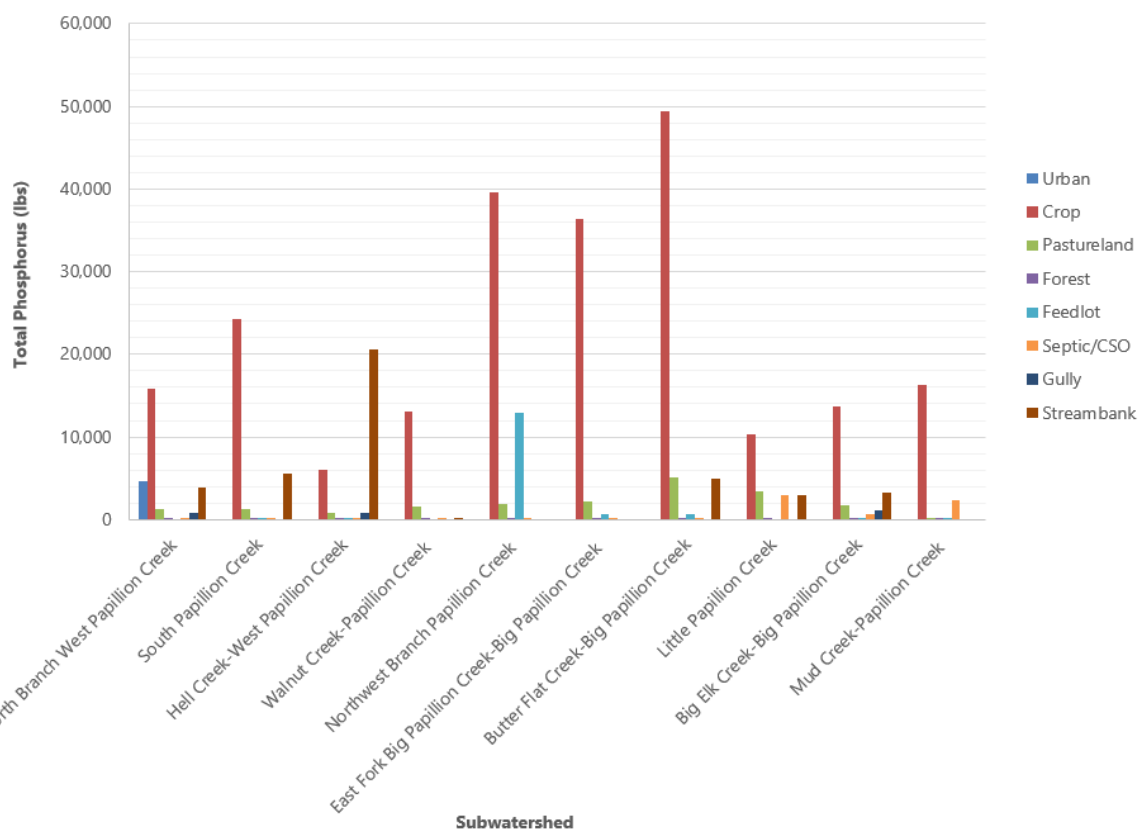

Figure 10-22. Modeled Existing Phosphorus Load Allocation

Table 10-20. Modeled Existing Nitrogen Loads

Subwatershed	Annual Total Nitrogen Load (lbs)	% Annual Total Nitrogen Load
North Branch West Papillion Creek	144,715	7%
South Papillion Creek	213,130	10%
Hell Creek-West Papillion Creek	178,722	8%
Walnut Creek-Papillion Creek	124,634	6%
Northwest Branch Papillion Creek	320,882	15%
East Fork Big Papillion Creek-Big Papillion Creek	237,459	11%
Butter Flat Creek-Big Papillion Creek	367,952	17%
Little Papillion Creek	210,070	10%
Big Elk Creek-Big Papillion Creek	223,753	10%
Mud Creek-Papillion Creek	168,918	8%
Total	**2,190,235**	**100%**

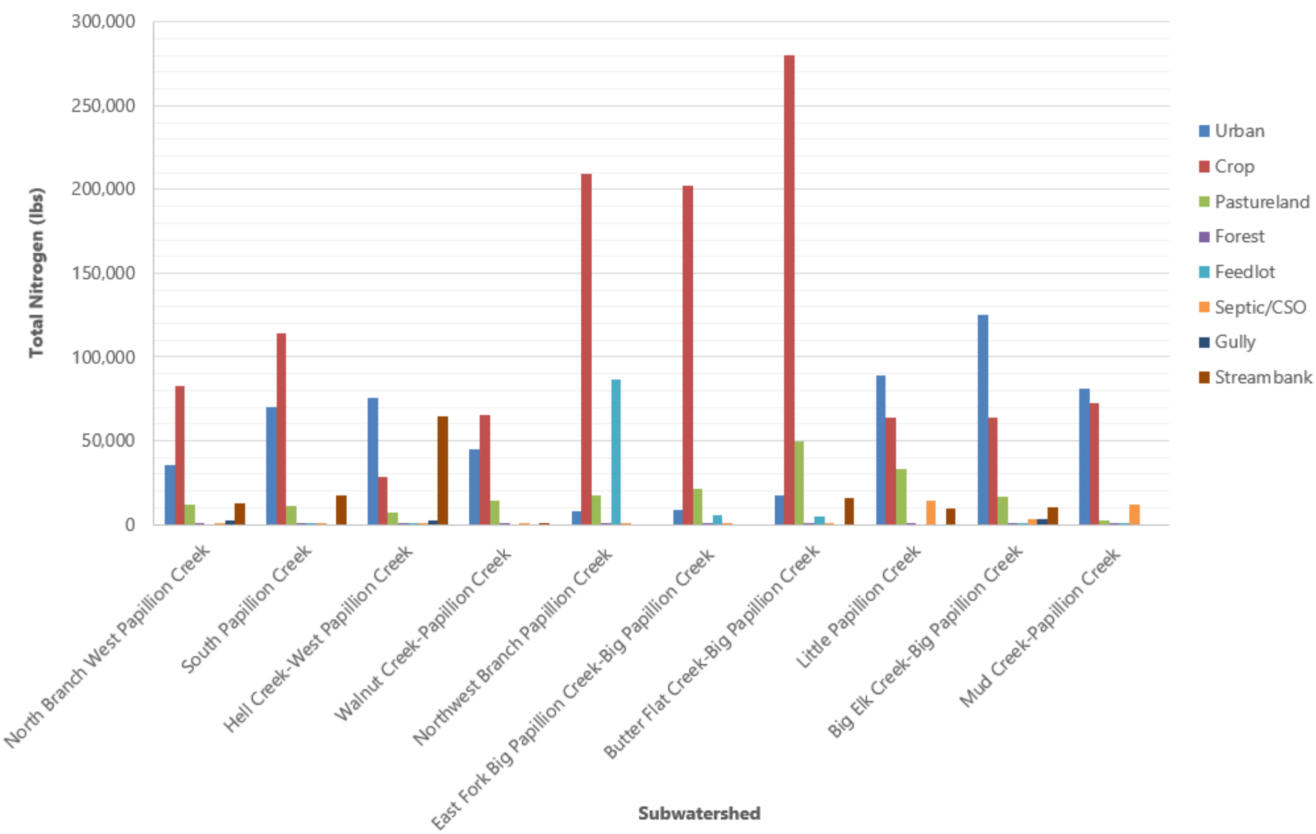

Figure 10-23. Modeled Existing Nitrogen Load Allocation

Table 10-21. Modeled Existing Sediment Loads

Subwatershed	Annual Existing Sediment Load (tons)	% Annual Total Sediment Load
North Branch West Papillion Creek	8,858	8%
South Papillion Creek	12,106	11%
Hell Creek-West Papillion Creek	20,081	19%
Walnut Creek-Papillion Creek	4,720	4%
Northwest Branch Papillion Creek	10,601	10%
East Fork Big Papillion Creek-Big Papillion Creek	9,515	9%
Butter Flat Creek-Big Papillion Creek	16,838	16%
Little Papillion Creek	7,258	7%
Big Elk Creek-Big Papillion Creek	9,652	9%
Mud Creek-Papillion Creek	5,734	5%
Total	**105,362**	**100%**

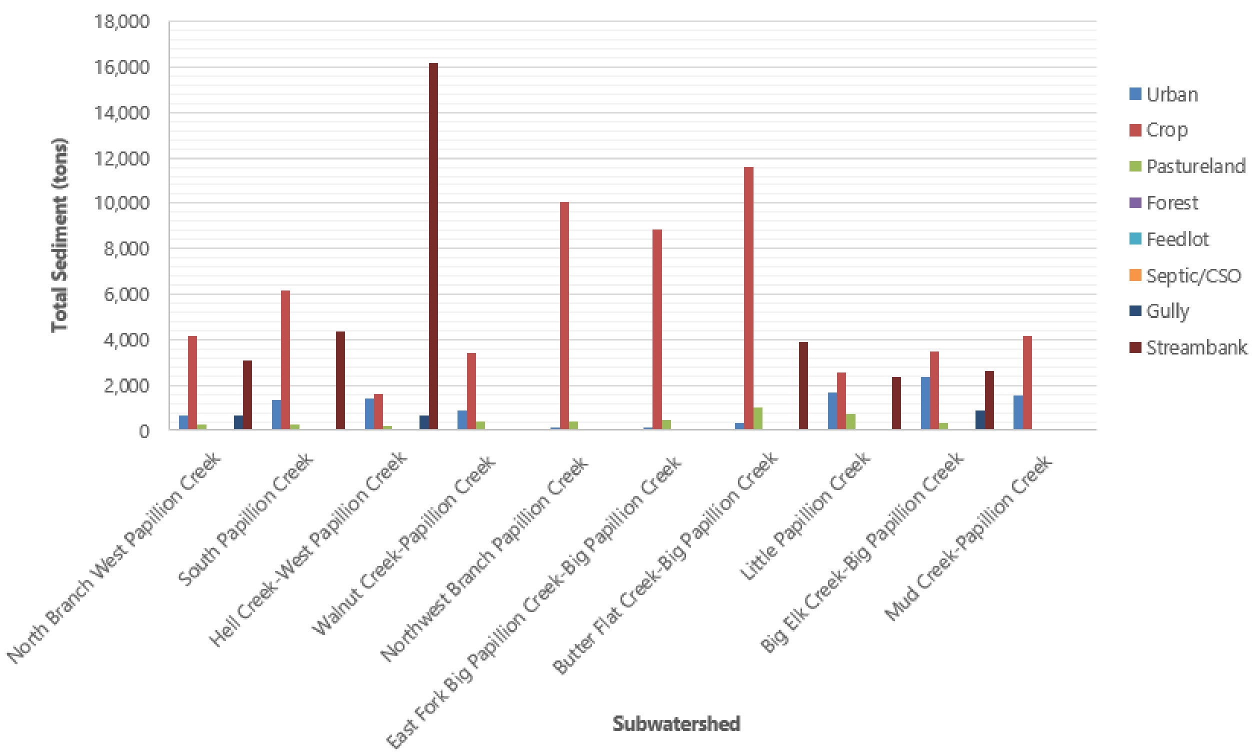

Figure 10-24. Modeled Existing Sediment Load Allocation

10.4.3 Other Impairments in Priority Area

Standing Bear Lake (MT1-L0100)

Impairment: Total Phosphorus, Total Nitrogen, Hazard Index compounds, Mercury, Sediment

A TMDL was developed in 2003 that addressed sediment and phosphorus pollutants of concern, therefore these are the two constituents that were modeled. Data used for the TMDL was from 1990 to 1998, reporting a phosphorus concentration of 60 µg /L. More current data was obtained from NDEQ from 2010 to 2015 that also reported an average concentration of 60 µg/L. A summary of the current data is presented in Table 10-22 that represents the conditions of Standing Bear Lake as a result of the pollutant loading from the watershed.

Table 10-22. Nutrient and Chlorophyll Concentrations for Summit Lake

	Data Period	Average Concentration
Total Phosphorus (µg/L)	2010-2015	60
Total Nitrogen (µg/L)	2010-2015	1,090
Chlorophyll *a* (mg/m^3)	2010-2015	36.77

Source: USEPA STORET

Additionally, bathymetric surveys have been performed on the lake to monitor the sedimentation that has occurred. As mentioned previously, that rate of sediment delivery peaked during development, and is tapering off with the area nearing full build out. A survey in 1989 showed the reservoir had lost 15% capacity, and a survey in 2002 showed approximately 18% of the permanent storage volume had been lost to sediment. This shows the rate has decreased along with the completion of the development.

Table 10-23. 2002 Standing Bear Conservation Pool Loss Summary

Condition	Value
Original Volume (acre-ft)	1,504
2002 Volume (acre-ft)	1,240
Volume Loss (acre-ft)	264
Percent Loss	18%

The existing sediment and nutrient loads were modeled for Standing Bear Lake. There are existing best management practices in place within the watershed, including detention basins and wetlands on tributaries of the lake, dry detention in the watershed, and terraces on the small field of row crops, which were considered in the analysis (Figure 10-25). The detention basins have aged and silted in over time, therefore treatment from the detention basins was assumed to be only 40% of their original effectiveness. A summary of the loading that reaches Standing Bear Lake is presented in Table 10-24.

Figure 10-25. Existing BMPs in Standing Bear Lake Watershed

Table 10-24. Existing Conditions Load Summary

	Phosphorus (lbs/yr)	Nitrogen (lbs/yr)	Sediment (tons/yr)
Modeled Watershed Load	1,759	13,667	329
Existing BMP Load Reductions	567	3442	126
Load to Lake	1,192	10,225	203

Although the TMDL was developed in 2002, physical characteristics (i.e. lake concentration, surface area and volume) applied to the EUTROMOD model used to calculate the load to the lake, experienced very minor changes when compared the most current data available (Table 10-25). Therefore, it was expected that the modeled phosphorus loads from each analysis would be similar. This indicated that there is likely very little internal loading, however this should be investigated further during project implementation. As expected, the sediment load data has drastically decreased along with the near full build out of the watershed.

Table 10-25. TMDL and Current Data Comparison

	TMDL Data		Most Current Data	
	Value	Year	Value	Year
Phosphorus Concentration (ug/L)	60	1990-1998	60	2010-2015
Surface Area (acres)	104	1998	116	2002
Volume (acre-ft)	1,249	1998	1,240	2002
Modeled Phosphorus Load (lbs/yr)	1,191	2002	1,192	2017
Modeled Sediment Load (tons/yr)	4,544	2002	203	2017

Thomas Creek (MT2-101111.2)

Impairment: Aquatic Community

Since the aquatic community impairments are not tied to a specific pollutant, load modeling was not performed. Based upon the R-EMAP assessment, the cause of the impairment is the lack of riparian vegetation and habitat for aquatic life. There are over 20,000 ft of stream that has no buffer or very limited riparian buffer width. Figure 10-26 shows an example of two different fields that reflect the two main conditions of buffers identified in the agricultural portion of the watershed. The one to the north of the county road has no buffer and the tree canopy removed. The field to the south has a buffer of approximately 10 ft with the tree canopy in place.

Figure 10-26. Thomas Creek Riparian Buffer Example

Towards the downstream reach of Thomas Creek, buffer conditions slightly improve with a wider tree canopy and development primarily setting back between 20 to 100 ft from the top of bank. The stream is incising and banks are eroding, as shown on Figure 10-27. There are vertical banks with no vegetation, and mass bank failure and stream widening has been occurring. Tributaries from the developed area to Thomas Creek are forming gullies at the discharge locations. These instability issues are caused by increased runoff when changes occur from native prairie conditions to agricultural and developed/impervious areas. Under such unstable conditions, there is very limited habitat to support aquatic life.

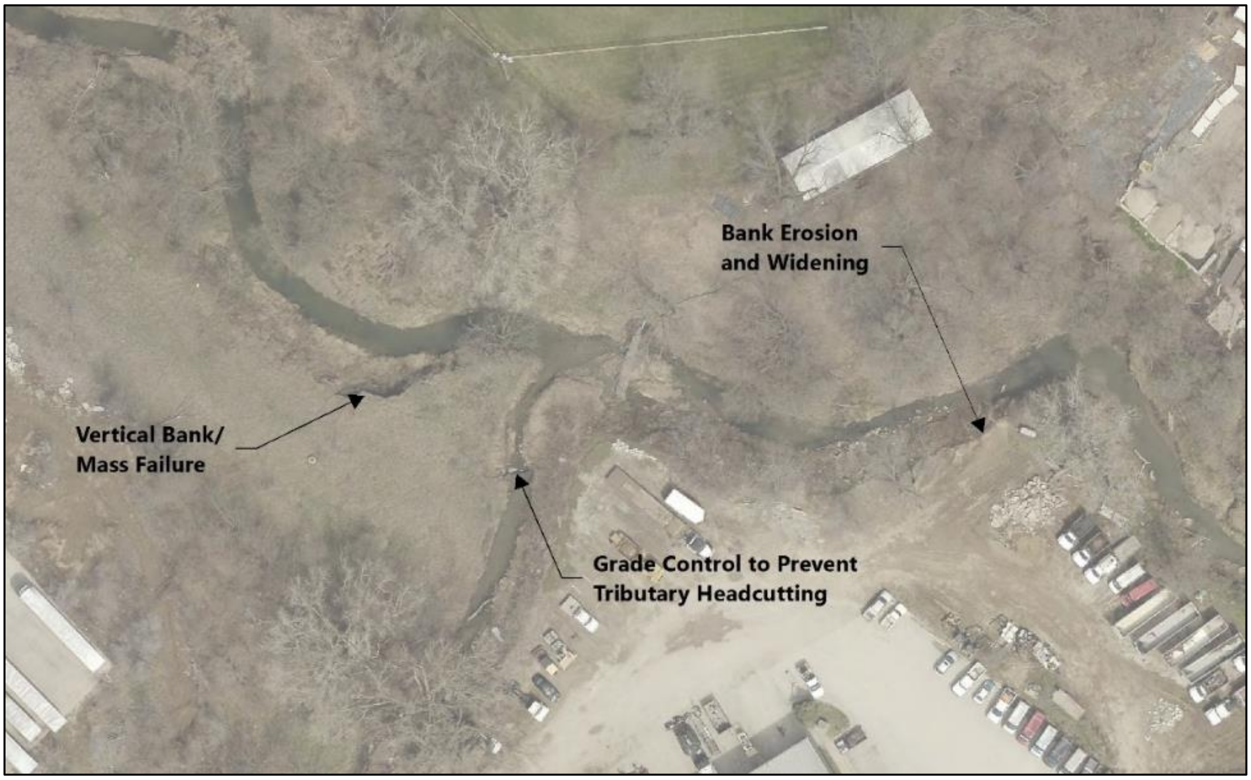

Figure 10-27. Thomas Creek Stream Instability Example

10.5 POLLUTANT LOAD REDUCTIONS

Pollutant load reductions are typically calculated with the goal of meeting water quality standards for a given parameter. The State of Nebraska currently has no stream standards for sediment or nutrients, therefore, reductions identified for stream segments are associated with reaching *E. coli* standards. No detailed watershed load modeling was performed in the Papillion-Bell Creek watershed outside the Priority Area. Detailed load reductions and BMPs for Papillion Creek (Priority Area) and Standing Bear Lake were developed, and recommendations for improvements to Thomas Creek are provided.

10.5.1 General Watershed

The SPARROW analysis indicated that the entire Papillion-Bell Creek watershed has sediment and nutrient loading rates where the receiving waterbodies would benefit from the implementation of load reducing best management practices. For land outside of the Priority Area, conservation practices listed in Chapter 7 that would apply to each land use should be pursued to reduce the loading rates throughout the watershed.

10.5.2 Priority Area – Papillion Creek

The expected seasonal geometric means from the TMDL and the 5-Alt are presented in Table 10-26 below. Both sets of data were used in the analysis, and the 5-Alt expected seasonal geometric mean was used to set the load reduction goal.

Table 10-26. TMDL and 5-Alt Expected *E. coli* Load Reductions

Waterbody Name	Segment	TMDL Seasonal Geometric Mean			5-Alt Seasonal Geometric Mean		
		Existing (col/ 100 mL)	Expected (col/ 100 mL)	Percent Reduction	Existing (col/ 100 mL)	Expected (col/ 100 mL)	Percent Reduction
Papillion Creek	MT1-10100	1,708	102	94	2,719	109	96
Big Papillion Creek	MT1-10110	1,705	102	94	n/a	n/a	n/a
Little Papillion Creek	MT1-10111	2,288	92	96	n/a	n/a	n/a
Cole Creek	MT1-10111.1	4,104	82	98	n/a	n/a	n/a
Big Papillion Creek	MT1-10120	1,605	112	93	n/a	n/a	n/a
Papillion Creek	MT1-10200	848	110	87	n/a	n/a	n/a

A future conditions model was developed to determine the necessary best management practices required to reach the *E. coli* expected seasonal geometric mean from the 5-Alt. Future conditions assumed complete CSO separation through the City of Omaha's ongoing efforts. Full build out of each city's Extraterritorial Jurisdiction (ETJ) was assumed with compliance to the WQ LID ordinance that was developed through the PCWP. Neither CSO separation or best management practices used to comply with WQ LID are eligible for 319 funding, and were not included in the budget developed for this Plan in Section 10.11.

Priority best management practices for the Priority Area listed in Table 10-27 were selected based on their effectiveness in targeting bacteria. It is more effective to eliminate pollutants from entering the watershed rather than treating them once introducing. It is suggested to follow the NRCS's ACT system for selecting the most effective practices.

Table 10-27. Priority Best Management Practices

Best Management Practice	Avoid	Control	Trap
Rural			
Cover Crop	X		
Manure and Land Application Management	X		
Livestock Exclusion/Alternate Water Source	X		
Riparian Buffers		X	X
Terraces	X	X	
Sediment Control Basins			X
Wet Detention Basins*			X
Grassed Waterways			X
Onsite Waste Treatment System Management	X		
Runoff Management Systems	X		
Urban			
Pet Waste Management	X		
Stream Stabilization		X	X
Wet Detention Basins*			X
Rain Gardens			X
Bioinfiltration Systems			X
*Includes water quality structures identified in the PCWP plan; does not include structures required for WQ LID compliance.			

Best management practices were inserted into the future conditions model to determine how much was required to meet the load reduction goal. With a very aggressive goal of 96% removal, several management practices often had to be implemented in series to reach efficiencies high enough to achieve sufficient removal. Nearly every acre in the watershed had to receive at least some form of treatment to meet the goal. This resulted in the recommendations including very high quantities for each practice applicable for the land uses present, as shown in Table 10-28.

Table 10-28. Recommended Best Management Practices and Load Reductions

BMP or Action[1, 2]	Quantity	Units	Area Treated (acres)	Modeled Annual Load Reduction			
				E.coli (billions of CFU)	Phosphorus (lbs)	Nitrogen (lbs)	Sediment (tons)
CSO Separation (not 319 eligible)	1	lump sum	9,314	3,299,549	5,819	29,097	0
WQ LID on Converted/ Developed Area (not 319 eligible)	71,319	acres	71,319	1,394,213	82,846	204,825	23,517
Cover Crop	71,319	acres	71,319	630,585	20,910	152,061	15,969
Manure and Land Application Management	71,319	acres	71,319	941,171	4,402	28,547	0
Livestock Exclusion	243	acres	24,314	65,124	11,016	33,015	3,541
Riparian Buffers	679	acres	17,948	193,386	11,015	17,756	1,754
Terraces[3]	5,337,200	ft	53,372	252,086	24,266	68,922	4,123
Sediment Control Basins	214	each	21,396	201,644	4,688	18,596	423
Grassed Waterways	5,337,200	ft	53,372	277,307	10,940	38,400	818
Wet Detention Basins	20	each	16,512	282,591	12,604	91,359	17,923
Onsite Waste Treatment System Management	2,117	private system	n/a	52,825	274	699	0
Runoff Management Systems	200	each	695	7,754	4,558	27,042	0
Stream Restoration	32.0	miles	10,275	24,396	3,201	9,006	604
Pet Waste Management	62,244	acres	62,244	115,027	1,591	13,001	0
Rain Gardens[4]	177,840	each	62,244	244,155	30,936	110,877	0
Bioinfiltration Systems	54,463	each	54,463	188,311	18,102	94,799	3,559
Soil Health Management or Source Tracking	undetermined			782,044	n/a	n/a	n/a
Total Load Reduction				8,952,167	247,170	938,003	72,231
Existing Load				9,325,174	384,061	2,190,235	105,362
Expected Load				373,007	136,891	1,252,232	33,131
Percent Load Reduction				96%	64%	43%	69%
Expected Seasonal Geometric Mean				109	n/a	n/a	n/a
Seasonal Geometric Mean Goal				109	n/a	n/a	n/a

[1]BMPs pertaining to cropland: fields that a) don't receive manure as fertilizer and/or b) aren't grazed are unlikely to contribute E. coli load reductions. Therefore, 319 money should not be spent on BMPs installed on cropland w/out manure inputs. Those BMPs may count as match funds.
[2]Any BMPs implemented with 319 funds within the MS4 are intended to implement protections above and beyond permit requirements.
[3]Terraces are not listed in the NPSMP as a BMP that addresses E. coli. Therefore, 319 funds should not be spent on terraces. Those BMPs may count as match funds.
[4]Rain gardens and biofiltration are eligible BMPs for 319 implementation but should be implemented at a rate commensurate with the urban loadings of E. coli relative to the impairment

Results of the analysis represent the following findings:

- Cover crops are implemented on 100% of cropland.
- Manure and Land Application Management reduces the amount of manure applied to cropland by one-third.
- Riparian buffers are implemented along 56 mi of stream in cropland with a 50 ft width on each side.
- Terraces are implemented to treat 74% of cropland.
- Sediment control basins are implemented to treat 30% of cropland, controlling 100 acres per basin.
- Grassed waterways are implemented to treat 74% of cropland.
- 20 wet detention basins control 16,512 acres based on locations identified in PWCP plan.
- Onsite waste treatment system management assumes all septic systems are inspected and any failing systems are repaired (model assumed 27% failure rate).
- Stream restoration projects are implemented along 32 miles of degrading streams in urban area.
- Pet waste management will be a watershed-wide outreach effort, but assumed compliance resulted in 100% of residential area reducing the amount of pet waste in private lots by 31%.
- Rain garden education will be an urban-wide outreach effort, but assumed compliance resulted in implementation of rain gardens to treat 100% of residential lots, assuming one garden per lot, as well as 100% of institutional areas/schools.
- Bioinfiltration systems are implemented to treat 100% of commercial developments and 100% of industrial developments.
- Some lingering loads were still present after applying multiple practices in series. The last approximately 5% of the load would need to be reduced using newer practices such as soil health management (discussed in more detail in Chapter 7) or source tracking to more accurately target and identify sources (see Monitoring, Section 10.9).

10.5.3 Other Impairments in Priority Area

Standing Bear Lake (MT1-L0100)

Impairment: Total Phosphorus, Total Nitrogen, Hazard Index Compounds, Mercury, Sediment

The loading capacity of the lake was developed in the TMDL for sediment and phosphorus. The same characteristic reported in Table 10-29 were used, except for the phosphorus concentration was reduced to 48 µg/L. Even though this TMDL was written before the state standard of 50 µg/L was established, the loading capacity developed will exceed the reduction needed to meet the updated guideline. Therefore, the loading capacity of 778 lbs is used for the future loading goal and will determine the necessary load reductions that are needed from recommended best management practices.

Table 10-29. Standing Bear Lake Phosphorus Load Summary

Condition	Value
Existing Load (lbs/yr)	1,192
Loading Goal (lbs/yr)	778
Reduction (lbs/yr)	413
Reduction (%)	37%

The load capacity for sediment was determined to be 10,000 tons/yr. Modeled sediment loading indicated an annual watershed load of 203 tons/yr, which is well below the loading capacity. Therefore, sediment was not used for modeling load reduction requirements. However, recommendations will be provided for addressing the sedimentation impairment.

A set of suitable best management practices for the watershed were selected and modeled to determine what strategies can be utilized to reach the 413 lb/yr phosphorus load reduction (see Table 10-30). It was determined that rehabilitating the existing wet detention basins would provide the greatest reduction. The rehabilitation may not require complete excavation of accumulated sediment, specifically in areas of established wetlands. The rehabilitation would likely include a combination of excavation for increased storage capacity to allow for settlement of sediment attached phosphorus, and creation of a settling forebay at the inlet of existing or new wetlands. This should be investigated further during project implementation. Additional recommendations to reduce phosphorus loading include one in-lake sediment forebay on the south side on the farthest tributary to the east that has no existing detention basin, a grassed waterway in the cropland, rain gardens throughout the watershed and a no-low phosphorus fertilizer outreach effort. The load reductions associated with each best management practice are listed in Table 10-30.

Table 10-30. Standing Bear Lake Phosphorus Load Summary

BMP or Action[1]	Quantity	Units	Area Treated (acres)	Phosphorus (lbs/yr)	Nitrogen (lbs/yr)	Sediment (tons/yr)
Wet Detention Basin Rehabilitations	4	each	2,626	197	1,501	38
Sediment Forebay	1	each	166	28	210	5
Low-No Phosphorus Fertilizer	3940	lots	1,379	74	197	0
Rain Gardens[2]	354	each	124	24	123	0
Grassed Waterway	500	ft	87	94	203	31
Total Load Reduction				417	2,234	74
Existing Load				1,192	10,225	203
Expected Load				775	7,991	130
Percent Load Reduction				35%	22%	36%
Load Goal				778	n/a	10,000

[1]*Any BMPs implemented with 319 funds within the MS4 are intended to implement protections above and beyond permit requirements.*
[2]*Rain gardens and biofiltration are eligible BMPs for 319 implementation but should be implemented at a rate commensurate with the urban loadings of E. coli relative to the impairment*

The low-no phosphorus fertilizer and rain garden best management practices will rely on public participation as a result of outreach efforts. Although the outreach will be watershed-wide, it was not assumed that there would be 100% participation. The quantities for these practices were adjusted to determine the amount that would be needed in order to reach the goals on top of the other best management practices that were recommended. The results reported above, indicate that 50% of the urban area in the watershed needs to comply with the no-low phosphorus recommendation and 4.5% of the urban area is treated with rain gardens, assuming one garden per lot. The number of rain gardens recommended is not in addition to those in the Priority Area – Papillion Creek. This table identifies the quantity that is to be incorporated specifically in the Standing Bear Lake watershed and is included in the totals that were recommended in Section 10.5.2.

To address the sedimentation impairment on the lake, it is recommended that the volume of the main body of lake be restored to its original storage capacity. It is not recommended that the developed wetlands west of the road, 144th Street, be excavated, but excavating the main body down to original depths would sufficiently address the sedimentation impairment. It is also recommended that any eroding banklines be stabilized to prevent direct sedimentation into the lake. It is recommended approximately 35% of the bankline should be stabilized. A summary of these recommendations are provide in Table 10-31.

Table 10-31. Standing Bear Sediment Impairment Recommendations

Best Management Practices	Quantity	Units
Main Body Excavation	425,920	CY
Bank Stabilization	5,000	ft

Thomas Creek (MT2-101111.2)

Impairment: Aquatic Community

The goal for Thomas Creek is to make improvements that would result in improved ICI and NHI metrics to produce a minimum of a "Good" rating in the R-EMAP assessment (or approved equal by NDEQ). This would be achieved with items that will improve the physical and habitat measurements of the creek, primarily including riparian buffers and stream restorations. The riparian buffer should not only improve the vegetative cover, but also reintroduce and/or increase tree canopy cover. Buffers should extend a minimum of 50 ft from the top of the bank on each side, and be planted with native grasses. Stream restorations will vastly improve stream stability and the ability to provide aquatic habitat. Designs would stabilize stream grades to reduce streambed incision that leads to bank failure and stream widening, as well as to promote pool and riffle formation. Bank slopes would be stabilized and regraded to allow increased vegetation cover, improved plant species and promote overhanging vegetation. The recommendations for each are provided in Table 10-32. However, note that these are not in addition to those recommended in the Priority Area – Papillion Creek. This table identifies the quantity that is to be incorporated specifically on Thomas Creek which are already included in the totals that are recommended in Section 10.5.2. This emphasizes the need for these management practices since they will be working towards improving the *E. coli* and Aquatic Community impairments.

Table 10-32. Thomas Creek Best Management Practices

Best Management Practices	Quantity	Units
Riparian Buffer	49	acres
Stream Restoration	3.5	miles

10.6 COMMUNICATION AND OUTREACH

The guiding principles of the Papillion Creek Watershed Partnership (PCWP) are cooperation, community participation, and comprehensive watershed planning. With this partnership already in place, the Papillion Creek watershed has an existing method of communicating to all impacted local governing agencies. The PCWP hosts open meetings have and will continue to be held to gather public input. The nine government bodies each decide independently to adopt common policies, and also lead individual outreach efforts. The contents of this Plan will be presented to PCWP and used for future planning.

Tasks for conducting public outreach for the Priority Area have been developed and will be used as a guide during plan implementation.

10.6.1 General Items in Priority Area

Task 1: Hire Watershed Coordinator

Task 2: Develop and implement PID strategy for each educational outreach effort identified in Section 6.4. Each will target the audience identified, and produce and deliver the necessary educational information to encourage participation.

10.6.2 Private/Cost Share Practices

Task 1: Develop funding program through which cost share can be orchestrated

Task 2: Develop a PID for promoting the participation in recommended practices

Task 3: Track participation and implementation

10.6.3 Agency Led Projects

Task 1: Focus relevant educational outreach PID efforts in the project watershed

Task 2: Hold two open houses: one to inform public of project and gather input, and the second to present the final outcome.

10.7 IMPLEMENTATION SCHEDULE

A detailed timeline was developed for the first 5 years until the Plan needs to be updated. It is not possible to accurately predict a schedule for implementing all recommendations. During the next update, the schedule can be revisited and adjustments can be made accordingly.

Table 10-33. Papillion-Bell Creek Watershed Timeline

Action (unit)		2017	2018	2019	2020	2021	2022+	
Papillion Creek	**# Planned**						**Remaining**	
Cover Crop (acres)	71,319		2,000	5,000	5,000	5,000	54,319	Reassess with plan updates
Manure and Land Application Management (acres)	71,319		5,000	10,000	10,000	10,000	36,319	
Livestock Exclusion	243		10	20	20	20	173	
Riparian Buffers* (acres)	630		25	50	50	50	455	
Terraces (ft)	5,337,200		10,000	10,000	10,000	10,000	5,297,200	
Sediment Control Basins (each)	214		10	30	30	30	114	
Grassed Waterways** (feet)	5,336,700		20,000	20,000	20,000	20,000	5,256,700	
Wet Detention Basins (each)	20		2	2	2	2	12	
Onsite Waste Treatment System Management (each)	2,117		10	40	40	40	1,987	
Pet Waste Management (acres)	50		1	1	1	1	46	
Stream Restoration* (miles)	29						29	
Rain Gardens** (each)	177,486			20	40	40	177,386	
Bioinfiltration Systems** (each)	54,463			5	10	10	54,438	
Soil Heath Management/Source Tracking (lump sum)	1						1	
Thomas Creek								
Riparian Buffers (acres)	49		5	5	5	5	29	
Stream Restoration (miles)	3.5				3.5		0	
Standing Bear								
Wet Detention Basin Rehabilitations (each)	4					4	0	
Sediment Forebay (each)	1					1	0	
Rain Gardens** (each)	354			50	50	50	204	
Grassed Waterways (feet)	500					500	0	
Main Body Excavation (CY)	425,920					425,920	0	
Shoreline Stabilization (feet)	6,000					6,000	0	
No-Low Phosphorus Fertilizer (acres)	1,379			200	200	200	779	

*Items to be implemented in Thomas Creek watershed that will improve Aquatic Community impairment; quantity for Thomas Creek subtracted out of total number recommended in Papillion Creek and included below

**Items to be implemented in Standing Bear Lake watershed that will improve Nutrient and Sedimentation impairment; quantity for Standing Bear Lake subtracted out of total number recommended in Papillion Creek and included below

10.8 MILESTONES FOR MEASURING IMPLEMENTATION PROGRESS

Milestones have been developed that should be used as a guide and will assist in tracking the steps to be taken to achieve substantial pollutant load reductions. Multiple projects can be initiated at the same time. The milestones identified for projects that receive 319 funds is reported in Table 10-34.

Table 10-34. Implementation Milestones

<table>
<tr><th>Milestone</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th colspan="2">2022+</th></tr>
<tr><td>Continued CSO separation (not 319 eligible)</td><td colspan="7">Ongoing</td></tr>
<tr><td>Hire Watershed Coordinator</td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Work with NRCS to designate priority watershed status for EQIP and set up/implement supplemental cost share</td><td>X</td><td colspan="5">Ongoing</td><td rowspan="9">Reassess with plan updates</td></tr>
<tr><td>Identify projects and apply for 319 funding</td><td>X</td><td></td><td>X</td><td></td><td>X</td><td></td></tr>
<tr><td>Align all funding partners and apply for additional grants</td><td>X</td><td></td><td>X</td><td></td><td>X</td><td></td></tr>
<tr><td>Complete Project Implementation Plan (PIP) for approved projects</td><td></td><td>X</td><td></td><td>X</td><td></td><td>X</td></tr>
<tr><td>Public outreach for 319 approved projects</td><td></td><td colspan="5">Ongoing</td></tr>
<tr><td>Design, permit and construct projects</td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Project monitoring</td><td></td><td></td><td>X</td><td></td><td>X</td><td></td></tr>
<tr><td>NDEQ rotation monitoring</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>Update Plan</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
</table>

10.9 EVALUATION CRITERIA

The ultimate purpose of establishing sound evaluation criteria is to improve approaches to manage nonpoint source pollution by learning from both successes and failures. In doing so, evaluation criteria has been established to assess all aspects of implementing this plan which includes implementation strategies, educational programs, monitoring networks, and overall project management. In order to facilitate a useful evaluation, each project should have clear and concise goals and objectives. Each nonpoint source project will undergo a post project review which will be conducted by the sponsor. The review process should answer the following key questions:

- What techniques and approaches worked?
- What techniques and approaches didn't work?
- What were the major road blocks?
- Did the project fully solve the problem that it was designed to address?
- What lessons were learned that can be applied to future projects?

Post project reviews will take into account both quantitative and qualitative metrics. Quantitative metrics will require the collection and assessment of environmental data. Review criteria will be summarized and included in final project reports.

Qualitative Metrics – Project Implementation and Administration

1. Project completed on time
2. Project completed on budget
3. Success in meeting project goals
4. Success of meeting project milestones
5. Positive and negative feedback from stakeholders
6. Required information delivered to agencies and funding partners
7. Problematic areas of the project and necessary changes for future efforts
8. Adequate technical and financial support of the project

Quantitative Metrics – Environmental Outcomes

9. Status of meeting measurable project objectives
10. Performance of management practices – pollutant load reductions
11. Changes in stream water quality, habitat, or biological communities
12. Changes in lake water quality, habitat, or biological communities
13. Progress in meeting water quality standards
14. Removal from the Section 303(d) list

Many nonpoint source projects do not result in immediate and measurable changes in water quality. The evaluation of metrics 10 through 15 may require long term monitoring commitments.

10.10 MONITORING

Future monitoring will generally be consistent with the ambient monitoring and rotating basin monitoring scheme utilized by NDEQ. Optional additional monitoring could be conducted to isolate areas of concern and to focus resources to address identified problems, as well as monitor the progress of project implementation. Periodically, NDEQ will conduct compliance monitoring at NPDES permitted facilities to verify permit limitations are being adhered to. Facilities are selected either randomly or in response to inspection or reported information.

Source Tracking

Analytical techniques have been introduced that may provide a greater level of confidence in the identification of pollutant sources. These techniques include microbial source tracking and specialized sampling that identifies the species of origin (cattle, swine, human) from which the bacteria were produced. It is recommended to perform source tracking to assist in more accurately identifying sources, as well as tracking reductions.

Pre and Post-Project Monitoring for *E. coli* Projects

Pre-and post-project monitoring is recommended to determine the effectiveness of best management practices installed. While there is existing stream sampling data, the locations are not specific enough to isolate the impacts of individual projects. If an owner is interested in understanding the load reduction achieved through a specific project, then it will be necessary to perform the water quality sampling detailed below.

<u>Water Quality Sampling</u>

- Parameter: *E. coli* bacteria
- Locations: 2 sites, one upstream and one downstream of project
- Conditions: No rain one week prior to sampling
- Sampling Period: May to September
- Targeted number of samples: 10

Lake Restoration Project Monitoring

Post-project monitoring is recommended if the project owner if interested in determining if the goals of the project have been met. The parameters below should be tested once a month from May to September to build a sufficient set of data for analysis.

- Dissolved phosphorus
- Total phosphorus
- Total nitrogen
- Total suspended solids
- Dissolved oxygen (surface to bottom profiles)
- Chlorophyll a
- Water clarity
- Temperature, pH, Conductivity (surface to bottom profiles)

Aquatic Community Project Monitoring

Project owners/agencies can be trained in the rapid bio-assessment protocol or other NDEQ approved methods for monitoring the physical habitat. This is recommended for stream restoration projects once a year for five years to ensure that the impairment has been addressed.

10.11 WATERSHED BUDGET

A budget was developed to implement all recommendations, as well as a budget for the first five years. Items are notated that include design and permitting costs in addition to the construction. These are generally larger structures that required substantial time to design and permit, and these costs need to be considered in the overall budget. Costs for public outreach and production of educational materials are included as a single lump sum line item to cover all practices that require public outreach.

Table 10-35. Papillion-Bell Creek Watershed Total Budget

Best Management Practices	Quantity	Units	Unit Cost	Total
Papillion Creek				
Cover Crop	71,319	acres	$90	$6,418,745
Manure and Land Application Management	71,319	acres	$50	$3,565,969
Livestock Exclusion/Alternate Water Source	243	each	$2,000	$486,281
Riparian Buffers	679	acres	$800	$543,200
Terraces	5,337,200	ft	$8	$42,697,600
Sediment Control Basins*	214	each	$65,000	$13,910,000
Grassed Waterways	5,337,200	ft	$4	$21,348,800
Wet Detention Basins*	20	each	$1,300,000	$26,000,000
Onsite Waste Treatment System Management	2,117	each	$6,000	$12,702,000
Runoff Management System	200	each	$5,000	$1,000,000
Pet Waste Management	50	lump sum	$6,000	$300,000
Stream Restoration*	32	mile	$1,950,000	$62,400,000
Rain Gardens	177,840	each	$500	$88,920,000
Bioinfiltration Systems*	54,463	each	$7,500	$408,472,500
			Sub-Total	$688,765,095
Thomas Creek				
Riparian Buffers (acres)	49	acres	$1,000	$49,000
Stream Restoration (miles)	3.5	miles	$1,950,000	$6,825,000
			Sub-Total	$6,874,000
Standing Bear Lake				
Wet Detention Basin Rehabilitations*	4	each	$260,000	$1,040,000
Sediment Forebay*	1	ft	$80,000	$80,000
Rain Gardens	354	each	$600	$212,400
Grassed Waterways	500	ft	$5	$2,500
Main Body Excavation*	425,920	CY	$16	$6,814,720
Shoreline Stabilization*	6,000	ft	$175	$1,050,000
No-Low Phosphorus Fertilizer	3,940	lots	$20	$78,800
			Sub-Total	$9,278,420
Non-Structural				
Public Outreach and Education	50	yrs	$5,000	$250,000
Plan Updates	10	each	$25,000	$250,000

Additional Monitoring	50	yrs	$2,000	$100,000
Soil Health Management/ Source Tracking	1	lump sum	$50,000	$50,000
			Sub-Total	$11,007,220
*Design and permitting costs also included				

Table 10-36. Papillion-Bell Creek Watershed 5 Year Budget

Best Management Practices	2017	2018	2019	2020	2021	Total
Papillion Creek						
Cover Crop (acres)		$180,000	$450,000	$450,000	$450,000	$1,530,000
Manure and Land Application Management (acres)		$250,000	$500,000	$500,000	$500,000	$1,750,000
Livestock Exclusion/Alternate Water Source (each)		$20,000	$40,000	$40,000	$40,000	$140,000
Riparian Buffers* (acres)		$20,000	$40,000	$40,000	$40,000	$140,000
Terraces (ft)		$80,000	$80,000	$80,000	$80,000	$320,000
Sediment Control Basins (each)		$650,000	$1,950,000	$1,950,000	$1,950,000	$6,500,000
Grassed Waterways** (feet)		$80,000	$80,000	$80,000	$80,000	$320,000
Wet Detention Basins (each)		$2,600,000	$2,600,000	$2,600,000	$2,600,000	$10,400,000
Onsite Waste Treatment System Management (each)		$12,000	$12,000	$12,000	$12,000	$48,000
Pet Waste Management (yrs)		$6,000	$6,000	$6,000	$6,000	$24,000
Stream Restoration* (miles)		See Thomas Creek				$0
Rain Gardens* (each)			$10,000	$20,000	$20,000	$50,000
Bioinfiltration Systems** (each)			$37,500	$75,000	$75,000	$187,500
Sub-Total		$3,898,000	$5,805,500	$5,853,000	$5,853,000	**$21,409,500**
Thomas Creek						
Riparian Buffers (acres)		$8,000	$8,000	$8,000	$8,000	$32,000
Stream Restoration (miles)				$6,825,000		$6,825,000
Sub-Total		$8,000	$8,000	$6,833,000	$8,000	**$6,857,000**
Standing Bear Lake						
Wet Detention Basin Rehabilitations*					$1,040,000	$1,040,000
Sediment Forebay*					$80,000	$80,000
Rain Gardens			$25,000	$25,000	$25,000	$75,000
Grassed Waterways					$2,000	$2,000
Main Body Excavation*					$6,814,720	$6,814,720
Shoreline Stabilization*					$1,050,000	$1,050,000
No-Low Phosphorus Fertilizer			$10,000	$10,000	$10,000	$30,000
Sub-Total			$35,000	$35,000	$9,021,720	**$9,091,720**
*Design and permitting also included						

Additional clarifications include:

- Manure and Land Application Management costs include storing and/or composting manure for more effective application timing or selling of manure rather than placing all manure available at the facility.
- Pet Waste Management costs include installation and management of bag dispensers and collection.
- Onsite Waste Treatment System Management costs include septic system inspections and repairs.
- Low-No Phosphorus Fertilizer costs include soil testing to determine fertilizer needs.