CARTER LAKE

Water Quality Management Plan

May 2008

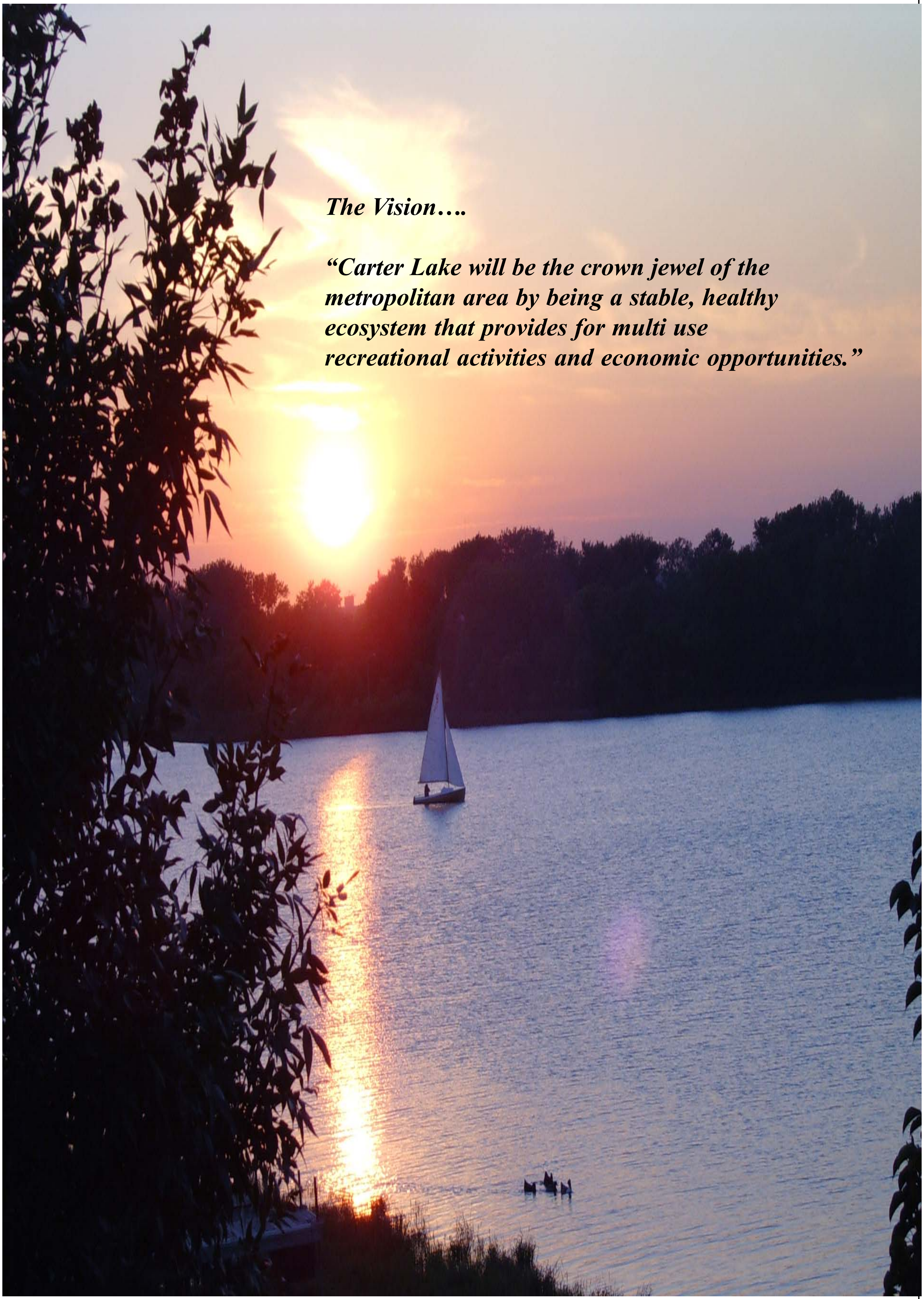
Project Sponsors:

City of Carter Lake

City of Omaha

Prepared by:

Carter Lake Environmental Assessment and Rehabilitation (CLEAR) Council



The Vision….

"Carter Lake will be the crown jewel of the metropolitan area by being a stable, healthy ecosystem that provides for multi use recreational activities and economic opportunities."

A Community-Based Water Quality Management Plan for Carter Lake Watershed

---

Project Sponsors

City of Carter Lake, Iowa
Russ Kramer, Mayor

City of Omaha
Mike Fahey, Mayor

Technical Advisory Team

City of Carter Lake, Iowa
Ron Rothmeyer

City of Omaha
Pat Slaven
Harald Flatoen

Iowa Department of Natural Resources
Mike McGhee
Chris Larson
Bryan Hayes

Nebraska Department of Environmental Quality
Paul Brakhage
Pat O'Brien
Deana Barger
Terry Hickman

Nebraska Game and Parks Commission
Mark Porath

Metropolitan Area Planning Agency
Paul Mullen
Lynn Dittmer

Papio-Missouri River Natural Resources District
Gerry Bowen

Iowa State University in West Pottawattamie County
Brad Richardson

Nebraska Department of Natural Resources
Steve Gaul
Josh Lear

University of Nebraska-Lincoln Extension in Douglas/Sarpy Counties
Steve Tonn

USDA Natural Resources Conservation Service
Dale Duval

Carter Lake Preservation Society
Jeanne Eibes
Jan Petersen
Joan Harder

West Pottawattamie County Soil & Water Conservation District
Kevin Seevers

Iowa Division of Soil Conservation
Bob Waters

Project Consultant:

Olsson Associates
Jason Farnsworth
Sara Hanson
Charles Ikenberry

CLEAR Water Council:

Peter Parkert	Doug Wallingford	Julie McKillip	Pam Christiansen
Pam Parkert	Stephanie Kelley	Merl Harder	Mike Dailey
Les Lundberg	Bill Van Trump	Doug Dodson	Bob Hegwood
Steve Wilbur	Hani Haider	Wayne Houston	

Foreword

The Community-Based Water Quality Management Plan for Carter Lake was instigated in response to a desire from watershed stakeholders to protect the water quality of Carter Lake for the support of aesthetic benefits, recreational use, aquatic and littoral wildlife and economic benefits.

The successful implementation of the community-based plan required the formation of partnerships between several state and local agencies from Iowa and Nebraska and interested watershed citizens. The City of Carter Lake and the City of Omaha joined forces with the Papio-Missouri River Natural Resources District, Iowa Department of Natural Resources, Nebraska Department of Environmental Quality, Nebraska Game and Parks Commission, Metropolitan Area Planning Agency, Iowa State University, Nebraska Department of Natural Resources, University of Nebraska-Lincoln Extension, Carter Lake Preservation Society, Iowa Division of Soil Conservation, and the West Pottawattamie County Soil and Water District. Representatives of these agencies formed a technical advisory team to assist the public in plan development.

Most importantly, this effort was based on the extensive involvement of interested and affected citizens, including watershed residents, businesses, and lake and recreational users. These stakeholders, together with the technical advisory team, developed a vision statement, identified goals, management alternatives, action plans and projects that, when implemented, would protect the water quality of Carter Lake.

The planning process also included an information and education component. By raising the awareness of the public's role in maintaining and improving the water quality of Carter Lake, a foundation was laid for a strong local partnership.

The development of the water quality management plan was largely funded by two grants. The first was a Watershed Project Development Grant from the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, and administered through the West Pottawattamie County Soil and Water Conservation District. The second grant was received from the Nebraska Department of Environmental Quality, funded by Section 319 of the Clean Water Act and administered by the Environmental Protection Agency through the Nebraska Department of Environmental Quality.

List of Figures

List of Acronyms

BMP – Best Management Practices
CLEAR – Carter Lake Environmental Assessment and Rehabilitation
CBWMP – Community-Based Watershed Management Planning
CLPS – Carter Lake Preservation Society
IDNR – Iowa Department of Natural Resources
ISU – Iowa State University
NDEQ – Nebraska Department of Environmental Quality
NGPC – Nebraska Game and Parks Commission
PCBs – Polychlorinated Biphenyl Compounds
RAFTMP – Regional Ambient Fish Tissue Monitoring Program
STEPL – Spreadsheet Tool for Estimating Pollutant Load
TAT – Technical Advisory Team
TMDL – Total Maximum Daily Load
TN – Total Nitrogen
TP – Total Phosphorus
TSS – Total Suspended Solids
WC – Watershed Council

I. Introduction

This water quality management plan is the culmination of a community based watershed management planning process initiated by the City of Carter Lake, Iowa and the City of Omaha, Nebraska for the lake of Carter Lake (Carter Lake). Carter Lake is an oxbow lake that lies in Pottawattamie County, Iowa and Douglas County, Nebraska. The lake serves as a natural catch basin for stormwater runoff and melting snow and is also used extensively for passive and active recreational activities. Over the years, Carter Lake has experienced both water quantity and water quality issues. Water quantity issues have been related to shallow depths, which, has restricted the use of the lake and high water, which has resulted in basement flooding to nearby residences and businesses.

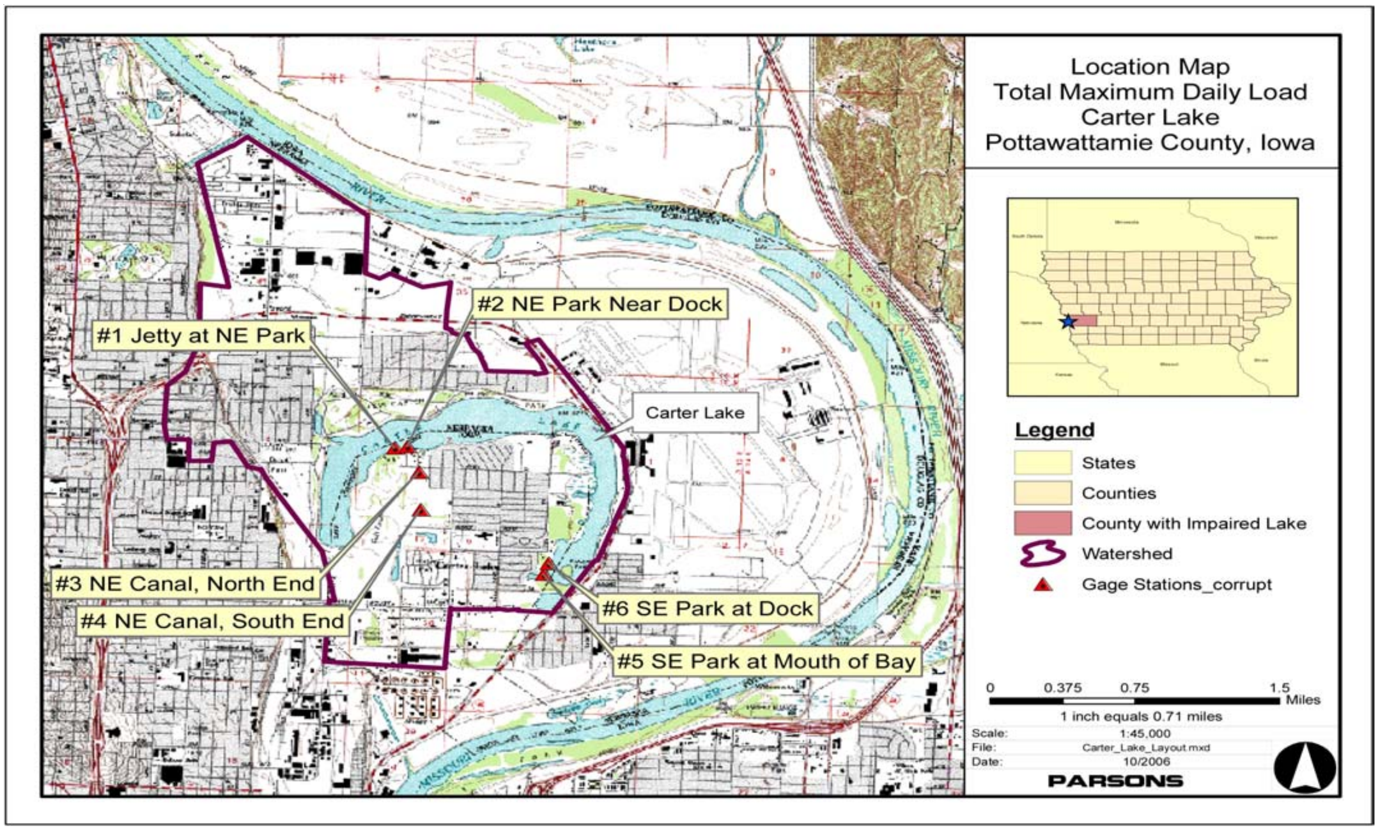
In 2006, the Cities of Carter Lake, Iowa and Omaha, Nebraska requested assistance from several resource agencies to address water quality issues. The Community-Based Watershed Management Planning (CBWMP) process was used in the development of this plan. This process is guided by interested citizens who form a Watershed Council (WC) and technical advisors who form a Technical Advisory Team (TAT). These two groups utilized a variety of expertise and interests to develop water quality goals for the lake and implementation strategies to meet those goals and improve the water quality in the lake.

A. Lake Description

Carter Lake. Carter Lake is an oxbow lake that lies in Pottawattamie County, Iowa and Douglas County, Nebraska. In 1877, flooding and shifting of the Missouri River created the oxbow lake. The lake is located directly west of Eppley Airfield and about two miles from the Omaha downtown area. The City of Carter Lake, Iowa lies completely within the concave portion of the lake and the City of Omaha and Levi Carter Park surrounds the lake on its convex side (Figure 1). The oxbow lake surface area is 315 acres and the storage volume is 2,520 acre-feet. Carter Lake has a mean depth of 8 feet and a maximum depth of 28 feet (Table 1). Carter Lake receives stormwater runoff from several locations, which include both underground storm sewers and overland contributing areas. The total drainage area around Carter Lake encompasses approximately 2,711 acres.

Carter Lake is used extensively for passive and active recreational activities including fishing, swimming, jet skiing, waterskiing and power boating. The Creighton University Rowing Team uses the lake for practices and regattas. The City of Omaha's Levi Carter Park surrounds the lake on its convex side. Access to the lake is available in Levi Carter Park, several public park access areas in the City of Carter Lake, and by residents living along the shoreline on the Iowa side. Omaha Parks, Recreation, and Public Property Department and the City of Carter Lake, Iowa do not collect economic data, or estimate the contribution that lake visitors make to the local economy. However, the Iowa Lakes Valuation Project estimated 47,131 household trips were made to the lake in 2002.

Figure 1. Lake and Vicinity Map



Source: TMDL Report for Carter Lake June 2007

Table 1: Carter Lake Features

Waterbody Name:	Carter Lake
Hydrologic Unit Code:	10230006
IDNR Waterbody ID:	IA 06-WEM-00265-L
NDEQ Waterbody ID:	MT1-L0090
Location:	Section 23 T75N R44W
Latitude:	41.29 N
Longitude:	95.92 W
Iowa Water Quality Standards Designated Uses:	Primary Contact Recreation Aquatic Life Support
Nebraska Water Quality Standards Designated Uses:	Primary Contact Recreation Aquatic Life-Warm Water Class A Agriculture Water Supply Aesthetics
Tributaries:	None
Receiving Waterbody:	Missouri River
Lake Surface Area:	315 acres
Maximum Depth:	28 feet
Mean Depth:	8 feet
Volume:	2520 acre-feet
Length of Shoreline:	35,376 feet
Watershed Area:	2711 acres
Watershed/Lake Area Ratio:	8.6:1
Estimated Detention Time:	3.04 years

Source: TMDL Report for Carter Lake June 2007

Carter Lake is on Nebraska's Section 303(d) list of impaired waters (NDEQ, 2006) for phosphorus, nitrogen, algae, and pH. As well, the state of Iowa has determined Carter Lake is impaired for excess algae and turbidity (Iowa DNR, 2004). The primary water quality issues with the lake stem from high nutrient concentrations. Elevated concentrations of phosphorus and nitrogen have contributed to blooms of blue green algae. Toxins produced by blue-green algae resulted in lake postings that recommended against full body contact for 18 weeks during the 2004 through 2006 recreation seasons. Carter Lake has also experienced occasional problems with bacteria. High bacteria densities resulted in a Section 303(d) listing in 2004 but the listing was removed in 2005.

B. Watershed Description

Topography

The total drainage area around Carter Lake encompasses approximately 2,711 acres (Figure 2). The watershed topography is nearly level.

Soils

The dominant soils of the watershed are Albaton and Carr (USDA Douglas and Sarpy Counties, Nebraska Soil Survey, 1975).

Albaton Series: The Albaton series consists of deep, nearly level, poorly drained soil on bottom lands in the Missouri River Valley. These soils formed in recently deposited clayey sediments. Very slow permeability and poor surface drainage make management of these soils difficult. Available water capacity is moderate. Moisture is released slowly to plants. The soils are mildly alkaline throughout the soil profile. Albaton soils are suited to cultivated crops, grass, and windbreak plantings.

Carr Series: The Carr series consists of deep, nearly level, moderately well drained soils on bottom lands in the Missouri River Valley. These soils formed in recently deposited, calcareous, loamy alluvium. Permeability is moderately rapid in the upper part of the soil and moderately slow in the lower part. Available water capacity is high. Moisture is released readily to plants. The surface layer is mildly alkaline. Carr soils are suited to cultivated crops, grass and windbreak plantings.

Hydrology

Average rainfall in the area is 31.9 inches. The annual average detention time for Carter Lake is 3.04 year based on outflow. The methodology and calculations used to determine the detention times are shown in Appendix A.

Land Use

Carter Lake has a watershed area of 2,711 acres and has a watershed to lake ratio of 8.6 to 1. Land use is predominately residential or commercial/industrial (57%, Table 2). Land uses for Carter Lake are show in Figure 3.

There are storm sewer outlets that discharge to the lake, and the City of Omaha, Nebraska and City of Carter Lake, Iowa have been issued a Municipal Separate Storm Sewer Systems (MS4) permit.

Figure 2. Watershed Drainage Map

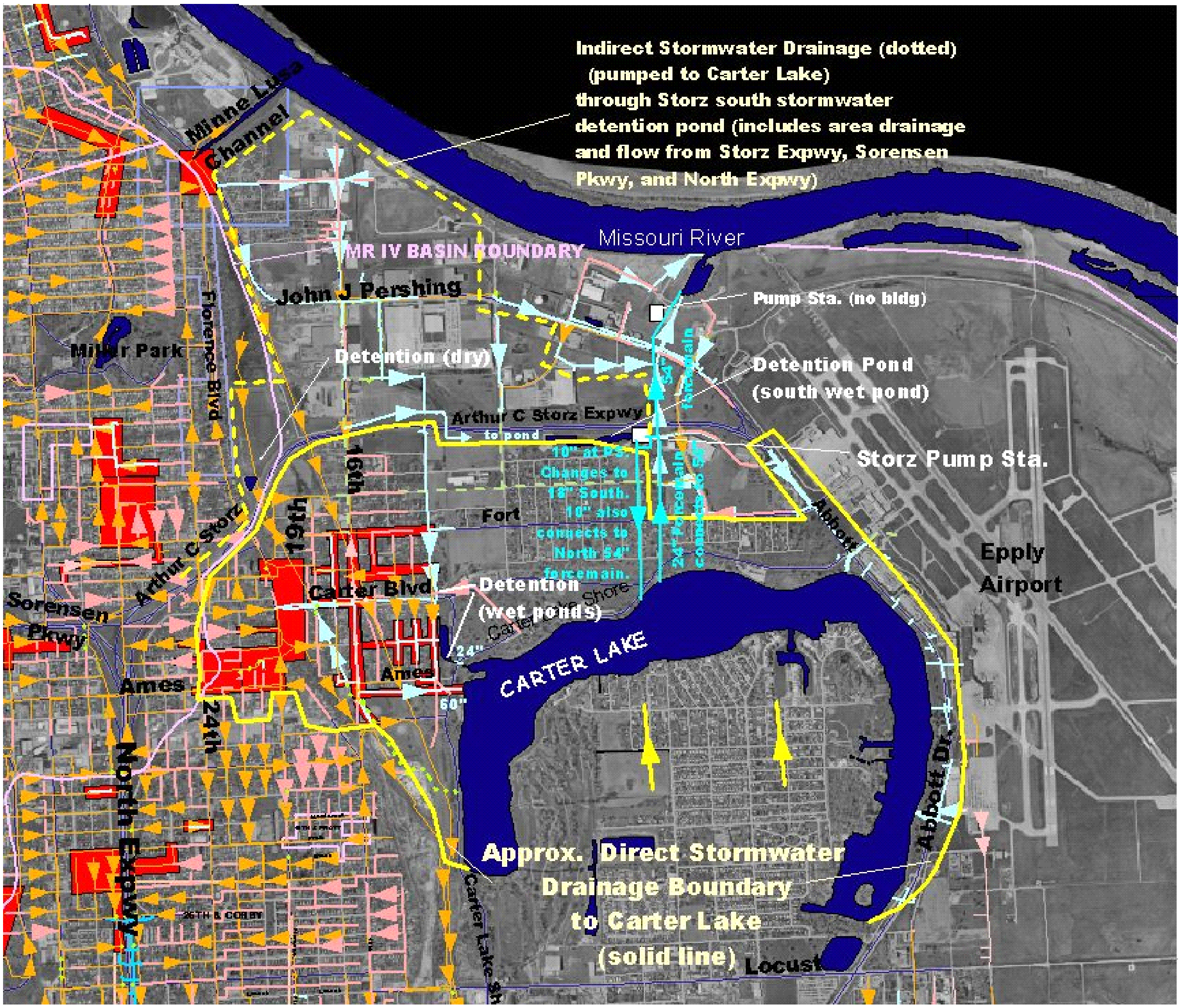
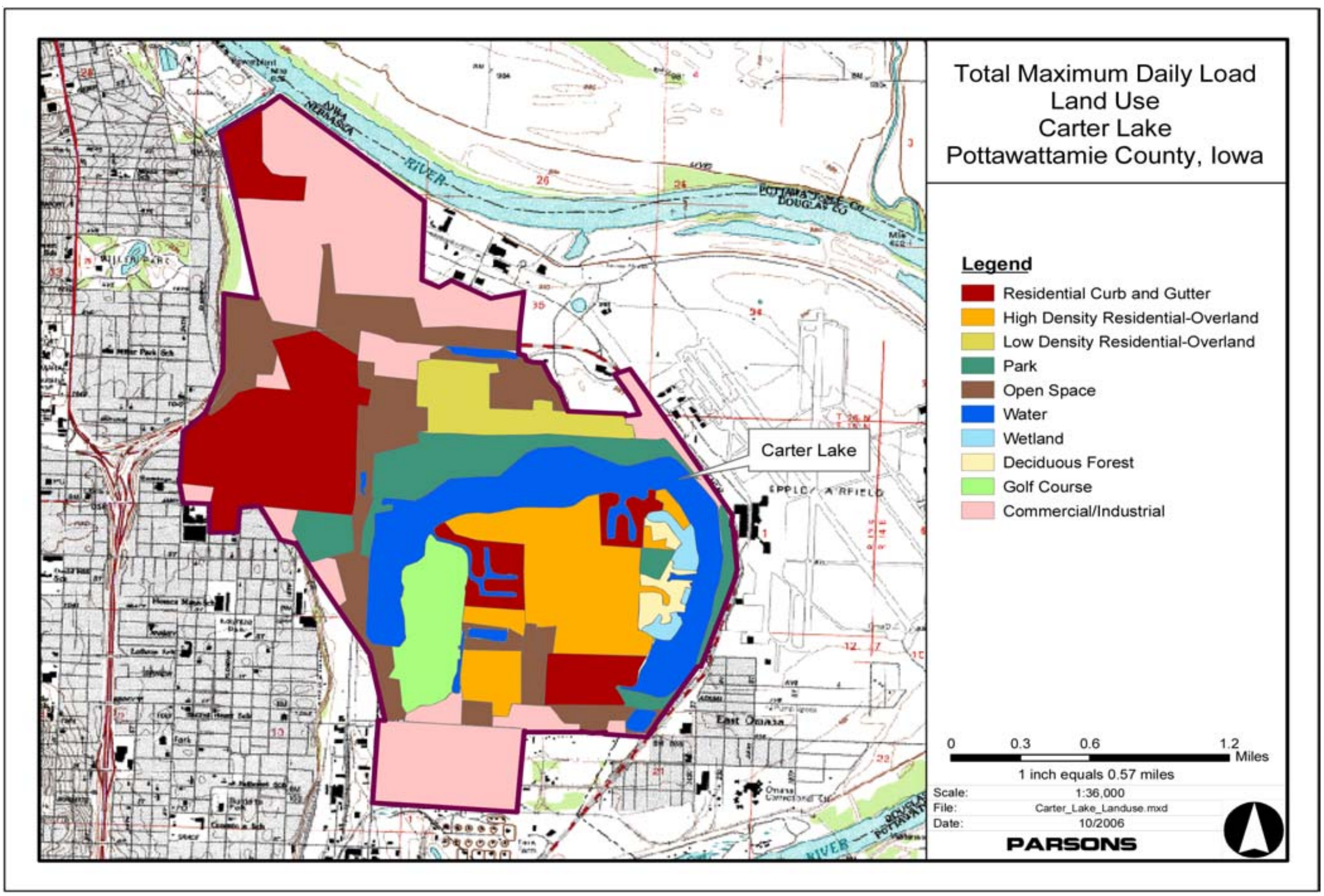


Table 2: Land Use in Carter Lake Watershed

Land Use	Area (acres)	Percent
Residential Curb and Gutter	532	19.5%
High Density Residential Overland	250	9.2%
Low Density Residential Overland	113	4.2%
Park	212	7.8%
Open Space	395	14.5%
Water	358	13.1%
Wetland	26	0.9%
Deciduous Forest	32	1.2%
Golf Course	122	4.5%
Commercial/Industrial	683	25.1%
TOTAL	2722	100%

Source: TMDL Report for Carter Lake June 2007

Figure 3: Land Use Map for Carter Lake



Source: TMDL Report for Carter Lake June 2007

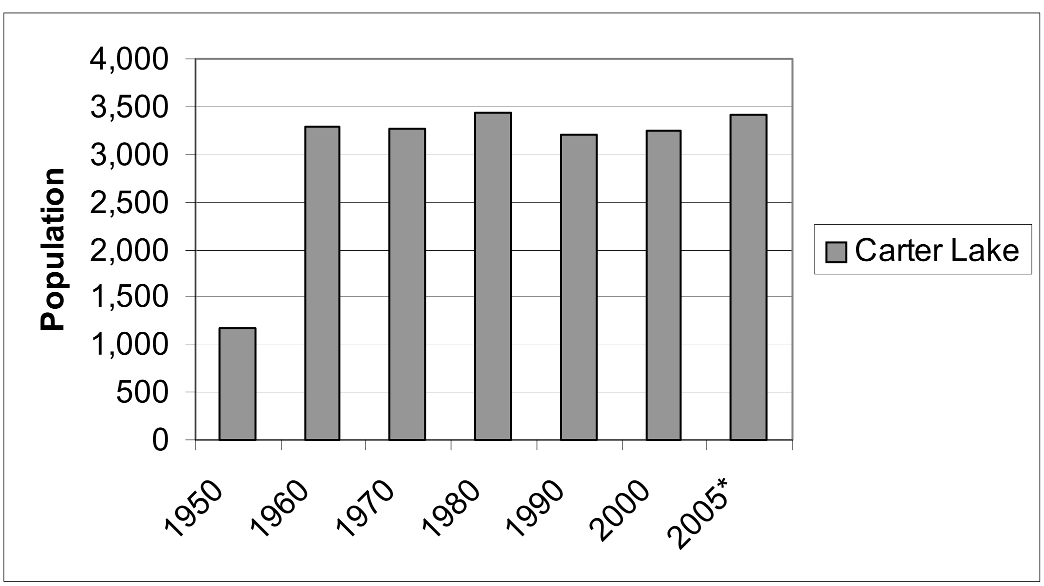
C. Climate

The climate in Douglas County is cold in the winter and hot in the summer. Summer temperatures average 74 degrees, with average daily highs around 84 degrees. The highest recorded summer temperature was 105 degrees in 1938. Humidity in the summer months ranges from 60 to 80%. The total annual average precipitation of 30 inches falls mainly in the months of April through September. Thunderstorms occur on approximately 50 days of the year, and can include hail, high winds, and occasionally tornados. Winter temperatures average 25 degrees with a recorded low of -32 degrees in January of 1882. Average snowfall is 28.4 inches.

D. Demographic Information

The population of the Carter Lake Watershed is mostly urban, part of a larger metropolitan area. The population of the watershed, as of 2000, has been estimated at 5,615 (comprised of the City of Carter Lake and a very small portion of the City of Omaha). The watershed is part of the larger Council Bluffs/Omaha Metropolitan Statistical Area (Nebraska Counties of Cass, Douglas, Sarpy and Washington. Iowa County of Pottawattamie), which had a population of 716,998 in 2000. The Census estimates that the population, within that same area, increased to 761,544 in 2005, an increase of 6%. The graph below shows the population change of the City of Carter Lake from 1950 to 2005. As the population has increased, the larger population has had an increased affect on the watershed. Because the City of Carter Lake is limited in area and is already fairly built up, it is believed that the population will remain fairly stable with minor fluctuations from this upper threshold.

City of Carter Lake Population Change



Source: U.S. Census 2005, U.S. Census estimate

E. Lake Usage and Economic Value

Water quality conditions play an important role in the amount of public use a lake or reservoir receives. In most cases, poor water quality can be associated with poor aesthetics and a poor fishery, which reduces public use. Prior to 2007 there had been no information collected at Carter Lake to evaluate lake usage. In 2007, volunteers were solicited to conduct general lake usage surveys. While these surveys were not designed to be statistically sound, they did provide general information on usage numbers and types of activities people were involved in while at the lake. In all, thirteen one-hour surveys were completed from April through September 2007. Eleven of these surveys were conducted during June and July. The surveys covered all days of the week and all daylight hours.

Watercraft trailers were surveyed at both Iowa and Nebraska boat ramps. Only June and July surveys were used for summary counts to represent "warm weather" use. A total of 65 watercraft trailers were surveyed during the 11 one-hour surveys, which equates to 5.9 trailers per survey. Approximately 58 percent of the watercraft trailers surveyed were in the Iowa parking areas while the remaining 42 percent were in the Nebraska parking areas. The maximum count of 16 trailers was documented on the afternoon survey of July 4.

A majority of the general vehicle parking during the survey period was observed in Levi Carter Park (62 percent). Approximately 28 percent of the parking use was in all the lots along Abbot Drive and Mabrey Park accounted for 10 percent.

Approximately 2,203 people were counted during the survey period, which equates to 169 people per one-hour survey. The survey revealed that approximately 80 percent of the people that visited the lake were there for passive uses such as picnicking, sunbathing, hiking and jogging (Table 3).

Table 3. Lake Usage

Use Category	Total For Use Category	Percent
Picknicking/Sunbathing	1,579	72%
Bank & Boat Fisherman	276	13%
Hikers/Joggers	174	8%
Shoreline Swimmers	74	3%
Power Boating	65	3%
Jet Skiing	32	1%
Canoeing/Sailing	3	>1%
TOTALS	**2,203**	**100**

Economic Value

Iowa lakes have great value to the citizens of the state. In the process of using lakes for fishing, boating, swimming and enjoying other outdoor recreation, Iowans also spend money that benefit local economies. During the 2002-2005 period, Carter Lake averaged 47,754 visitors annually. They spend an average $2.51 million annually which in turn supports 31 jobs and $0.63 million of labor income in the region.

Table 4. Average Spending

Category	Single Day	Multiple Day	Annual Single Day	Annual Multiple Day	Total
Supplies	$17.00	$59.65	$780,769	$108,921	$889,690
Eating and Drinking	$9.45	$96.30	$434,016	$175,844	$609,860
Gas and Car Expenses	$5.10	$29.70	$234,231	$54,232	$288,463
Lodging	$0.60	$69.80	$27,557	$127,455	$155,011
Shopping and Entertainment	$10.85	$36.05	$498,314	$65,827	$564,142
Total	$43.00	$291.50	$1,974,887	$532,279	$2,507,166

Table 5. Spending, Labor Income, and Job Effects of Lake Visitations

Category	Spending	Income	Jobs
Supplies	$889,690	$102,766	4.7
Eating and drinking	$609,860	$174,129	13.0
Gas and Car Expenses	$288,463	$18,384	0.8
Lodging	$155,011	$45,389	2.2
Shopping and entertainment	$564,142	$61,381	2.9
Total	$2,507,166	$402,049	23.6

Table 6. Economic Value of Direct and Secondary Recreational Spending

Category	Total Sales	Labor Income	Value Added	Jobs
Agriculture	$4,797	$605	$785	0.1
Construction	$22,863	$4,410	$5,212	0.1
Manufacturing	$111,322	$11,127	$15,978	0.2
Tran.Utilities	$119,876	$18,269	$33,413	0.3
Trade	$1,947,730	$222,492	$341,661	9.7
Fin.Ins.R.Estate	$298,117	$30,497	$82,572	1.0
Prof. Services	$448,786	$81,387	$102,122	2.1
Other Services	$881,262	$252,879	$378,481	17.0
Government	$135,126	$4,619	$47,463	0.1
Total	$3,969,878	$626,285	$1,007,687	30.6

Each recreation trip or visitation has an associated set of expenditures. The composition of these expenditures for typical trips of single day or multiple days (Table 4) is based on a usage survey of Storm Lake and Rock Creek Lake during the 2002 season. Applying these usage averages to Carter Lake results in the estimated spending figures in Table 5.

This level of spending is linked to other economic activity in the region as the initial expenditures are re-spent on goods and services in the regional economy. These multiplier effects are estimated with an Input-Output model for the region and are summarized in Table 6.

In addition to the "expenditures impact," an environmental improvement project can affect the value of real estate in a local region and therefore alter the tax base and level of real estate taxes collected. Like the increased market activity that generates more revenue to local businesses and jobs to local inhabitants, increased tax revenues may be a strong incentive for a community to support an environmental project. However, like the "expenditures impact" of a project, these tax revenues do not measure the value of the project from a societal prospective (that is, it would not be a component of benefits in a cost-benefit analysis).

There is, however, a component of these changes in real estate values that does measure part of the economic value of the project: the increase in the property value itself. If the project makes a lake or region more desirable to live in, then people will be willing to pay more for homes in the area than they would be in lieu of the project. This increased demand bids up the prices of homes in the area. This increased price is basically reflective of the value of the project, rather than the innate value of the home (the same house sold for less before the project was built than afterwards, so the difference in price can be attributed to the value of the project). The figures in tables 4-6 only represent Iowa data.

II. Public Input and Partnerships

A. Public Input Process

The Community-Based Watershed Planning Process

The public is increasingly aware of environmental issues, and interested in making sound environmental decisions as they relate to community development. Watershed partnerships formed through a community-based watershed management planning process can provide a forum for constructive negotiation and mediation, and promote opportunities for balancing environmental concerns with the economy.

These partnerships also bring groups and individuals together with the agencies that have the technical expertise to support community-driven conservation initiatives. Linked to an effective funding strategy, locally led environmental stewardship can be a dynamic and responsive process by which we can protect our most valuable natural resources.

A Community Based Planning process developed by the Nebraska Department of Environmental Quality and USDA Natural Resources Conservation Service was utilized to develop a watershed partnership for Carter Lake. There are twelve preplanning activities that are conducted before beginning the public process. The steps are as follows:

Pre-Planning Activities Checklist:

- A Project Sponsor is identified.
- The Watershed-wide Conservation Planning Process and its benefits are understood and endorsed by the sponsor.
- A Technical Advisory Team made up of key resource people is established.
- The planning area is defined on a map.
- A written commitment is obtained from the sponsor to initiate the planning process.
- A Project Manager/Coordinator is appointed and duties defined.
- Any existing data and maps are gathered for use.
- The need for additional information and data is determined.
- An Educator for the Project is selected, and a public education plan is developed.
- A brainstorming session is used to identify key stakeholders in the planning area.
- A list of the stakeholders, local partners, agencies, and organizations to be invited to the initial public meeting is compiled.

The community-based approach to the watershed planning process involves a series of steps designed to encourage participation and foster a sense of ownership in the plan by interested stakeholders. The steps of the planning process follow:

Community-Based Approach to Watershed Planning Steps

1. Conduct Public Meeting #1.

Present resource information to develop public awareness of the resource issues in the area.

2. Facilitate Public Meeting #2.

a) Generate a "Vision" for the area.
b) Develop the objectives of the project.
c) Prioritize the stakeholders concerns.
d) Form the Watershed Council.

3. Inventory the resources in the area.

a) Identify additional resource information and data needed.
b) Develop and action plan for collection of new data.
c) Compile all the needed resource data.

4. Analyze resource data.

Complete data assessment or modeling.

5. Formulate management alternatives to address resource problems and meet the goals and objectives of the process.

6. Evaluate the recommended management alternatives.

Evaluate the management alternatives with the Watershed Council to prioritize, delete or add to the recommendations as endorsed by the group.

7. Conduct Public Meeting #3.

Present the recommended alternatives to the stakeholders.

8. The Project Sponsors make final decisions on which alternatives are to be included in the Watershed Management Plan.

9. Develop a Watershed Management Plan that includes:

a) Information/Education and outreach plan.
b) Structural and management practices that will be needed.
c) Potential funding sources for the implementation phase.
d) Assignment of actions or tasks.

10. Conduct Public Meeting #4

a) The Project Sponsors present the Watershed Management Plan to the stakeholders for comment.
b) The schedule for implementation is presented to the public.

11. The Project Sponsors approve the Watershed Management Plan.

12. Implementation of the Watershed Management Plan is carried out as funding is obtained according to the implementation schedule.

13. The Watershed Council and Technical Advisory Team meet regularly to evaluate implementation progress and impacts based on benchmarks established. The sponsors may have to go back to step 4 if objectives are not being met.

14. Celebrate when milestones in the Watershed Management Plan are reached. Public functions would be very appropriate.

A series of three public meetings were held to inform and involve the public in the process (see Table 7). Watershed residents, lake and park users, homeowners associations, skiing clubs, business owners, and other interested stakeholders were initially invited to attend two public informational meetings. The meetings were widely advertised by posters, television spots, direct mailing, email lists, and web site notices.

B. Public Meeting Attendance

Approximately 110 people attended the first informational meeting at Carter Lake Elementary School October 5, 2006. At the first public meeting, members of the Technical Advisory Team presented technical information about Carter Lake and the watershed. The attendees were given a chance to discuss their perceptions and concerns about the lake, and to ask questions of the advisory team. Following the technical presentations the meeting participants broke into small groups, led by trained volunteer facilitators, and developed a vision statement. The second public meeting was held on October 24, 2006 with approximately 48 persons in attendance. Meeting participants approved a vision statement and identified and prioritized watershed and lake issues and concerns. The Carter Lake Environmental Assessment and Rehabilitation Water Council led the third watershed meeting on March 11, 2008 which 150 people attended.

Table 7. Partnership Meetings

Meeting	Date	Location
Public Information Meeting 1	October 5, 2006	Carter Lake Elementary School
Public Information Meeting 2	October 24, 2006	Carter Lake Elementary School
Watershed Council Meeting 1	November 28, 2006	Carter Lake Library
Watershed Council Meeting 2	January 10, 2007	Carter Lake Library
Watershed Council Meeting 3	February 7, 2007	Carter Lake Library
Watershed Council Meeting 4	March 14, 2007	Carter Lake Library
Watershed Council Meeting 5	May 16, 2007	Carter Lake Library
Watershed Council Meeting 6	June 20, 2007	Carter Lake Library
Watershed Council Meeting 7	July 17, 2007	Carter Lake Library
Watershed Council Meeting 8	August 14, 2007	Carter Lake Library
Watershed Council Meeting 9	September 18, 2007	Carter Lake City Hall
Watershed Council Meeting 10	December 4, 2007	Carter Lake Library
Watershed Council Meeting 11	January 23, 2008	Carter Lake Library
Public Information Meeting 3	March 11, 2008	Shoreline Golf Club

C. Summary of Public Input - Public Meetings 1 and 2

Visioning: Participants at the first public meeting were asked to envision what they ideally would like the lake and watershed to be in the 20 years. Working in six small groups led by volunteer facilitators, participants developed vision statements that reflected their image of Carter Lake and the watershed. The vision statements generated emphasized multi use recreational opportunities, a healthy ecosystem and a source of pride for the metropolitan area.

Because of time constraints, the Technical Advisory Team consolidated the draft statements, using the common themes and as much of the original language as possible, into a single vision statement for Carter Lake. A draft of the vision statement was presented at the second public meeting for public comment and adoption. The final vision statement adopted by the stakeholders is as follows:

"Carter Lake will be the crown jewel of the metropolitan area by being a stable, healthy ecosystem that provides for multi use recreational activities and economic opportunities."

Issue Identification and Prioritization: In facilitated small group sessions at the second public meeting, stakeholders generated lists of concerns and issues that they felt should be addressed in a watershed management plan for Carter Lake. The groups were informed that the watershed management plan would focus on water quality issues but that the stakeholders could list any concerns or issues. Many participants identified water quantity issues. The concerns by the small groups were compiled into a comprehensive list and posted on the wall in order for the entire group to prioritize the topics.

The stakeholders identified a total of 77 issues and concerns about Carter Lake and its watershed. Each person was given 5 colored stickers which they could place next to the issues about which they felt most strongly. The entire list of issues and concerns is listed below.

Water level (dredging, reestablish water depth, increase natural springs, education) .. …………20
Water depth .... …………………………………………………………………………...........11
Level stability ... …………………………………………………………………………....10
Water quality (fertilizers/nutrients, toxic algae, pet waste, turbidity, education) .. ……………….9
Lake stewardship (trash, overuse, reckless users, education) ... ………………………………..9
Water quality (clarity, edible fish) ... ………………………………………………………...9
Water level (stable, lack of depth)………………………………………………………........8
Reduce access points to Levi Carter Park ... ……………………………………………………8
Water clarity and quality .... ………………………………………………………………7
Water clarity .... ………………………………………………………………………7
Stable water level .... ………………………………………………………………………7
Island restoration/protection ... ……………………………………………………………6
Park law enforcement ... ……………………………………………………………………..5
Shoreline aesthetics and stability ... ………………………………………………………….5
Water clarity .... ………………………………………………………………………5

Lack of water quantity control .... ……………………………………………………………5
Lack of information and education . ………………………………………………………4
Eagle habitat protection .... ………………………………………………4
Long term maintenance of improvements ..... ……………………………………………4
Lake deeper..4
Shore stabilization ... ………………………………………………………………………...3
Clean shoreline and lake bottom .. ………………………………………………………..3
Preserve wildlife habitat and variety .. ……………………………………………………3
Wildlife habitat and fishery (rooted plants, turbidity, education) . ………………….....………..3
Canal opening depth and pilings hazard …………………………………………………......3
Clean and enhance the southwest shoreline ……...…………………………………………3
Trash (public/private) ………………………………………………………………………..3
Lack of law enforcement for lake regulations …………………………………………….....2
Rough fish (preserve variety) ……………………………………………………………….2
Patrolling the shoreline (dumping, Omaha/Carter Lake partnership)……………………………..2
Enforcement/safety . …………………………………………………………………………2
Parts of lake too shallow. ……………………………………………………………………2
Lack of Frisbee golf course ………………………………………………………………2
Lack of avian observatory. ……………………………………………………………….....2
Safer boat ramps ……………………………………………………………………………2
Improve the lighting all around the lake ……………………………………………………2
Eagle-friendly lake ……………………………………………………………………………..1
Lack of bike path ……………………………………………………………………………1
Transient population ………………………………………………………………………...1
Stormwater inflow quality ……………………………………………………………………..1
Insufficient park lighting ……………………………………………………………………1
Modern restrooms ……………………………………………………………………………...1
Algae blooms ………………………………………………………………………………..1
Boat ramps need to be improved – too short ……………………………………………………...1
Safety around boat ramps and docks ……………………………………………………..1
Stormwater quality ……………………………………………………………………………..1
Unstable shorelines …………………………………………………………………………1
Aesthetic lake important ……………………………………………………………………1
Trash dumping (close 11th Street access, more trash collection in park) . …………………...………1
Watershed resident education ………………………………………………………………1
Clean watershed ……………………………………………………………………………..0
Recreational trail around the lake ………………………………………………………...0
Quality fishery/fish management ……………………………………………………………0

Lack of fish habitat ……………………………………………………………………………..0
Lack of excursion boat ……………………………………………………………………………0
Lack of tourist attraction …………………………………………………………………………0
Boat traffic safety/education ……………………………………………………………………...0
Insufficient hazard marking ………………………………………………………………………0
Lack of respect for other equipment ……………………………………………………………...0
Edible fish from a quality fishery …………………………………………………………………...0
Improve the cleaning function of the stormwater retention cells ………………………………...0
Pull out old pilings ………………………………………………………………………………..0
Clean up the island ………………………………………………………………………………..0
Trash .... ……………………………………………………………………………………...0
Secure trash cans …………………………………………………………………………………0
Septic tanks ..... ……………………………………………………………………………………0
Quality fishery……………………………………………………………………………….......0
Contaminated sediments (fish tissue) . ……………………………………………………………0
Safe playground equipment .. ……………………………………………………………………..0
Would like to see more rain gardens.. ...…………………………………………………………..0
Too much water . ……………………………………………………………………………………0
Too little water .. …………………………………………………………………………………..0
Phragmites ..... ……………………………………………………………………………………0
Types of watercraft .. ……………………………………………………………………………...0
Managing runoff for lake water level ... …………………………………………………………..0
Lack of angler access .. ……………………………………………………………………………0
No public beach – unused building...0

Water quantity issues received the most votes. Recreational uses of the lake have been restricted for the past few years do to low water levels. Decreased amounts of precipitation and reduced watershed stormwater inflow have caused the water quantity problems. Water quantity issues are being addressed by the cities of Omaha and Carter Lake. Water quality related issues will be addressed by the watershed management plan. Non water quality issues were given to the appropriate agency or city government to address.

Forming the Watershed Council. Names of interested citizens were solicited at the first and second public meetings. A Watershed Council of interested stakeholders was established at the end of the second public meeting. The volunteer citizens group met and selected a name, a leadership team, and established qualitative water quality goals. The name of the group is the Carter Lake Environmental Assessment and Rehabilitation (CLEAR) Water Council. The CLEAR Water Council worked with the Technical Advisory Team and an engineering consultant to establish watershed management strategies for the lake.

D. Summary of Public Input – Public Meeting 3

The final public meeting to present the Water Quality Management Plan to the public was held on Tuesday March 11, 2008 in Carter Lake, Iowa. An estimated 150 people attended the open house meeting. At this meeting attendees were encouraged to provide written and verbal comments on the alternatives that were being included in the plan. Additional comments were allowed via e-mails for several weeks after the meeting took place.

There were a total of thirteen written comments from the public meeting and two via email after the meeting. Five of those comments concerned the no wake zones, one concerned the homes with septic systems, and one concerned filling the deep hole near the island with dredge spoil would eliminate that cool, deep water habitat for fish. Comments on the no wake zones were four to one negative to positive. Three commented and thanked all for the hard work we put in on the plan. The other five comments concerned the lack of a public vote, not enough attention to the water quantity, and some thought the meeting was a waste of time.

Technical team members and CLEAR council members manning the stations at the public meeting reported that people asked a lot of questions and the majority of comments were positive. Concerns reported to the stations included seepage from the canals, the behavior of the lake bottom after the dredging, the no wake areas, and the effects of alum treatment. Fishery renovation got all positive comments.

Overall, the interest in the project and support for the plan has been very good. As this project progresses it will be important to continue to keep the public both informed and involved.

III. Water Quantity

Supplemental Water Source Alternatives and Recommendations

Background

One of the key assumptions throughout the Watershed Plan is that the Lake is maintained near or at full-pool. The desired lake elevation should be 970.3 feet (mean sea level)[1]. Significant fluctuations from this level will adversely impact the overall effectiveness of many of the proposed solutions to improve the water quality.

For example, low water levels will increase turbidity because boating will stir up the bottom of the lake and re-suspend silt and bottom debris. Conversely, high water levels will flood any engineered structures designed to control erosion and maintain the developed wetlands adjacent to the lake. As a result, an important element for the water quality plan is to include a mechanism to control the level of the lake so as to remain within a predetermined range. The recommended variance is +/- 0.5 foot from full pool or a variance between 969.8 and 970.8 feet in elevation.[2]

---

[1] Carter Lake Intergovernmental Task Force, May 1984 from Carter Lake Water Diversion Project, Technical Report assembled by Omaha Public Works Department, August 1986, page 1.
[2] "Carter Lake Water Level Control – Preliminary Design Report", The Schemmer Associates, Inc, January 1997, page 15.

Additional Sources of Water are Needed to Maintain the Lake Level

During long periods of drought, there is no natural means of replenishing the Lake. Previous engineering studies have estimated that in a year of average precipitation, the lake loses approximately 9.35 inches of depth because evaporation and seepage are greater than the inflow from rainfall[3]. During a series of abnormally dry years (such has been the case from 2003 – 2007), the lake level dropped to as low as 967 MSL. During this recent time of low lake levels, recreation is curtailed and at times dangerous, the fish population suffers, and toxic algae blooms are more frequent.

Water Out: The North Flood Control Lift Station

In 1998-99, the cities of Omaha and Carter Lake constructed the North Flood Control Lift Station. This facility is equipped with two pumps with capacities of 4500 gallons per minute each, which are used to control the lake level in the event of a flood. These pumps have the capacity to drain the lake 1.5 feet in less than 10 days in the event of a significant rain event such as the August 1999 eleven inch rain event.

North Flood Control Lift Station

Water In: The Missouri River Barge Canal

Abandoned Missouri River Barge Canal pump location

Before the North Flood Control Lift Station was installed a small pump was used to bring surface water from the Missouri River Barge Canal to Carter Lake through a series of pipes and storm sewers via the Storz Street pumping station. This pump was used only once to bring water into the lake during the summer of 1990. After that, above-average precipitation occurred and the pump was not used. Subsequently, the barge canal silted in. The pump was removed and this system is no longer useable, but the piping is still in place.

Water In: The Kiwanis Park Pond and Well

In 2007, the city of Omaha completed the improvements to the Kiwanis Park, pond and fountain. The Carter Lake Preservation Society and the City of Carter Lake worked together to fund an Aquifer Test Analysis on the well that fills the pond. The test indicated that 45% of well water was obtained from induced infiltration of the lake. The 1000 gpm pump is located in a well 900 feet from the lake. Even though this well is less efficient, the two cities of Carter Lake and Omaha agreed to continue pumping so the pond will overflow into the lake as a small, supplemental source of water.

Kiwanis Park Pond overflows to Carter Lake

[3] Section 22 Study Planning Assistance to States. Evaluation of Lake Levels for Carter Lake, Iowa Hydrology Analysis, August 1985, page 3.

Lake Recharge System Recommendation

The recharge system recommendation is based on much of the work and infrastructure that was developed in the 1990s. Instead of pumping surface water directly from the Missouri River, the plan now calls for the installation of a well that will pull naturally filtered, ground water from a location near the Missouri River. Surface water could contain polluted runoff, sediment, and undesirable aquatic life. The newly constructed well will then use the piping system still buried near the old barge canal pump. A feasibility study conducted by the engineering firm Jacobson Helgoth in 2006 identifies possible well types that could be used for this purpose.

After researching possible locations and alternatives with the City of Omaha and well drilling experts at Layne Western Company, a site has been selected for a test well. The site is located on City of Omaha property at the end of Dock Street.

The Dock Street ☆ location appears to be an ideal site for the test since it meets the requirements of:

1. Proximity to the river;
2. Access to the existing infrastructure; and
3. No need to cross private property.

The City of Omaha has granted the Carter Lake Preservation Society permission to construct a test well that will determine if this site can yield the quantity and quality of the water needed for recharging the lake. This test will be completed by the end of May.

Assuming the test well yields positive results, the next step would be to develop a detailed cost estimate for constructing a permanent vertical well on that site and tying into the piping still in place from the old barge canal surface pump. The cities of Omaha and Carter Lake would also need to develop a cooperative agreement for ongoing maintenance of this well, similar to the Kiwanis Park well agreement.

Summary

Looking forward, a recharge system will consist of a permanent well located on the City of Omaha's right of way near Dock Street. A 2000 to 4000 gpm pump will provide clean water to Carter Lake using the existing infrastructure from the old barge canal system. Once operational, the Dock Street recharge well and the north flood control lift station will work in tandem to maintain the lake level within the optimal range of full pool. They will be able to add water slowly and steadily to the lake during drought and extended dry periods, but quickly remove water during a high rainfall event.

IV. Water Quality and Fisheries Summary

A. Introduction

Carter Lake is a shallow, well-mixed lake that may exhibit short-term thermal stratification during the summer months. Other characteristics of Carter Lake include poor water clarity, high nutrient concentrations, frequent algae blooms, periodically high bacteria, and fish tissue contamination from PCBs.

In 2006, a Total Maximum Daily Load (TMDL) was completed for Carter Lake. The TMDL was based on a 2006 Section 303(d) listing for nutrients and blue green algae toxins. Additional information on existing nutrient concentrations, nutrient loads, and nutrient targets can be found in the TMDL which is listed as Attachment B in this plan. The TMDL was approved by the U.S. Environmental Protection Agency – Region 7 in the fall of 2007.

B. Water Quality Standards

Nebraska

Carter Lake is protected for Aquatic Life (Warmwater Class A), Primary Contact Recreation, Aesthetics, and Agricultural Water Supplies under Title 117, Nebraska's Surface Water Quality Standards (NDEQ, 2006).

Iowa

Carter Lake is protected for warmwater aquatic life (Class B(LW)), primary contact recreation (Class A1), and fish consumption uses (Class HH) as described in the Iowa Water Quality Standards (Chapter 61, Iowa Administrative Code (IDNR, 2006)).

C. Data Availability And Assessment Responsibilities

A minimal amount of water quality data has been collected at Carter Lake. Weekly bacteria data was collected in 2000, 2005 and 2006 and weekly blue green algae toxin data was collected in 2005 and 2006. The primary sources of data provided in this report are Iowa State University (ISU), Iowa Department of Natural Resources (IDNR), Nebraska Game and Parks Commission (NGPC), and Nebraska Department of Environmental Quality (NDEQ).

Data summarization and assessments were conducted by the NDEQ. The reservoir growing season, which is referenced several times in the summary, is defined as being from May through September. These are typically the months that produce the greatest pollutant loadings and the poorest water quality conditions in a lake or reservoir.

D. In-Lake Water Quality Summary

Total Suspended Solids

Organic and inorganic solids that are suspended in the water can create problems for aquatic life as well as decrease the aesthetic qualities of a lake or reservoir. In Carter Lake, large numbers of rough fish along with wave action and power boating compound the problems with suspended solids through the re-suspension of bottom sediments.

Information on total suspended solids (TSS) concentrations in Carter Lake was available from 2000 to 2006. Annual median TSS concentrations ranged from 10 mg/l in August of 2000 to 82 mg/l in July 2003 (Figure 4). The median concentration for the period of record was 30 mg/l. Carter Lake has exhibited a significant increasing trend in TSS concentrations from 2000 through 2006. There is no water quality standard for total suspended solids.

Information on organic and inorganic solids in Carter Lake was available from 2000 to 2006. Organic solids are comprised mainly of algae cells while inorganic solids are comprised mainly of sediment. Percent organic solids have ranged from 46 percent in 2000 to 94 percent in 2005 with a median of 70 percent (Figure 5). This data suggests that a significant portion of the suspended solids in the lake can be attributed to algal growth.

Figure 4. Total Suspended Solids Concentrations In Carter Lake

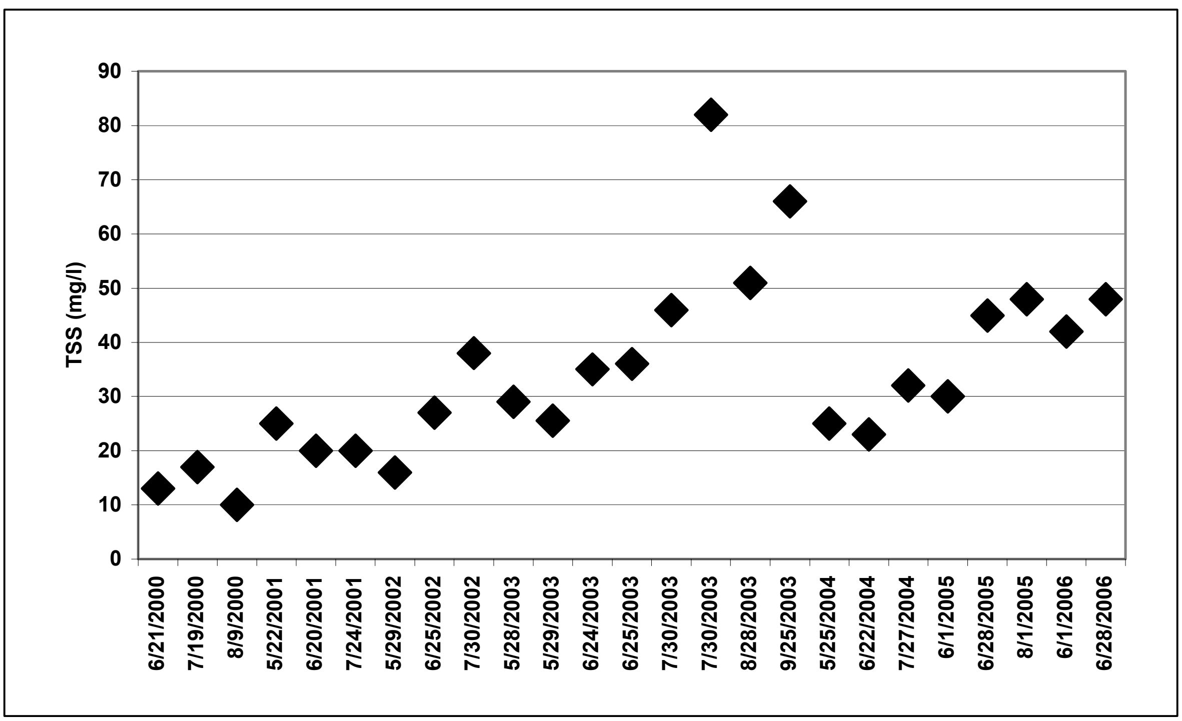
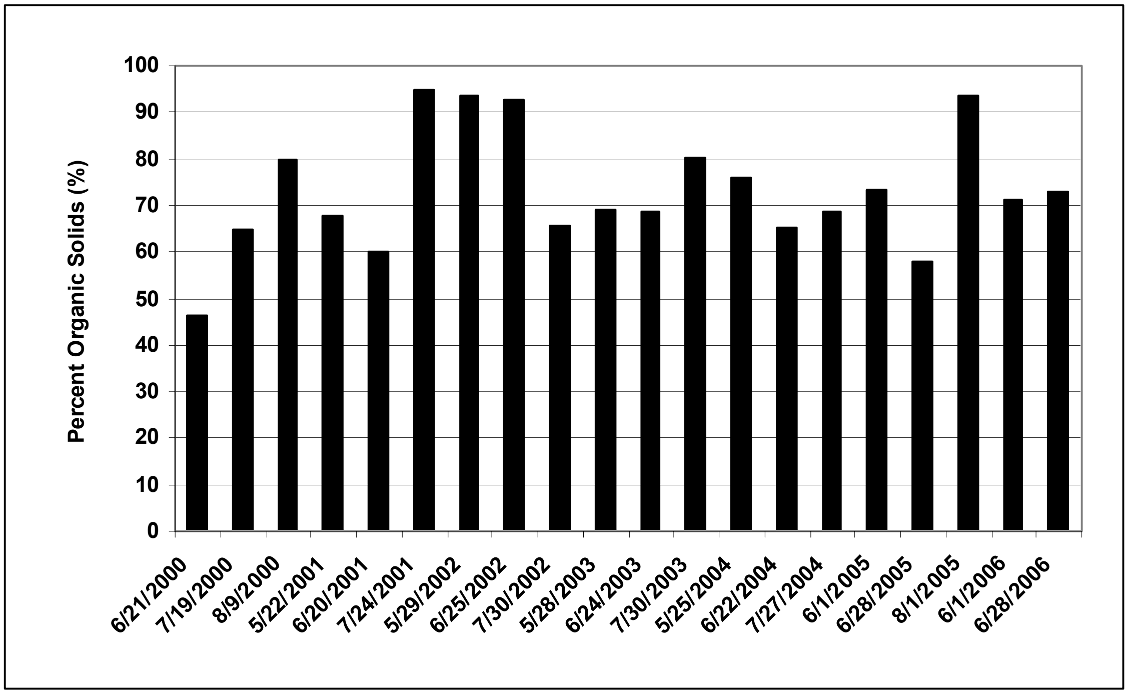


Figure 5. Percent Of Total Suspended Solids That Are Organic in Carter Lake



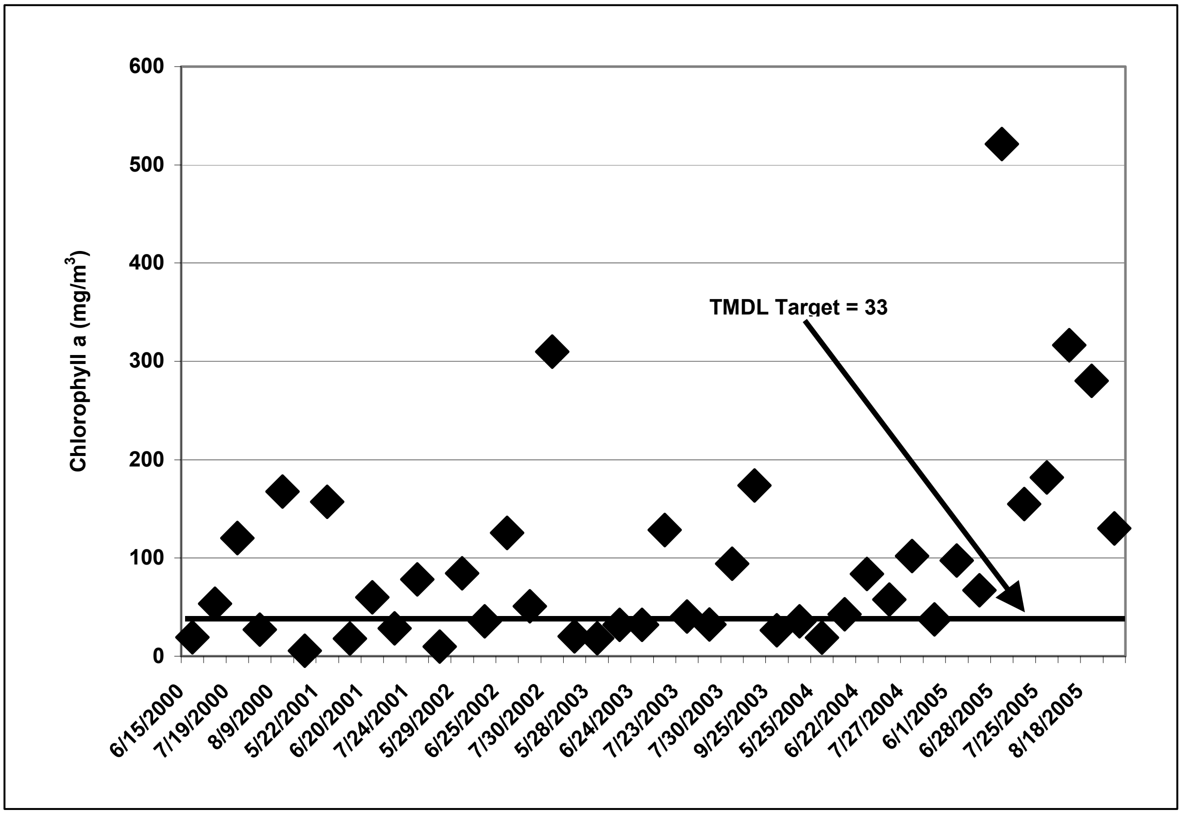
Algae

The production of algae is controlled primarily by water temperature, light availability, and nutrient availability. In addition to degrading aesthetics, dense growths of algae can lead to the depletion of dissolved oxygen. Blue green algae blooms have frequently occurred at Carter Lake. High concentrations of toxins released by blue green algae have resulted in beach postings for 18 weeks from the 2004 recreation season through the 2006 recreation season. Beach postings are alerts indicating possible health problems associated with full-body contact activities (e.g. swimming, wading, water skiing, jet skiing).

Chlorophyll concentrations are used as an indicator of algal biomass. This test is inclusive of all types of algae. Chlorophyll information for Carter Lake was sporadically available from 1990 through 2006. Annual growing season (May – September) median chlorophyll *a* concentrations ranged from 18.1 mg/m^3 in May of 1993 to 521.1 mg/m^3 in June of 2005 (Figure 6). The chlorophyll *a* target value identified in the TMDL is 33 mg/m^3. Carter Lake has exhibited a significant increasing trend in chlorophyll concentrations from 2000 through 2006.

Blue green algae toxin data was available from 2004 through 2006. In 2004, beach postings were initiated when toxin concentrations exceeded 15.0 ppb. In 2005, the beach posting criterion was changed to 20.0 ppb. Four of the six samples collected in 2004 exceeded 15 ppb while three of twenty-one and four of twenty-two samples exceeded 20.0 ppb in 2005 and 2006 respectively.

Figure 6. Growing Season Chlorophyll *a* Concentrations in Carter Lake

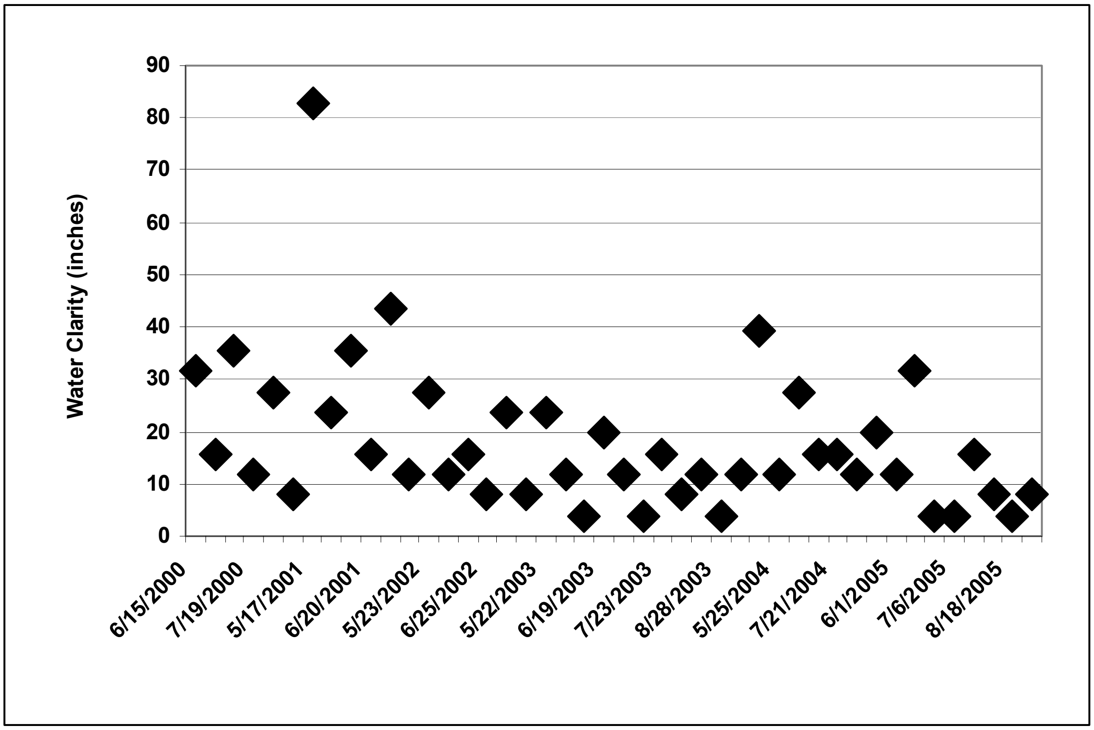


Water Transparency

The transparency of water can limit or promote the production of certain species of algae, fish, and aquatic plants. The depth to which light will penetrate in a lake or reservoir is dependant upon several factors. In Nebraska, the two main influences on light penetration are algae and suspended sediment.

Information on water transparency in Carter Lake was available from 2000 through 2005. Annual growing season water transparency measurements ranged from 4 inches on numerous dates to 83 inches in May of 2001 (Figure 7). The median water transparency from 2000 – 2005 was 14 inches. The goal established for the project is 54 inches. Carter Lake has exhibited a significant decreasing trend for water clarity since 2000.

Figure 7. Water Transparency Measurements at Carter Lake



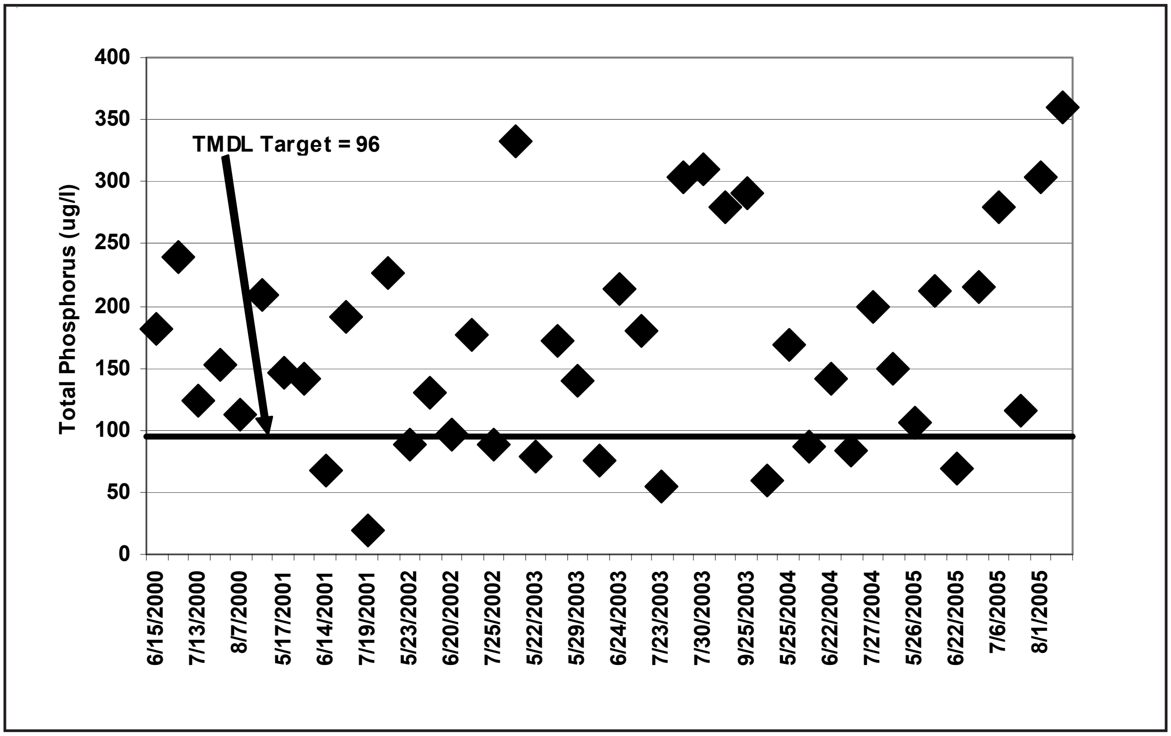
Nutrients

Phosphorus and nitrogen are the two nutrients most critical for the production of algae in Nebraska lakes and reservoirs. High concentrations of these nutrients can stimulate the production of excessive amounts of algae commonly known as algal blooms.

Total phosphorus is comprised of both dissolved phosphorus and particulate phosphorus. Dissolved phosphorus is readily available for uptake by biological organisms while particulate phosphorus must be converted to the dissolved phase before utilization can take place. While total phosphorus indicates the amount of phosphorus that is "potentially available" to biological organisms, the amount of dissolved phosphorus plays a more important role in determining current productivity. Since particulate phosphorus is bound to soil particles, high nutrient concentrations can be associated with high sediment loads and/or high concentrations of suspended sediment.

While there was no information on dissolved phosphorus, information on total phosphorus concentrations in Carter Lake was available from 2000 through 2005. The annual growing season median concentration of total phosphorus ranged from 19 ug/l in July of 2001 to 360 ug/l in August of 2005 (Figure 8). The total phosphorus target value identified in the TMDL is 96 ug/l. Thirty-three of the forty-four total samples collected since 2000 exhibited concentrations greater than the TMDL target value of 96 ug/l.

Figure 8. Total Phosphorus Concentrations in Carter Lake (2000 – 2005)

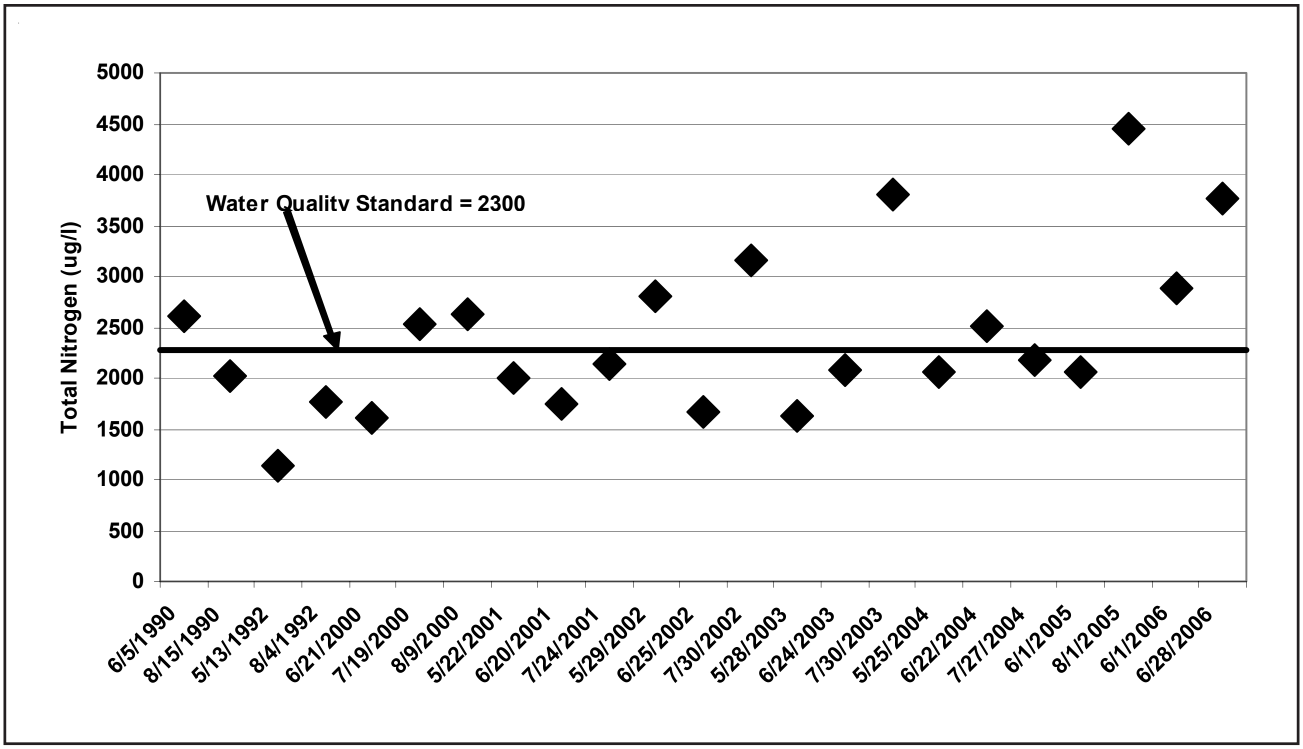


Information on nitrogen constituents in Carter Lake was available from 1990 through 2005 (Figure 9). Total nitrogen was determined by summing kjeldahl nitrogen concentrations and nitrate-nitrite nitrogen concentrations. Total nitrogen concentrations ranged from 1130 ug/l in May of 1992 to 4450 in August of 2005. The median growing season nitrogen concentration for the period of record is 2140 ug/l. The Nebraska Water Quality Standard for total nitrogen is 2300 ug/l (NDEQ, 2006). Total nitrogen concentrations exceeded the water quality standard in thirteen of the twenty-three total samples collected.

Samples for total ammonia were collected in 1990, 1991, and 1992. Of the eight samples collected, none exceeded the Nebraska Water Quality Standard.

Total Nitrogen (TN) to Total Phosphorus (TP) ratios can be an indicator of potential problems with blue green algae. The lower the ratio, the more favorable the conditions are for blue greens to out-compete other types of algae. Literature suggests that ratios below 11.0 favor blue green algae. Ratios for Carter Lake ranged from a high of 21.5 in 2002 to a low of 6.7 in 2000. Ratios less than 11.0 were exhibited for nine of the seventeen dates from 2000 through 2005. The median ratio for the period of record was 10.9.

Figure 9. Total Nitrogen Concentrations in Carter Lake (2000-2005)



Dissolved Oxygen

For aquatic life, one of the most important constituents dissolved in water is oxygen. Sources of dissolved oxygen to a lake or reservoir include flowing water, transfer from the atmosphere, and production by plants. Oxygen is consumed or removed from these systems through chemical and biological processes causing oxygen demands. The amount of dissolved oxygen water can hold is dependent upon water temperature. Warmer water has less of a capacity to hold dissolved oxygen than cooler water.

While numerous dissolved oxygen measurements have been taken at Carter Lake, most have been near the surface of the lake, which limits the assessment that can be made. The minimum surface measurement reported was 7.8 mg/l, which is well above Nebraska's Water Quality Standard of 5.0 mg/l (NDEQ, 2006). Four surface to bottom profiles were collected in 2003. Dissolved oxygen was measured to a maximum depth of 6.5 feet. The profile collected in August 2003 exhibited measurements below the water quality standard at depths of 3 feet and 5 feet.

Metals

The influx of heavy metals can be a concern for reservoirs that have urban watersheds. Contamination from heavy metals can cause both short-term and long-term concerns for human health and aquatic life.

Information on heavy metals in Carter Lake was available from 1990 and 1992 (Table 8). The only metals found in concentrations above the laboratory reporting limit were dissolved arsenic and dissolved iron. Neither dissolved arsenic nor dissolved iron was found in concentrations above Nebraska's Water Quality Standards.

Table 8. Metals Concentrations in Carter Lake

Metal	Number of Samples	Concentrations (ppb)	Number of Standards Violations
Total Selenium	2	R.L.	0
Dissolved Arsenic	2	3.09 & 1.52	0
Dissolved Copper	2	R.L.	0
Dissolved Iron	2	94.0 & 17.5	0
Dissolved Iron	5	R.L.	0
Dissolved Lead	2	R.L.	0
Dissolved Manganese	2	R.L.	0
Dissolved Nickel	2	R.L.	0
Dissolved Zinc	2	R.L.	0
Total Mercury	2	R.L.	0

R.L. = pollutant was at or below the reportable limit

In 1990, a total of 28 different contaminants were analyzed from the bottom sediments of Carter Lake (Table 9). The only detectable concentrations found were for heavy metals. While there are no state water quality standards for metals in bottom sediments, arsenic was slightly above guidelines developed for Great Lakes Harbor Sediments (Fitchko, 1989). The concentration of arsenic at Carter Lake was in the range of concentrations found in the bottom sediments of other eastern Nebraska reservoirs surveyed by NDEQ in 1990.

Table 9. Summary of Pollutants Monitored in the Bottom Sediments of Carter Lake (1990).

Pollutant	**Number of Samples**	**Concentration(a)**	**Comparative Concentrations(b)**
Alachlor (mg/kg)	1	ND	None Established
Aldrin (mg/kg)	1	ND	None Established
Dieldrin (mg/kg)	1	ND	None Established
Chlordane (mg/kg)	1	ND	None Established
4,4 DDE (mg/kg)	1	ND	None Established
4,4 DDD (mg/kg)	1	ND	None Established
DDT (mg/kg)	1	ND	None Established
Endrin (mg/kg)	1	ND	None Established
Heptachlor (mg/kg)	1	ND	None Established
Heptachlor Epoxide (mg/kg)	1	ND	None Established
Toxaphene (mg/kg)	1	ND	None Established
Gamma BHC (mg/kg)	1	ND	None Established
PCB-1242 (mg/kg)	1	ND	None Established
PCB-1254 (mg/kg)	1	ND	None Established
PCB-1221 (mg/kg)	1	ND	None Established
PCB-1232 (mg/kg)	1	ND	None Established
PCB-1248 (mg/kg)	1	ND	None Established
PCB-1260 (mg/kg)	1	ND	None Established
PCB-1016 (mg/kg)	1	ND	None Established
Total Cadmium (mg/kg)	1	0.81	6 mg/kg
Total Selenium (mg/kg)	1	0.20	None Established
Total Arsenic (mg/kg)	1	7.48	3mg/kg-8mg/kg
Total Copper (mg/kg)	1	7.9	25mg/kg-75mg/kg
Total Lead (mg/kg)	1	27.6	40mg/kg-60mg/kg
Total Mercury (mg/kg)	1	0.07	1mg/kg
Total Nickel (mg/kg)	1	12.8	20mg/kg-50mg/kg
Total Zinc (mg/kg)	1	35.5	90mg/kg-200mg/kg
Total Iron (mg/kg)	1	11.5	None Established

(a) ND = not detected
(b) U.S. EPA Region V, Guidelines For The Pollutional Classification Of Great Lakes Harbor Sediments. Concentration range indicates “Moderately Polluted” to “Heavily Polluted” sediments.

Bacteria

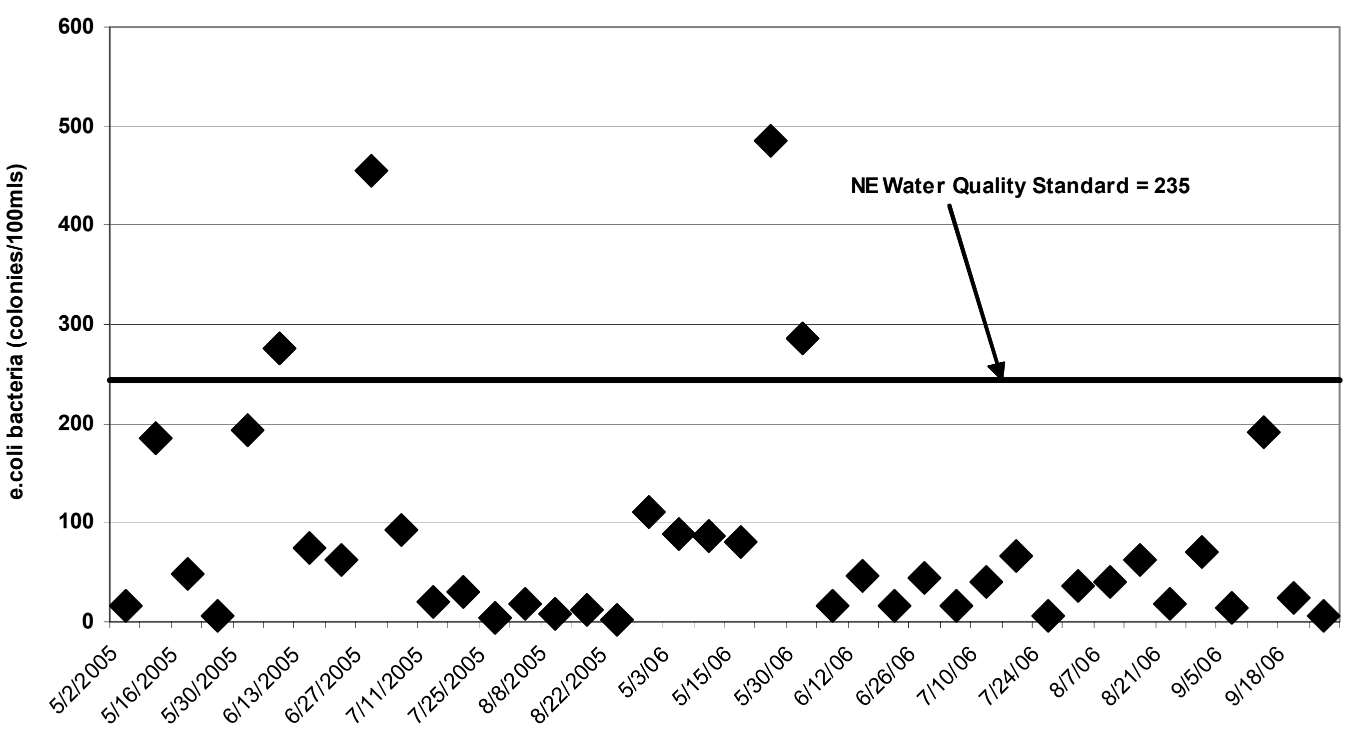
Microorganisms are ever present in all terrestrial and aquatic ecosystems. While many types are beneficial, functioning as agents for chemical decomposition, as food sources for larger animals, and as essential components for the nutrient cycle, they can also cause illness if ingested by humans.

Waste from warm-blooded animals is a source for many types of bacteria found in waterbodies. Fecal coliform and E.coli bacteria are used as indicators for more serious types organisms being present. Unfortunately, most types of bacteria originate from a multitude of sources (sanitary wastewater, stormwater, livestock and wildlife) making it difficult to differentiate between individual contributions.

Fecal coliform bacteria in Carter Lake were monitored during the 2000 recreation season (May 1 – September 30). In 2005 and 2006, fecal coliform monitoring was replaced with E.coli bacteria monitoring. Seven of the twenty-three fecal coliform samples collected in 2000 exceeded Nebraska's Water Quality Standard of 400 colonies per 100 mls (Figure 10). The geometric mean was 178 colonies per 100 mls.

A total of forty E.coli samples were collected in 2005 and 2006. While the geometric mean of 39 colonies/100mls was well below the standard of 126, four of the forty samples exceeded the single sample maximum standard of 235 colonies per 100 mls (Figure 10).

Figure 10. E. Coli Bacteria Concentrations In Carter Lake (2005-2006)



Sediment

Sedimentation is the sinking of particles (silt, algae, dead organisms) through the water column and their deposition on the bottom of the impoundment. In Nebraska, a majority of the sedimentation to reservoirs stems from soil erosion during runoff events. In addition to the loss of useable lake area for recreation, sedimentation can affect water temperatures, water transparency, nutrient levels, and habitat. Sediment loading in urban drainages can increase significantly during land development. There is no information available to estimate historic sediment loading and deposition in Carter Lake.

Carter Lake Fishery Assessment

The fishery at Carter Lake has a long history of fish management and pollution related problems, such as poor water quality. Frequent winter-kills during the 1970s and 1980s were a symptom of the nutrient and sediment loading from the urbanized watershed as well as the overall shallow nature of this oxbow lake. The combined affect of frequent fish kills and the ever present rough fish population made establishing and maintaining a sport fishery in Carter Lake difficult. At the present time the Carter Lake fishery is both a contributor to and a product of the poor water quality.

The desired sport fishery consisting of largemouth bass, bluegill, crappie, and channel catfish, is present in Carter Lake but negatively impacted by rough fish populations and poor water quality. A rough fish population made up of common carp, black bullhead, and buffalo species compete for resources and contribute to the poor water quality. The feeding activity of carp uproots aquatic vegetation and re-suspends nutrients leading to turbid water conditions and aquatic vegetation dominated by nuisance algae. Under these conditions reproduction of largemouth bass an important predatory fish species is severely limited. Fish stocking efforts to overcome this largely fail given the poor water quality and lack of habitat. Without a significant top predator in the lake, rough fish and slow growing bluegills dominate. Other undesirable fish species present in Carter Lake that compete for resources include yellow bass, freshwater drum, and gizzard shad. Under the present state of the fishery, anglers enjoy limited success fishing for crappie and channel catfish.

The numerous Best Management Practices (BMP) including eradicating the rough fish being explored by the CLEAR Council will benefit the water quality and the fishery. Eliminating the rough fish population in Carter Lake requires a whole lake chemical treatment with a fish toxicant labeled “rotenone”. This treatment will eradicate all of the fish in the lake. Restocking the Carter Lake with largemouth bass, bluegill, crappie, and channel catfish would begin within weeks of the treatment. Success and long term benefits of this technique will depend on preventing the re-establishment of rough fish in the lake. Fortunately, one of the most likely sources of common carp introduction from the past has been eliminated because the Missouri River no longer floods into Carter Lake. Educating anglers about not reintroducing undesirable species like carp and yellow bass will be an important task. With the improved water quality and lack of common carp in the lake, aquatic vegetation will re-establish itself providing important fish habitat and tying up nutrients once available to algae.

Fish Tissue

In 1978 the Regional Ambient Fish Tissue Monitoring Program (RAFTMP) was initiated. This program initially monitored rivers and streams for toxic organic and inorganic contaminants in fish tissue but was expanded in 1986 to include lakes and reservoirs. Carp and largemouth bass were sampled in Carter Lake during the 1980s, 1990s and 2000s. Carp were analyzed in 1988 and 1989, and largemouth bass were collected from 1990-92, and again in 1996, 2000, 2001 and 2005. Numerous pollutants were screened, including polychlorinated biphenyl compounds (PCBs), several pesticides including DDT and dieldrin, and four heavy metals, including mercury. PCBs, Chlordane and its isomers, DDE, hexachlorobenzene, and mercury and selenium were all detected. PCB concentrations were above the fish consumption advisory trigger levels in 1990-92, and again in 1996. In 2000, PCBs were below detection limits. In 2001 fish tissue samples were mistakingly not analyzed for PCBs, therefore no values were available and it stayed on the advisory list. Carter Lake was sampled in 2007 but results have not been received from the laboratory (NDEQ, 2007).

V. Project Goals and Objectives

From the list of water quality related issues, the Watershed Technical Advisory Team presented qualitative project goals to the Watershed Council. The Watershed Council discussed the suggested qualitative goals and approved the following goals for use as the foundation for established of quantitative objectives and the development of management alternatives. The qualitative goals are:

Goal 1. Achieve a "Full Support" status for the aquatic life use.

- Objective 1. Increase growing season median water clarity from 16 inches to 54 inches to meet the Iowa Lake Restoration Program Goal, but not to fall below 30 inches to meet the TMDL goal.
- Objective 2. Reduce growing season in-lake total phosphorus from 153 ug/l to 75 ug/l.
- Objective 3. Reduce growing season in-lake nitrogen from 2,140 ug/l to 409 ug/l.
- Objective 4. Decrease growing season median chlorophyll *a* concentrations from 59 mg/m3 to 21 mg/m3.
- Objective 5. Maintain water column average dissolved oxygen above 5.0 mg/l throughout the year.
- Objective 6. Maintain healthy aquatic habitats that support balanced populations of fish, amphibians/retiles and invertebrates.

Goal 2. Reduce contaminant levels in fish to "safe levels."

- Objective 7. Reduce and maintain contaminant levels below water quality standards in the Carter Lake inflows.

Goal 3. Achieve and maintain a "full support" status for the recreation use.

- Objective 8. Maintain E. coli bacteria concentrations below 235 col./100mls during the recreation season.
- Objective 9. Maintain algae toxin concentrations below 7 ppb for all 22 weeks of the recreation season and prevent level of algae toxins above 20 ppb in any measurement.
- Objective 10. Provide a sustainable recreational fishery by adopting regulations and management plans jointly recommended by the Iowa Department of Natural Resources and the Nebraska Game and Parks Commission.

Goal 4. Maintain a "full support" status for the aesthetic use.

- Objective 11. Keep the lake and park free of trash and junk.
- Objective 12. Stabilize areas of eroding shoreline.

VI. Nine Key Elements

A. Pollutant Sources

Pollutants that contribute to reduced water quality in Carter Lake originate from both natural and man-made processes and activities that occur in the watershed and within the lake itself. Pollutant loads from the watershed, also called external loads, are dependent on the land use, human and animal activities, and soil types that are present in the watershed. The primary land uses within the Carter Lake watershed include large residential areas, industrial/commercial areas, airport parking lots, city streets, a golf course, park area/open space, and open water areas, such as wetlands, ponds, and the lake itself. Some examples of sources that contribute to the external load from the watershed include nutrient-rich fertilizers, runoff from streets that contain grease/oil, pet and animal waste, and processes that occur at some industrial sites.

Pollutant loads from within the lake are called internal loads. Internal pollutant loads result from resuspension of lake-bottom sediment and pollutants, decay of dead organisms such as fish and aquatic plants, and from shoreline erosion. Sediment resuspension occurs naturally in lakes due to wind and wave action, but can be increased due to other factors, such as power boating, jet skis, and bottom feeding fish (e.g., carp and bullhead). The Total Maximum Daily Load (TMDL) report for Carter Lake reported the total existing phosphorus load in Carter Lake to be 3,166 lbs per year. The TMDL did not separate the phosphorus load into external and internal components.

Because both internal and external processes contribute phosphorus to Carter Lake, as discussed above, both categories of pollutants were evaluated in the development of the Watershed Management Plan. The Spreadsheet Tool for Estimating Pollutant Load (STEPL) was used to model the existing and future conditions of the Carter Lake watershed. STEPL is a model approved by the EPA that calculates nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs). Table 10 describes the subwatersheds and information used to model the existing external load to Carter Lake. See Figure 11 for subwatershed locations.

Table 10. Subwatershed Parameters and Estimated Existing Phosphorus Load

Subwatershed	Area (acres)	Primary Land Use	STEPL OUTPUT: Phosphorus Load (lb/yr)
W1	68	Commercial and High Density Residential	190
W2	124	Commercial and High Density Residential	281
W3	40	Low Density Residential	26
W4	357	Low Density Residential	115
W5	304	Commercial/Industrial	151
W6	30	High Density Residential	24
W7	56	High Density Residential	45
W8	13	High Density Residential	11
W9	11.5	High Density Residential	9
W10	121	Golf Course	164
W11	346	High Density Residential	239
W12	63	Airport Parking	75
W13	9	Airport Parking	11
W14	78	Airport Parking	73
		Total External Load:	**1,414 lbs**

By subtracting the STEPL output for external load from the existing total load reported in the TMDL, the existing internal load was calculated as 1,752 lbs. This reveals that over half of the phosphorus load is due to internal processes.

Figure 11. Subwatersheds

During the modeling process, several modifications to STEPL default parameters were made, as well as a number of assumptions that should be noted. First, water quality sampling was conducted throughout the duration of the project. The STEPL default pollutant concentration values associated with each land use were modified according to the sampling data to more accurately represent the existing conditions specific to the Carter Lake watershed. In addition, STEPL does not have a default runoff concentration for golf courses, therefore a 'user defined' land use category was created and the concentration was determined based on the sampling data and typical values found in research/literature. A modification for the pollutant loading to the lake was also made based on historical evidence that indicated that the golf course pond overflows and discharges to the lake only during infrequent, high intensity rainfall events. Therefore, the load from the pond was reduced by a factor of three to reflect discharge once every three years on average.

The TMDL Report (NDEQ, 2006) established that total phosphorus loading should be reduced from 3,166 lbs to 1,462 lbs per year, which is a 53.8 percent reduction. The CLEAR Water Council established a more aggressive goal of 75 percent reduction on phosphorus loading to Carter Lake. Recall that the STEPL model used in the development of the Watershed Management Plan estimated the existing external load to be 1,414 lbs per year. Even if the entire external watershed load is eliminated, 1,752 lbs (the internal load) would remain, and neither the TMDL target nor the CLEAR Water Council goal would be attained. Therefore, the Watershed Management Plan must include both watershed BMPs, as well as in-lake water quality improvement alternatives.

A comprehensive package of recommended watershed BMPs to reduce the external load to an achievable level was modeled using STEPL. Recommended watershed BMPs include alum stormwater injection, a wet detention pond, bioretention (rain gardens, bioswales, filter strips, and vegetated buffers), septic tank inspections, stormwater quality inlets, fertilizer management, and pet waste management. Pollutant reductions for each BMP were obtained using STEPL defaults and commonly used literature values. The location and configuration of the various watershed BMPs are described in the Management Practices and Load Reductions Section of the Watershed Management Plan. The STEPL simulation of post-BMP conditions reveal that a reduction of 796 lbs of phosphorus per year could feasibly be obtained by implementation of the recommended watershed BMPs. This equates to a 25-percent reduction in total load to the lake.

The phosphorus reductions from in-lake improvement alternatives were assessed by a variety of methods outside of the STEPL model. In-lake improvement alternatives include in-lake alum treatment, wetland enhancement/creation, watercraft management, fish renovation, shoreline stabilization, sediment forebays, and targeted dredging. Phosphorus reductions associated with each alternative are reported in Management Practices and Load Reductions Section of the Watershed Management Plan. A total removal of 1,359 lbs of phosphorus is predicted from in-lake improvements. Combined with the external reduction of 796 lbs, the Watershed Management plan is projected to remove a total of 2,155 lbs of phosphorus loading per year from the lake. This results in an annual load of 1,011 lbs per year to Carter Lake. The projected reduction exceeds the TMDL target and gets very near the goal of the CLEAR Water Council. The phosphorous reduction associated with several alternatives (fertilizer management, pet waste management, targeted dredging, and information and education activities) was not able to be quantified, but the associated reductions will likely meet and possibly exceed the goals set by the CLEAR Water Council.

B. Load Reductions and Targets

While the goals established for Carter Lake are achievable, they are very aggressive. Given the excessive amount of internal phosphorus loading in the lake, management and protection efforts within the boundaries of the lake will be as essential as watershed treatment. This includes negating as much historical damage to the lake as possible. In-lake alternatives such as the alum treatment, fish renovation and targeted dredging will provide a significant amount of immediate benefits by removing a pool of phosphorus that has built up in the lakes bottom sediments, biomass of fish and in the water column. These alternatives will remove approximately 65,800 pounds of phosphorus from the lake. This is equivalent to 21 years worth of phosphorus loading. Without implementing these measures, water quality improvements realized from external loading reductions would be noticed only on a long-term basis, if at all. These alternatives will also provide extended benefits for internal reductions in phosphorus.

The estimated phosphorus reduction from all the recommended Watershed and In-lake alternatives is 2,155 pounds, equating to a 69% reduction in the total phosphorus load (Table 11). This would meet the TMDL phosphorus loading reduction goal of 53.8% but is 6% short of meeting the goal of 75% established by the CLEAR Council (Table 12).

While annual loading reductions could not be quantified for some of the alternatives, the extended benefits of targeted dredging and the Information/Education Program could account for additional reductions. A large reduction to the external phosphorus load could be achieved from addressing pet waste alone. It was estimated that 863 pounds of phosphate is generated in the watershed on an annual basis just from dogs. While the amount of pet waste that reaches the lake on an annual basis is unknown, it could constitute a large percentage of the external phosphorus load and thus a potentially large reduction if the problem was addressed successfully through education and enforcement of existing ordinances. Additionally, the reductions estimated for individual alternatives is probably less than what would be achieved with all alternatives working together.

Maintaining a full lake will be critical for the long-term improvement in water quality at Carter Lake. Low water levels are more conducive to the re-suspension of bottom sediments. If a supplemental water source is considered for Carter Lake it is highly recommended that the quality of that water be closely evaluated in respect to the water quality goals in this plan. Low phosphorus water could provide water quality benefits through dilution while high phosphorus water would comprimise the goals of this plan.

It should be stressed that the goal of this plan is to meet a desired state of water quality in the lake. While the loadings and loading reductions provide the numeric path to achieve this desired state there are no guarantees that the desired state will be achieved. As with any long-term plan, an extensive monitoring program is needed to evaluate progress in meeting goals. If goals are not met in a reasonable period of time, adjustments should be made to the plan. Finally, while this plan focuses on phosphorus, other damaging pollutants such as PCBs, bacteria, sediment, and oil and grease will also be addressed by the recommended alternatives.

Table 11. Estimated Phosphorus Loading Reductions From Recommended Alternatives

Alternative	Estimated Reduction (pounds)	Percent Reduction
Watershed Treatment		
Detention/Alum Injection	504	16
Bioswales/Bioretention	218	7
Septic Tank Inspection/Upgrade	49	2
Water Quality Inlets	25	1
Sub-totals	***796***	***26***
In-lake Treatment		
In-lake Alum	448	14
Wetland Creation	270	9
Fish Renovation	168	5
Shoreline Stabilization	130	4
Sediment Forebays	103	3
Targeted Dredging	Not Estimated	
Information/Education	Not Estimated	
Sub-totals	***1,359***	***35***
Other Alternative Considerations		
Watercraft Management	240	8
Supplemental Water Supply	Not Estimated	
Whole Lake Dredging	Not Estimated	
Stormwater Filters	Not Estimated	
Sub-totals	***240***	***8***
TOTALS	**2,155**	**69**

Table 12. Phosphorus Reductions Based on TMDL and Council Goals

Existing Annual Load	TMDL Target Reduction	CLEAR Council Target Reduction
3,166 pounds	1,703 pounds (53.8%)	2,374 pounds (75%)

C. Management Practices

The CLEAR Council, Technical Advisory Council, and Olsson Associates conducted a thorough evaluation of techniques that could be used to improve water quality at Carter Lake. The CLEAR and Technical councils were well aware that an aggressive plan would need to be implemented to achieve the desired conditions. In doing so, a holistic approach was taken in accounting for problems and pollutant sources both in the watershed and in the lake itself. It was a priority for the CLEAR Council to include a strong Information and Education program to accompany the treatment alternatives. The Information and Education program is intended to be dynamic to account for needs as the implementation of alternatives progresses.

Water quality alternatives were separated into three categories in this plan: 1) Watershed Alternatives, 2) In-lake Alternatives, and 3) Other Alternative Considerations. Alternatives were evaluated individually based on estimated phosphorus reduction effectiveness and social acceptability, then as a package to determine if nutrient reduction and other water quality goals could be achieved. While the estimated phosphorus reduction for each alternative is reported, the uncertainty around these estimates is high and the cumulative benefits of all the alternatives are unknown. The CLEAR and TA councils encourage project sponsors to implement all the Watershed and In-lake Alternatives and Information/Education Program as recommended in this plan. The Other Alternative Considerations were either not adopted by the CLEAR Council or were not addressed in the water quality planning process.

The total phosphorus load reduction needed to meet the goal of the Total Maximum Daily Load (TMDL) is 1,704 pounds or a 53.8% reduction from the calculated in-lake and watershed loads. If all the Watershed and In-lake Alternatives recommended were implemented, an estimated reduction of 2,155 pounds (69%) could be realized. While water quality experts were not able to quantify annual reductions for the some of the alternatives, they could cumulatively account for the additional 6% reduction needed to meet the more aggressive reduction goal of 75% established by the CLEAR council. Where possible, phosphorus loading reductions were reported as an "average annual reduction." Some alternatives, such as the in-lake alum treatment and targeted dredging will provide a significant initial phosphorus reduction in addition to longer term reductions. The initial reductions were reported when applicable.

While treatment cost was not a consideration for the inclusion of a practice into the plan, preliminary cost estimates of each practice is included to provide project sponsors and possible funding sources with additional information for the final selection of alternatives. Estimated costs for each practice are based on initial construction costs and do not account for annual maintenance. Annual maintenance costs are provided in the Estimate of Costs section of this plan.

1. Watershed Alternatives

Slightly less than 50 percent (1,414 pounds) of the total phosphorus in the reservoir comes from external sources or the "watershed." Several alternatives were identified to address these pollutant loads. The reduction to the phosphorus load if all the recommended Watershed Alternatives were implemented is estimated to be 796 pounds, which equates to a 56 percent reduction to the external load and a 25 percent reduction to the total load.

Alum Stormwater Injection

This alternative offers very high pollutant removals from stormwater entering Carter Lake. A chemical (alum) is injected into the stormwater system, where it binds with phosphorus and other pollutants and settles to the bottom of a sediment basin near the lake, or within the lake itself. High and relatively certain pollutant reductions are to be expected with this alternative. The injection system would function like a small-scale treatment plant, and would include alum storage facilities (which may be located in the ground), an injection pumping system, an alum feed system to convey alum from the storage tanks to the stormwater system and a contact chamber.

We recommend using an alum injection system to treat flows outleted from the 60-inch concrete outfall and the wet pond at the northwest corner of the lake. If it is feasible to route the 60-inch concrete outfall into the wet detention pond (as described in the section below), these could be treated with one injection system.   It is also recommended that an alum injection system be implemented to treat the stormwater that enters the northeast corner of the lake at the intersection of Abbott Drive and Carter Boulevard. The feasibility of this option is uncertain and would have to be investigated in further detail. Water quality data at all three of these locations indicated high phosphorus concentrations. Alum injection would remove 80 to 90 percent of this phosphorus, in addition to very high removals of bacteria, suspended sediment, and heavy metals.

Northwest System

*Estimated Phosphorus Reduction	*Treatment Cost
437 pounds annually	$506,000

* *The reduction and cost in this table include both the wet detention pond and the alum injection system.*

Northeast System

Estimated Phosphorus Reduction	Treatment Cost
67 pounds annually	$97,000

Wet Detention Pond

Wet ponds offer a moderate to high sediment removal efficiency, and moderate to high phosphorus and bacteria removal. There are limited places to incorporate new wet detention ponds in the Carter Lake Watershed. We would recommend construction of new ponds as part of the overall stormwater system whenever the opportunities arise. There is an existing wet pond that should be retrofitted to increase water quality benefits located at the northwest corner of the lake in Levi Carter Park.

The wet pond at the northwest corner of the lake has historically provided some water quality treatment. However, due to years of filling with sediment, vegetation, trash, and debris, this pond is no longer functioning well for water quality improvement. There is a dense algae layer at the surface in the summer, and very low water clarity. Sampling data confirm that outflow from this pond will add to the load of phosphorus and other pollutants to the lake. Our recommendation includes cleaning out and expanding this pond to increase pollutant removal. If feasible, it is suggested that the 60-inch concrete outfall located south of the pond be rerouted to flow into the detention pond to provide additional treatment to the stormwater that would have drained directly to the lake. The feasibility of this option is uncertain and would have to be investigated in further detail.

The expansion of the wet pond may offer aesthetic and recreational benefits to the users of the lake and park, as well as additional wildlife habitat and a setting for outdoor education. In addition, this pond may feature multiple basins for increased treatment, and may be used in conjunction with an alum stormwater injection system described above. Design considerations should include any future park enhancements (e.g. fountains, trails, parking lots).

The golf course pond collects stormwater from a number of pump stations throughout the City of Carter Lake. The frequency of discharges from the pond to the lake is not well documented, but is thought to occur every three to four years. Consequently, in some years, the phosphorus load to the lake from this pond may be zero. The overall impact to the lake when overflow does occur is not as damaging as initially expected. Even if the overflows from the golf course pond with high phosphorus concentrations discharge to the lake once every three years, the load is not significant compared to other more constant sources of pollutants. Dredging or introduction of wetland vegetation would be helpful, but is not a requirement for this plan. Due to the infrequent overflow of the pond, improvement to this feature does not have high priority. Costs were not determined for this alternative because of the low priority.

The practice of using the water in the pond to irrigate the golf course should be continued. This provides benefits by recycling stormwater, thus reducing potable water usage, by promoting ground filtration and through nutrient consumption by the turf. The estimated phosphorus reduction and treatment cost is included in the Northwest Alum Stormwater Injection System above.

Bioretention (Rain Gardens), Bioswales, Filter Strips, and Vegetated Buffers

Bioretention features, often referred to as "rain gardens," are a type of structural best management practice (BMP) commonly used for stormwater quality improvement in urban areas. When properly designed and maintained, they can offer highly efficient reduction of phosphorus, as well as other pollutants.

More specifically, rain gardens can be placed next to paved commercial areas, in city right-of-ways, and in other key areas around the lake. We strongly encourage the implementation of rain garden features at the golf course, which can add value to the landscape as well as to water quality. Similarly, we would encourage the promotion of rain gardens as a landscaping technique at private residences. These could be installed individually or as clusters. Development of a cost-share program may make this a more feasible option. Other lower cost options, such as rain barrels exist for homeowners as well. As with other structural BMPs, widespread implementation across the watershed will greatly enhance the overall pollutant reductions achieved by this alternative. The City of Carter Lake has already installed two rain gardens on public property covering approximately 2,000 square feet. It should be noted that the annual removal of dead plant biomass from any vegetated system would decrease the transport of nutrients to the lake.

Vegetated bioswales, filter strips, grass swales, and vegetated buffers are watershed alternatives that function much in the same way, but take slightly different forms. They should be implemented throughout the watershed as improvements to existing ditches, replacements for concrete-lined channels, and substitutes to concrete pipes and channels for future construction. All four alternatives utilize vegetation to improve water quality through filtration, increased infiltration to the ground, and in uptake of nutrients into plant biomass. There are several concrete channels near the lake that could be replaced with one of these methods. In addition, existing swales and ditches in Levi Carter Park could be enhanced with vegetation more suitable for water quality improvement. Two flow routes that run through the golf course and into the lake should be modified to function as vegetated bioswales. Lastly, a vegetated buffer is suggested for locations around the perimeter of the lake.

Estimated Phosphorus Reduction	Treatment Cost
*218 pounds annually	*$1,487,600

* *The reduction and cost in this table include both bioretention and bioswale alternatives and were based upon the quantity and placement suggested by Olsson as seen on Figure 1. This includes 100,000 square feet of bioretention at an estimated $8.00 per square foot and 3,750 linear feet of vegetated bioswale/filter strips at an estimated $120 per linear foot and 32,000 linear feet of vegetated buffer at $1.50 per linear foot.*

Septic Tank Inspections

While there are numerous homes on private septic in the watershed, the contribution of pollutants such as phosphorus and bacteria to the lake is believed to be low because of land slope being minimal (reduced runoff), drainage conveyance being grass, and the low number of homes with potential problems (national failure rate being 2%). While there would be water quality benefits associated with finding and correcting failing septic tanks the cost of this effort is significant. Other more feasible options may include local health agencies conducting the inspections at a reduced cost, providing inspection cost-share to homeowners, educating homeowners on the issue, or replacing private septic systems with a sanitary sewer system.

Estimated Phosphorus Reduction	Treatment Cost
49 pounds annually	$50,000

Water Quality Inlets

Water quality inlets are placed in existing storm drains to filter pollutant-laden runoff before it enters the storm sewers, which eventually flow to Carter Lake. These inlet filters do a very good job of removing sediment and grit from runoff, as well as metals, oil, and grease and trash that is carried to the storm drains. Unfortunately their efficiency is not as high for phosphorus removal. However, the pollutants they do remove can contribute to non-algal turbidity in Carter Lake. Also, removing sediment and grit will reduce bacteria, which periodically exceeds acceptable levels for contact recreation. To achieve significant water quality improvement, grate inlets should be retrofitted with filters throughout the drainage area to Carter Lake.

Estimated Phosphorus Reduction	Treatment Cost
25 pounds annually	$45,000*

** Cost based on installing 30 filters at $1,500 per filter.*

Fertilizer Management

Fertilization is the process by which essential nutrients are artificially supplied to plants. In urban areas, lawn fertilizers can be a significant source of phosphorus to surface waters. Problems occur when fertilizers are over applied or when applied to areas that are subject to high runoff such as sidewalks and driveways. While the CLEAR Council does not recommend a phosphorus fertilizer ban, they have focused on this management practice in the Information/Education Program.

Pet Waste Management

Similar to no-phosphorus fertilizer, implementation of a pet waste management program is a simple and inexpensive method of obtaining phosphorus (and other pollutant) load reductions to the lake. Because the cities of Carter Lake and Omaha already have an ordinance that requires pet owners to pick up after their pets, we recommend continuing enforcement of this policy, as well as educating residents in both the Iowa and Nebraska portions of the watershed. An estimated 863 pounds of phosphates are generated in the watershed annually just from dog waste indicating the potential significance of this problem. This component will also be a focus of the Information/Education Program.

2. In-lake Alternatives

Over 50 percent (1,752 pounds) of the total phosphorus in the reservoir can be attributed to internal sources making the in-lake components an important part of the overall plan. Water quality in Carter Lake has slowly degraded since it first became an oxbow lake. The effects of long-term degradation need to be reversed before loading reductions can be expected to improve water quality in a reasonable period of time. The in-lake alum treatment and targeted dredging will provide a significant amount of short term benefits by removing pollutants like phosphorus and PCBs that are already in the system. Phosphorus reduction estimates for these alternatives are provided for a one-time (initial) and annual removal of phosphorus from either the bottom sediments or water column. The total amount of phosphorus that would be initially removed from the lake through the targeted dredging and in-lake alum is 65,800 pounds. This is equivalent to 21 years worth of phosphorus loading. The annual loading reduction from all the in-lake alternatives is estimated to be 1,359 pounds, which is a 78% reduction to the internal load or a 43% reduction to the total load.

In-lake Alum Treatment

Due to the high internal phosphorus load within Carter Lake, even complete control of all external loads would not necessarily result in immediate tangible benefits to the lake. Through modeling the expected impacts of watershed alternatives, it is also apparent that significant in-lake control is required to meet the water quality goals set forth by the TMDL and CLEAR Council. In-lake alum treatment involves the addition of alum to the water column of a lake. After alum is injected just below the water surface, it bonds with phosphates to form a floc, and precipitates (settles) to the bottom of the lake. The alum floc removes phosphorus and other pollutants from the water column as it settles, and forms a thin layer on the top of the sediment. This layer acts as a barrier to prevent the release of phosphorus to the water column from the sediment. The alum is not toxic to plants, animals or humans. Initially, a very high removal rate is to be expected. The lifetime of effectiveness for this alternative is very difficult to estimate, as is it is dependent upon site-specific conditions. Technical experts believe that power boating will reduce the duration of alum effectiveness through the re-suspension of bottom sediments.

Estimated Phosphorus Reduction	Treatment Cost
1,938 pounds initially 448 pounds annually	$600,000

Wetland Enhancement/Creation

In addition to creating small "pocket" wetlands as part of the sediment forebays, creation of additional, larger wetlands would be beneficial to water clarity, phosphorus reductions, and benefits associated with fish renovation. For maximum phosphorus removal, we recommend creating a large wetland near the outlet of the drainage ditch that conveys overflow from the golf course pond to the southwest end of the lake. Additionally, wetlands should be established behind the offshore breakwater structures located on the north Omaha shoreline. These large wetlands would contain rooted vegetation that will compete with floating algae for phosphorus uptake. This competition will help reduce the frequency and severity of algal blooms.

In addition to creating the wetlands described above, the large wetland on the shoreline across from Abbott Drive could be enhanced. The goal of the enhancement would be to increase the pollutant removal efficiency from the stormwater that enters this wetland from the east edge of the City. There are currently undesirable plant species along the lake side of this wetland, and the wetland has been "expanding" into Carter Lake. Rehabilitation of this wetland could help address this issue as well. Because this is an existing wetland, any activity impacting it would require permits from the US Army Corps of Engineers. The permit may require mitigation, which should be satisfied by the creation of the additional wetlands described above.

Estimated Phosphorus Reduction	Treatment Cost
270 pounds annually*	$601,310*

* *The reduction and cost are based upon the locations suggested by Olsson as seen on Figure 1. The cost to construct each wetland is highly variable, largely dependant upon the amount of cut/fill required to reach desired elevation.*

Watercraft Management

The impacts of motorized watercraft on water quality have been well documented. These impacts can relate to water clarity, shoreline erosion, bottom sediment re-suspension, and aquatic plant colonization, all of which are targeted for improvement at Carter Lake. Since the longevity of some of the proposed treatment methods will be shortened by wake producing activities the sponsors should give this alternative as much consideration as any other alternative. The CLEAR and Technical councils recommend implementing no-wake boating restrictions to effectively protect a minimum of 100 acres.

Estimated Phosphorus Reduction	Treatment Cost
240 pounds annually	Not Applicable *

* *The only direct cost associated with this alternative is in regards to how the no-wake areas are marked. Project sponsors should evaluate options for marking no-wake areas.*

Fish Renovation

The fish population of Carter Lake does not meet state fisheries management goals nor is it conducive for meeting water quality goals stated in this plan. The presence of carp and bullhead can be surprisingly significant contributors to reduced water clarity by stirring up sediments with their feeding habits. Renovating the fishery of the lake will help reduce internal pollutant loads, while at the same time rebalance the species population. Additional fish habitat and angler access structures are also important components of the fish renovation. Increased water quality and fishing opportunities will bring additional patrons to the lake. In addition to increasing water clarity, removal of existing fish tissue that has bio-accumulated PCBs over the years would remove large amounts of this harmful material from the ecosystem and food chain of the lake.

Estimated Phosphorus Reduction	Treatment Cost
168 pounds annually	$200,000

Shoreline Stabilization

The protection of the shorelines offers numerous benefits to the lake. First, it reduces erosion along the shore, which increases water clarity. While maintaining near shore water depth, some stabilization techniques also improve the aesthetics and accessibility of the shoreline. These areas can be targeted for fish habitat, which enhances the benefits of the recommended fish renovation. Shoreline stabilization efforts will require hard armoring on high boating use areas of the lake. To the extent possible, stabilization will be tailored to the preferences of the CLEAR Council and will address needs of special user groups such as the Creighton Row Team. Several different configurations of shoreline stabilization were considered, including Offshore Breakwaters, Jetties, Rock Riprap Protection, Geotube Protection and Shoreline Regrading. The quantity, location and configuration of shoreline stabilization is highly dependent upon whether no-wake zones are implemented and where they are located.

Estimated Phosphorus Reduction	Treatment Cost
130 pounds annually*	$2,483,455*

* *The reduction and cost are based upon the locations suggested by Olsson as seen on Figure 1. The locations and configurations were chosen assuming that no-wake zones will be implemented and includes a combination of the above structures to achieve a total of 13,210 linear feet of protected shoreline.*

Sediment Forebays

Forebays should be constructed at major stormwater outfalls to capture sediment as it enters the lake. This will improve water clarity of the main body of the lake by reducing suspended sediment and will also reduce phosphorus loads by capturing phosphorus that is attached to sediment. Forebays can also reduce bacteria loading, particularly for smaller runoff events. They can be constructed using a number of techniques, including riprap or geotubes filled with sediment dredged as part of the targeted dredging alternative. Establishment of wetland vegetation in these forebays would increase the water quality benefits and offer added aesthetic value.

Estimated Phosphorus Reduction	Treatment Cost
103 pounds annually*	$1,159,200*

* *The reduction and cost are based upon the locations suggested by Olsson as seen on Figure 1. This includes four forebays (perimeter length of 1,120 linear feet) at an estimated cost of $900 per linear foot.*

Targeted Dredging

Some areas in Carter Lake have become shallow from inflowing sediment. While some of the sediment is deposited throughout the lake, most of the deposition occurs near stormwater outfalls. Nearly 60 percent of the lake's surface area has a depth of at least 8 feet, which is also the mean depth. Much of the remaining 40 percent includes areas around the shoreline, and a few shallow spots within the main body of the lake. It is recommended that these areas (not including the shoreline) should be dredged to provide 8 feet of depth when the lake is at the desired level (elevation 970.3). Sediment removal in these areas will not only reduce the potential for re-suspension but the process will also remove phosphorus and other targeted pollutants such as PCBs from the lake.

Removal of sediment in these areas will do a number of things to help improve the quality of water in Carter Lake. Increased depth in shallow areas will reduce sediment re-suspension and increase water clarity. Targeted dredging will improve fish habitat, thereby increasing the water quality benefits obtained with the fisheries renovation. Targeted dredging will also increase the efficiency and longevity of whole-lake alum application. While direct benefits of targeted dredging may not be apparent, it enhances the performance of a number of other water quality improvements, making this alternative a vital component of the overall plan. The cost provided is based on sediment not containing high levels of pollutants that will require special handling and/or disposal.

Estimated Phosphorus Reduction	Treatment Cost
63,862 pounds initially* Annual Reduction Not Estimated	$1,610,000*

** The reduction and cost are based upon the locations suggested by Olsson as seen on Figure 1. This includes 92,000 cubic yards of excavation at an estimated cost of $17.50 per cubic yard. The phosphorus reduction reported is the amount of phosphorus removed that will no longer be available to be recycled, not removed directly from the water column.*

Targeted Fill

Material removed from targeted dredging will be hydraulically pumped to locations of the lake in which seepage losses may be occurring, such as the deep hole near the island by Abbott Drive. This alternative may help reduce seepage losses from Carter Lake through potential sand layers at deep elevation without adding significant additional costs over and beyond those spent on dredging. To ensure coverage of potential sand lenses the hole must be filled to elevation 954 (several feet above the sand level reported from a boring (adjacent to the hole) taken by the United States Army Corps of Engineers), which would require 35,000 cubic yards of material. The maximum volume the hole could store is approximately 64,000 cubic yards

Estimated Phosphorus Reduction	Treatment Cost
Not Estimated	Subsidiary to Targeted Dredging

3. Other Alternative Considerations

Supplemental Water Source

Water quantity has been a long-term issue at Carter Lake. Water quantity and water quality are typically connected in lakes and reservoirs. This seems to be the case at Carter Lake as well. Although a minimal amount of water quantity and water quality data was available, some constituents such as total phosphorus, algae production and water clarity appeared to be influenced by low water conditions. Additionally, the effectiveness of all the water quality alternatives were evaluated based on a full lake pool (Elevation 969.8 to 970.8) so if lake levels were low over an extended period, in-lake loading reduction targets would need to be increased to meet the desired in-lake conditions. The quality of supplemental water entering Carter Lake will play a major role in meeting the goals of this plan. Low phosphorus water would significantly benefit water quality through dilution while high phosphorus water could negate any improvements made from other efforts to reduce phosphorus in the lake.

Estimated Phosphorus Reduction	Treatment Cost
Not Estimated	$2,000,000

Whole Lake Dredging

Sediment removal for the entire lake was deemed as not being cost effective. A crude cost estimate for removing 3 feet of sediment from the bottom is about $26.7 million (approximately 1.5 million cubic yards at 17.50 per cubic yard). Additional concerns arise with the effectiveness of this treatment being unknown and potential risks with creating more seepage than what already exists. To address seepage concerns, a polymer sealant could be applied to the lake bottom after dredging is performed. This would create an additional cost ranging from $1million to $6 million.

Estimated Phosphorus Reduction	Treatment Cost
Not Estimated	$26,700,000

Prefabricated Stormwater Filter

The prefabricated stormwater filter is a passive filtration system that effectively removes pollutants from overland storm water runoff. These systems are constructed underground in concrete vaults and target a full range of pollutants in urban runoff, including sediment, soluble heavy metals, oil and grease, organics and nutrients. The system removes pollutants through mechanical filtration, ion exchange, and absorption. The system does not have high phosphorus removal rates, as some of the other alternatives do. Therefore it was not the recommended alternative in any location. However, if it is discovered past the concept development stage that the recommended alternative in a desired location is not feasible, further investigation around the feasibility/effectiveness of implementing prefabricated stormwater filter(s) is recommended.

Estimated Phosphorus Reduction	Treatment Cost
Dependent Upon Location	$9,350 - $19,550*

* *The cost is on a per unit basis and does not include installation expenses.*

D. Information and Education Program

The Carter Lake Environmental Assessment & Rehabilitation (CLEAR) council formed a sub-subcommittee to develop and promote an educational plan. The education plan is intended to be a dynamic plan that will address educational needs of the watershed residents as defined by the CLEAR Council and sub-committee. The first task of the sub-committee was to establish educational goals. An initial set of action items that support these goals have also been developed. These action items will be the focus of the first year of the project.

Goal 1. Promote stewardship among the users of public and private recreational areas within the watershed environment.

Action 1. Stencil sidewalks with awareness message to all users.
Estimated Cost: $500

Action 2. Post signs on the consequence of pet waste and trash.
Estimated Cost: $1,200

Action 3. Solicit volunteers to remove trash from the lake and park areas.
Estimated Cost: Volunteer Time

Goal 2. Promote awareness of Best Management Practices (BMP) to homeowners and businesses in the Carter Lake Watershed.

Action 4. Promote the installation of rain gardens on public and private land through the development and dissemination of information, workshops, and tours of existing sites.
Estimated Cost: $5,000

Action 5. Promote phosphorus free fertilizers by providing free soil tests and fertilizer for homeowners and holding workshops on lawn care.
Estimated Cost: $18,000

Action 6. Promote existing disposal days for auto waste products and disseminate educational materials on the impacts of these products on water quality.
Estimated Cost: $2,000

Action 7. Educate boat owners on proper fueling of watercraft and impacts of fuels on water quality.
Estimated Cost: $2,000

Goal 3. Inform the public of activities that have been done and will be done to improve the lake.

Action 8. Establishing a web-site that provides photos and continual updates on ongoing or completed components of the project.
Estimated Cost: $1,000

Action 9. Use the blue channel and local media for periodic updates on what has been done or special events related to the project.
Estimated Cost: NA

E. Schedule

The schedule for implementing the Water Quality Management Plan will be dictated by several factors. One primary factor that will influence the schedule is the acquisition and timing of grant funds. At this time the sources of project funds are unknown but it is likely that one to two years could elapse before funding is secured and required paper work is in place. The first step in the implementation process will be to hire a consultant to prepare a final Master Plan. This plan will include final designs, quantities and costs. It is also a priority to initiate the Information/Education Program. The first step in this process is to secure funding to hire an Information/Education Coordinator to develop and deliver the program. It is anticipated that implementation activities will begin sometime in 2009 and will take a minimum of four years to complete.

	2008	2009	2010	2011	2012	2013
Finalize Management Plan	X					
Initiate Information/Education Program	X					
Initiate Watershed & In-lake Treatment		X				
Initiate Project Monitoring		X				
Complete Watershed & In-lake Treatment					X	
Complete Project Monitoring					X	

F. Milestones

Pre-project planning activities will be finalized upon the completion and sponsor approval of the Water Quality Management Plan. It will take several years to fully implement the final package of recommended in-lake and watershed alternatives. Specific project milestones will become more evident as the project progresses. Milestones are closely tied to project sequencing, which has not been established. Preliminary milestones have been identified for the major project components: Information/Education Program, Watershed and In-lake Treatment, Project Monitoring.

	2008	2009	2010	2011	2012	2013
Information/Education						
- Secure Funding for I/E	X					
- Hire I/E Coordinator	X					
- Finalize I/E Work Plan		X				
- Annual Progress Evaluation		X	X	X	X	X
Watershed & In-Lake Treatment						
- Secure Funding for Master Planning	X					
- Hire Consultant for Master Planning	X					
- Master Plan & Final Design Completed		X				
- Project Funding Secured		X	X			
- All Project Permitting In Place		X	X			
- Begin Watershed & In-lake Treatment		X				
- Treatment Progress Evaluation		X	X	X	X	X
Monitoirng						
- Develop Annual Monitoring Plans		X	X	X	X	X
- Data Assessment & Reporting			X	X	X	X

G. Evaluation Criteria

The Water Quality Goals and Objectives will be the basis for evaluating the success of the project in meeting loading reduction goals since loading reductions were determined from a desired state in the lake. If funding allows, monitoring may also be conducted on the primary inflows to evaluate pre- and post project changes in water quality. A pre-project high-flow database for selected inflows was started in 2006.

An assessment of water quality data will be conducted on an annual basis. The results of these assessments will be provided to the Project Sponsors, Watershed Advisory Council, and Technical Advisory Committee. It will be the responsibility of the project sponsor to track progress on implementing the alternatives. Progress will be reported to the public through tools such as websites, the media, and written reports.

H. Monitoring

Future monitoring at Carter Lake will be conducted to serve two primary purposes. One is to facilitate the implementation of water quality alternatives and the second is to document progress in meeting project goals and objectives.

Specific monitoring may be required in order to get state and federal approval to implement some measures. For example, sediment quality tests may be required prior to the disposal of lake bottom sediments outside the lake boundaries. Specific monitoring needs related to implementing the plan will be defined in the preliminary design phase of the project.

Routine monitoring will be important in tracking water quality conditions during and after the project. Since the response in water quality to in-lake and watershed treatments are not well documented in the literature, a long-term monitoring program will be required to evaluate the progress in meeting the water quality goals and objectives identified in this plan. It should be noted that it may take several years after project completion before the biological communities and chemical constituents reach stability.

Since water quality goals and objectives pertain to in-lake conditions, monitoring activities will be focused in the lake. Routine monitoring activities will encompass a combination of physical, chemical, and biological elements. Specific monitoring approaches will be designed annually through a coordinated effort among several agencies. All monitoring activities will follow existing protocols established by the respective agencies and will be documented in an annual monitoring plan. Proposed monitoring parameters, collection frequencies and responsibilities are provided in Table 13.

Information provided from the monitoring activities will be distributed to the project stakeholders. The monitoring results will be used, as appropriate, to revise the monitoring strategies, implementation strategies, and/or the project goals and objectives.

Table 13. Proposed Monitoring at Carter Lake

Parameter	Frequency	Responsible Party (a)
Lake Water Levels	Weekly	CLPS
User Surveys	Annually	CLPS
Water Clarity	Monthly During Growing Season	NDEQ
Total Suspended Solids	Monthly During Growing Season	NDEQ
Total Phosphorus	Monthly During Growing Season	NDEQ
Kjeldahl Nitrogen	Monthly During Growing Season	NDEQ
Nitrate/Nitrite Nitrogen	Monthly During Growing Season	NDEQ
Chlorophyll	Monthly During Growing Season	NDEQ
Atrazine	Monthly During Growing Season	NDEQ
Alachlor	Monthly During Growing Season	NDEQ
Metolachlor	Monthly During Growing Season	NDEQ
Dissolved Oxygen	Monthly During Growing Season	NDEQ
Temperature	Monthly During Growing Season	NDEQ
pH	Monthly During Growing Season	NDEQ
Conductivity	Monthly During Growing Season	NDEQ
Algae Toxins	Weekly During Recreation Season	NDEQ
E.coli bacteria	Weekly During Recreation Season	NDEQ
Dissolved Copper	Annually	NDEQ
Dissolved Zinc	Annually	NDEQ
Dissolved Lead	Annually	NDEQ
Dissolved Mercury	Annually	NDEQ
Dissolved Iron	Annually	NDEQ
Dissolved Manganese	Annually	NDEQ
Total Selenium	Annually	NDEQ
Fish Tissue	One Time Every Five Years	NDEQ
Adaptive Population Monitoring - Fish	Varying Schedule	IDNR/NGPC

(a) CLPS = Carter Lake Preservation Society, NDEQ = Nebraska Department of Environmental Quality, IDNR = Iowa Department of Natural Resources, NGPC = Nebraska Game and Parks Commission

I. Resources

A. Project Cost

Olsson Associates determined "preliminary" cost estimates for water quality improvement alternatives targeted for Carter Lake. Estimates of cost are broken into the various alternative categories provided in the Alternative Section of this plan. Costs outlined below include installation/ construction cost and maintenance costs where possible.

The alternatives recommended by the CLEAR and TA councils total $9,991,620. This includes Watershed Treatment Alternatives, In-lake Treatment Alternatives and the Information and Education Program (Tables 14,15,16). Costs identified for alternatives in the "Other Alternatives for Consideration" category total $33,027,482 (Table 17).

Table 14. Estimated Watershed Treatment Cost

Activity	Installation/Construction Cost	Maintenance Cost
Bioswales/Bioretention	$1,487,600	Not Estimated
Detention/Alum Injection	$603,000	$20,000/yr(a)
Water Quality Inlets	$45,000	$100/yr/inlet
Septic Tank Inspection	$50,000	Not Applicable
Sub-Total	$2,185,600	
15% Contingency	$327,840	
TOTAL	**$2,513,440**	

(a) Annual maintenance cost based on injection at two locations

Table 15. Estimated In-lake Treatment Cost

Activity	Installation/Construction Cost	Maintenance Cost
Targeted Dredging	$1,610,000	Not Estimated
Shoreline Stabilization	$2,483,455	Not Estimated
Forebay Enhancement	$1,008,000	Not Estimated
Wetland Creation	$601,310	Not Applicable
In-lake Alum Treatment	$600,000	Not Estimated (a)
Fish Renovation	$200,000	$308,095 (b)
Watercraft Management	$0(c)	Not Applicable
Sub-Total	$6,502,765	
15% Contingency	$975,415	
TOTAL	**$7,478,180**	

(a) The longevity of this treatment is unknown. Additional treatment needs will be determined from data collected after the first treatment.
(b) Maintenance cost is a one-time cost every ten years (fish removal, restocking, vegetation management).
(c) The only direct cost associated with watercraft management is the cost of marking the designated area(s). Options for marking and associated costs should be evaluated by the project sponsors.

Table 16. Estimated Information/Education Program Cost

Activity	Installation/Construction Cost
General WQ Education	$1,500
Pet Waste & Trash Signage	$1,200
Lake Trash Removal	Volunteer Time
Rain Garden Promotion	$5,000
Phosphorus Free Fert. Promotion	$18,000
Waste Disposal Promotion	$2,000
Watercraft Education	$2,000
TOTAL	**$29,700**

Table 17. Other Alternatives for Consideration

Activity	Installation/Construction Cost
Supplemental Water Source	$2,000,000
Whole Lake Dredging	$26,700,000
Prefabricated Stormwater Filter	$19,550
Sub-Total	$28,719,550
15% Contingency	$4,307,932
TOTAL	**$33,027,482**

B. Financial Resources

There are numerous local, state and federal sources of funding for water quality restoration and protection projects (Table 18). Additional funding opportunities are available for Carter Lake given its location within two states. Funding may be needed for multiple activities such as project planning, management practice installation, Information/Education activities and monitoring.

In contrast to raising revenue through taxes and fees, which are subsequently dedicated to environmental projects, bonds, loans and grants can be used to invest in pollution prevention, environmental protection, and environmental improvements.

Bonds and loans entail repayments of principal and interest, although interest rates may be governmentally subsidized. In contrast, grants represent sums of money awarded by local, state and federal governmental entities and even the private sector for specifically designated purposes for which no repayment is required. Each form of capital, bonds, loans and grants, serves distinct purposes and have certain limitations.

Government loan programs have similar limitations as do government grant programs, although interest rates on the loans may be subsidized particularly for small communities. In contrast, commercial loans are more flexible, but typically more expensive for public and private borrowers. Commercial loans represent the greatest source of investment capital for private businesses, compared to grants and bonds. At present, the tax-exempt municipal bond market remains the dominant source of governmental environmental financing in this country, even compared to grants and loans. The federal wastewater treatment construction grants program has virtually ended, and even the Clean Water State Revolving Fund (SRF) loan program which has replaced it and the newer Drinking Water SRF, operate through the bond market. Over half of the Clean Water SRFs issue bonds to leverage their wastewater loans. By the end of 1997, these SRFs had issued almost $10 billion in revenue bonds out of a total loan pool of $24 billion. Furthermore, local debt obligations, both general obligation and revenue bonds, account for the greatest source of local capital for environmental improvements ranging from pollution control to parks and open space.

Although bonds represent the largest source of ready and expandable capital, they are the most complex and expensive way to borrow, with the exception of SRF bond-backed loans for which interest rates are subsidized. The high expense results from legal and other fees, administrative time, and in some cases the voter approval process required for issuing bonds. Since small borrowers incur the same costs as large borrowers, loans may be more advantageous for small borrowers than bonds.

While grants are the cheapest source of funds, comparisons of government grant/loan equivalency ratios demonstrate that additional governmental mandates required under grants may substantially raise the costs and time of construction (lowering the effective value of the grant aid). Grants are regarded as highly desirable by recipients, and are often crucially important in startup situations. However, since grants are designed by the awarding agency to meet certain, often specific, goals, they may carry additional mandates, require matching monies, involve difficult application procedures, and be piecemeal and small in size for individual recipients. Grants, moreover, are hardly free in the sense that the ultimate sources of funds are tax dollars. The redistribution of tax revenues to some communities and not others can be a very sensitive issue. Historically, many grant programs have been somewhat unstable since they must be approved annually by legislative bodies whose memberships are ever changing. The total amount of grant monies, moreover, is strictly limited by appropriation and competition.

Information on environmental financing, in part, was exerted from the Environmental Protection Agency website: www.epa.gov (EPA, 2008).

C. Technical Resources

Project sponsors will need technical assistance throughout the course of the project. The Technical Advisory Team (TAT) that was established for the Community Based Planning Process will serve as the primary technical advisors for the implementation project. Representatives of this group can provide assistance in fishery management, water quality, landuse planning, parks and recreation, monitoring, and grants administration. Private consultants can be obtained for specialized assistance not provided by agencies represented on the TAT. Specialized assistance includes such things as the estimation of quantities and cost, engineering design, the development of bid packages, preparing requests for proposals, and obtaining permits.

Table 18. List of Potential Funding Sources for Environmental Projects

Administering Entity	Program Name	Program Description
IDALS/DSC www.agriculture.state.ia.us/waterqualitypractice.htm	Soil and Water Enhancement Account (REAP & WPF)	REAP funds for water quality improvement projects and wildlife habitat & forestry practices; 50-75% cost-share; Used as state match for EPA 319 funding
IDALS/DSC www.agriculture.state.ia.us/lwpp.htm	Local Water Protection State Revolving Loans (SRF)	Low interest loans provided by SWCDs to landowners for permanent water quality improvement practices; subset of DNR program
USDA/NRCS www.nrcs.usda.gov/programs/whip/	Wildlife Habitat Incentives Program (WHIP)	Cost-share contracts to develop wildlife habitat
USDA/NRCS www.nrcs.usda.gov/programs/ccpi/index.html	Cooperative Conservation Partnership Initiative (CCPI)	Conservation partnerships that focus technical and financial resources on conservation priorities in watersheds and airsheds of special significance
USDA/NRCS	Iowa Conservation and Partnerships: "Supersheds" Program	Cooperative effort among conservation agencies and organizations to combine resources to implement resource improvement projects
USDA/NRCS www.nrcs.usda.gov/programs/watershed/index.html	Public Law 83-566	Contains authority to improve water quality as well as control flooding, reduce soil erosion, provide recreation, and provide a water supply
USDA/NRCS www.nrcs.usda.gov/programs/watershed/pl534.html	Public Law 78-534	Permanent practices built for the purpose of erosion and flood control in Little Sioux River basin.
USDA/NRCS www.nrcs.usda.gov/programs/cig/	Conservation Innovation Grants (CIG)	Nationwide grants for innovative solutions to a variety of environmental challenges
ACOE www.mvp.usace.army.mil/environment/	Aquatic Ecosystem Restoration - Section 206	Restoration projects in aquatic ecosystems such as rivers, lakes and wetlands
IDALS www.agriculture.state.ia.us/IWIRB.htm	Watershed Improvement Fund	Local watershed improvement grants to enhance water quality for its beneficial uses including economic development.
EPA/IDNR www.iowadnr.com/water/nonpoint/index.html	Section 319 Clean Water Act	Source of low-cost financing for farmers and landowners, livestock producers, community groups, developers, watershed organizations, and others
EPA www.iowadnr.com/water/nonpoint/watershed.html	Targeted Watershed Grants	Nationwide grants for implementation of activities and BMPs specifically designed to improve water quality

Table 18. (Cont.)

Administering Entity	Program Name	Program Description
EPA www.epa.gov	Water Quality Cooperative Agreements [Section 104(b)(3)]	Developing, implement, and demonstrate innovative approaches relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution
IDNR www.iowadnr.com/water/tmdlwqa/index.html	Water Monitoring and Assessment Program	Information available concerning water quality in lakes, streams, and wetlands
IDNR www.iowater.net/defaultExp.htm	IOWATER	Training, supplies, and technical support for citizen water quality monitoring network; subset of ambient program
IDNR/IFA www.iowadnr.com/water/srf/index.html	State Revolving Fund (SRF)	Provides low interest loans to municipalities for waste water and water supply; expanding to private septics, livestock, stromwater, and NPS pollutants
IDNR	Lake Restoration Fund	Provides funding for restoration of Iowa's publicly owned lakes, in combination with watershed improvement to improve water quality. New in 2006
IDNR www.iowadnr.com/reap/index.html	Resource Enhancement and Protection Program (REAP)	Provides funding for enhancement and protection of State's natural and cultural resources
IDNR/DSC	Stream bank Stabilization & Habitat Improvement	Penalties from fish kills used for environmental improvement on streams impacted by the kill
IDNR www.iowadnr.com/other/mapping.html	GIS mapping data for watershed managers	Watershed Atlas provides a variety of interactive GIS data layers for watershed planning on all watersheds in Iowa
IDNR wqm.igsb.uiowa.edu/	Ambient Water Quality Monitoring Network	Delivers consistent, unbiased information about the condition of Iowa’s surface and groundwater resources
IDNR www.iowadnr.com/water/index.html	Other Water Programs	
Federal Agencies cfpub.epa.gov/fedfund/	Other Grant and Loan Programs	Searchable database for federal funding programs
IDNR	Conservation Reserve Enhancement Program (CREP II) **	To maintain and improve the water quality of priority lakes and cold water streams in Iowa
NE Environmental Trust www.environmentaltrust.org/	Environmental Project Fund	To preserve critical habitat areas, protect water supplies and establish recycling programs in Nebraska

Table 18. (Cont.)

Administering Entity	Program Name	Program Description
EPA/NDEQ www.deq.state.ne.us	Section 319 Clean Water Act	Grants to implement NPS pollution control programs & projects; Requires 40% non-fed. match
NDEQ www.deq.state.ne.us	State Revolving Loans (SRF)	Low interest loans provided for water quality improvement practices
Papio-Missouri River NRD www.papionrd.org		The NRD provides funds for flood control and environmental education and restoration projects in their district.
NGPC www.ngpc.state.ne.us	Aquatic Habitat Program	Administers lake and reservoir rehabilitation funds for targeted waterbodies

Acronyms: USDA/NRCS=United States Department of Agriculture/Natural Resources Conservation Service, IDALS/DSC=Iowa Department of Agriculture and Land Stewardship, ACOE=United States Army Corp of Engineers, IDNR=Iowa Department of Natural Resources, NDEQ=Nebraska Department of Environmental Quality, NGPC=Nebraska Game and Parks Commission, Papio-Missouri River NRD=Papio-Missouri River Natural Resources District.

VII. References

Chow, Ven Te. 1964. Handbook of Applied Hydrology. McGraw-Hill Book Company.

Fitchko 1989. Criteria for Contaminated Soil/Sediment Cleanup. Pudvan Publishing Company, Northbrook, Illinois.

Holdren, C., W. Jones, and J. Taggart. 2001. Managing Lakes and Reservoirs, North American Lake Management Society and Terrene Inst., in coop. with Office of Water Assess. And Watershed Protection Div., US EPA, Madison, WI.

IDNR. 2006. Chapter 61: Iowa water quality standards. Iowa Administrative Code, Iowa Department of Natural Resources.

ISU. 2007. The Economic Value of Iowa's Natural Resources Daniel Otto, Dan Monchuk, Kanlaya Jintanakul,and Catherine Kling, Department of Economics, ISU Extension Center for Agricultural and Rural Development College of Agriculture, Iowa State University. Commissioned by the Sustainable Funding for Natural Resources Study Committee, Iowa General Assembly December, 2007

NDEQ 1995. Holmes Lake Stormwater Study-Bacteria Assessment. Nebraska Department of Environmental Quality, Surface Water Unit. Lincoln, NE.

NDEQ 2007. Regional Ambient Fish Tissue Monitoring Program. Annual Fish Tissue Reports 1990 – 2001. Nebraska Department of Environmental Quality, Lincoln, NE.

NDEQ 2003. Stepping Toward Better Watershed Management in Nebraska – A Community Based Approach to the Watershed Management Planning Process, Nebraska Department of Environmental Quality, Water Quality Planning Unit. Lincoln, NE.

NDEQ 2006. Title 117 – Nebraska Surface Water Quality Standards, Nebraska Department of Environmental Quality, Water Quality Division. Lincoln, NE.

NOAA 2000. National Oceanic and Atmospheric Administration – National Climatic Data Center. 2000. Climatological Data Annual Summary, Nebraska, 2000, Volume 105, Number 13.

Reckhow, K.H. 1992. EUTROMOD Nutrient Loading and Lake Eutrophication Model. Duke University – School of the Environment. Durham, NC.

USACE 1985. Section 22 Study Planning Assistance to States. Evaluation of Lake Levels for Carter Lake, Iowa Hydrology Analysis. United States Army Corps of Engineers, Engineering Division, Omaha District, Omaha, NE.

USACE 1997. Holmes Lake Area-Capacity Tables. United States Army Corps of Engineers, Engineering Division, Omaha District, Omaha, NE.

USCB 2005. U.S. Census 2005. United State Census Bureau, Washington, D.C.

USDA 1975. Soil Survey of Douglas and Sarpy Counties, Nebraska. United States Department of Agriculture – Soil Conservation Service.

USDA 1987. Reservoir Operation Study Computer Program (RESOP) User Manual, Technical Release 19 (TR-19). United States Department of Agriculture - Natural Resources Conservation Service.

USEPA 1992. Stormwater Management Model, Version 4, October 1992, USEPA, Athens, GA.

USEPA 1999. Protocol for Developing Nutrient TMDLs. United States Environmental protection Agency. Office of Water, 4503 F, Washington, D.C.

USEPA 2008. Guidebook of Financial Tools. U.S. Environmental Protection Agency Website: www.epa.gov/efinpage/guidebook.htm

USGS 2000. Water Resources Data, Nebraska, Water Year 2000, Water Data Report NE-00-1. United States Geological Survey. Lincoln, NE.

Young, R.A., C.A. Onstad, D.D. Bosch, and W.P. Anderson, 1987. AGNPS, Agricultural Nonpoint Source Pollution Model. A watershed analysis tool. U.S. Department of Agriculture, Conservation Research Report 35.

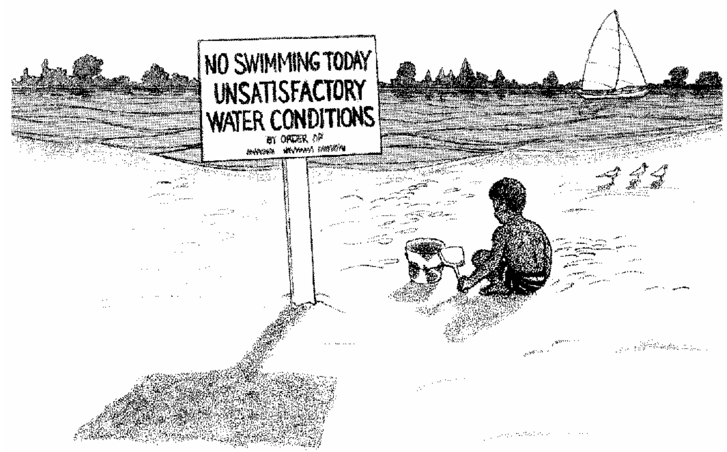
Appendices

Appendix A. Meeting Documentation

Appendix B. Carter Lake TMDL

Appendix A

THE LAKE IS SICK



Diagnosis: Runoff pollution from homes, yards, businesses, streets, sidewalks, parking lots and driveways is making Carter Lake sick.

Remedy: Develop a watershed management plan to prevent runoff pollution and improve the water quality in Carter Lake.

Prescription: Watershed residents, business owners, lake users, interested citizens are invited to attend Community Based Watershed Management Planning Public Meetings to develop a Carter Lake Watershed Management Plan:

Thursday, October 5, 2006 7 p.m. – 9 p.m.

Tuesday, October 24, 2006 7 p.m. – 9 p.m.

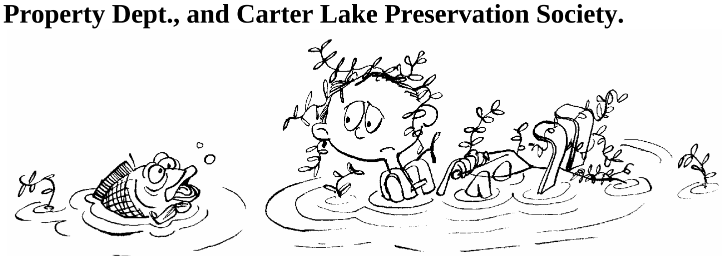
Carter Lake Elementary School

1105 Redick Blvd, Carter Lake

Doors open at 6 p.m. ; Meeting starts at 7 p.m.

Sponsored by City of Carter Lake and City of Omaha

Cooperating Agencies- Iowa Natural Resources Conservation Service, Iowa Dept. of Natural Resources, Papio-Missouri River Natural Resources District, West Pottawattamie County Iowa Extension, University of Nebraska–Lincoln Extension in Douglas/Sarpy Counties, Nebraska Dept. of Environmental Quality, Nebraska Game and Parks Commission, Nebraska Dept. of Natural Resources, MAPA, West Pottawattamie County Soil and Water Conservation District, Omaha Public Works Dept., Omaha Parks, Recreation and Public Property Dept., and Carter Lake Preservation Society.



Carter Lake Watershed Public Meeting #1
October 5, 2006
Carter Lake Elementary School
1105 Redick Blvd., Carter Lake, Iowa

Agenda

7:00 P.M. Welcome — Steve Tonn

Introduction of Project Sponsors

7:10 P.M. Watershed Resource Issues

Water Quality Issues — Paul Brakhage, NDEQ

Fisheries Issues — Chris Larson, Iowa DNR

7:40 P.M. Community Based Watershed Management Planning Process — Steve Tonn,

7:50 P.M. Watershed Vision Statement Exercise — Facilitators/TAT Members

8:40 P.M. Wrap Up and Announce 2nd Public Meeting — Steve Tonn

8:45 P.M. Displays Open and Informal Discussion with TAT

Carter Lake Watershed
Public Meeting # 2
October 24, 2006

Agenda

7 p.m.	Welcome	Steve Tonn
7:05	Present Draft Vision Statement	Kevin Seevers
7:10	Recap of Public Meeting #1	Steve Tonn
7:20	Brainstorming Resource Concerns/Issues	Facilitators/TAT Members
7:50	Break and Voting/Prioritizing Resource Concerns	
8:05	Discussion of Role of Watershed Council Recruitment of Watershed Council Members	Steve Tonn
8:15	Report on Prioritizing of Resource Concerns	TAT Members
8:30	What's Next and Adjourn	Steve Tonn

Establishing the Watershed Council
Identifying Goals and Objectives relating to Resource Concerns/Issues

Carter Lake Watershed Council Meeting
November 28, 2006

Agenda

1. Introductions

2. Role of Watershed Council - Steve Tonn, Douglas/Sarpy Counties Extension

    A. Watershed Council Name

    B. Additional Members from Watershed from Omaha

        1. Omaha businesses in watershed – Kevin Seevers, West Pott. Co. SWCD

    C. Watershed Council Officers

3. Carter Lake TMDL - Pat O'Brien, Nebraska Dept. of Environmental Quality

4. Review and Discuss Resource Concerns/Issues – Watershed Council/Technical Advisory Team

5. Discuss Goals and Objectives for Resource Concerns/Issues –Watershed Council/Technical Advisory Team

    Alternative Matrixes – Paul Brakhage, Nebraska Dept. of Environmental Quality

        In Lake

        Watershed

        Request For Proposal for a Consultant

6. Next Meeting Date, Time, Location

Carter Lake Watershed Council Meeting Minutes
November 28, 2006

Members present were Hani Haider, Steve Wilbur, Merle Harder, Mike Dailey, Doug Dodson, Barb Hawkins, Pam Christensen, Julie McKillip, Les Lundberg, Peter Parkert, Pam Parkert; and Technical Advisory Team members Lynn Dittmer, MAPA; Paul Brakhage, NDEQ; Pat O'Brien, NDEQ; Gerry Bowen, Papio-Missouri River NRD; Ron Rothmeyer, City of Carter Lake; Harald Flatoen, Omaha Public Works Dept.; Kevin Seevers, West Pott. Co. SWCD; Joan Harder, CLPS; Jeanne Eibes, CLPS; Mike McGhee, Iowa DNR; Chris Larson, Iowa DNR and Steve Tonn, Douglas/Sarpy Counties Extension.

The meeting began with introductions by Watershed Council members and Technical Advisory Team members. Steve Tonn discussed the role of the watershed council and emphasized their role as decision makers in the development of the watershed management plan. The group discussed trying to increase the membership of the Council to include members from North Omaha and other interest groups. Kevin Seevers distributed a list of Omaha business owners in the watershed. Peter Parkert mentioned that an Omaha Airport Area Business Owners Group used to be active in the area. Mr. Parkert offered to contact the inactive members and invite them to participate on the Council. The consensus of the group was that this would be a better approach than sending out several members to visit with the business owners individually. Ron Rothmeyer will contact fishermen and the Boys Club and invite them to participate on the Council. Steve Wilbur asked if the Omaha Airport Authority should be invited to serve on the Council. The Omaha Airport Authority is an important stakeholder. Steve Tonn will invite the Omaha Airport Authority to serve on the Council. Steve Wilbur offered to contact the Levi Carter Park caretaker about serving on the Council. Kevin Seevers reported that he had visited with the Shoreline Golf Club greens keeper about the Council. Kevin said that the greens keeper indicated an interest in being involved. Steve Tonn asked if the members wanted to select a name for the Council. Discussion followed with several ideas expressed. The Council will decide on a name at the next meeting. The expectation is for Watershed Council members to lead the meetings and work with Kevin Seevers and Steve Tonn and other technical advisory team members in the development of the plan. A leadership team of a chairperson, vice-chairperson and secretary will be selected at the next meting.

Pat O'Brien, NDEQ, presented information on the Carter Lake Total Maximum Daily Load (TMDL) standard established for Carter Lake. The presentation was very informative and a lively discussion followed. Hani Haider suggested that the Council learn about the Municipal Separate Storm Sewer System permit that is required for the City of Carter Lake and Omaha. Representatives from the two cities will be asked to come to a future meeting to discuss the topic. The Council reviewed and discussed the list of resource concerns/issues identified at the public meetings in October 2006. Hani Haider noted that water level was the primary issue identified at the meetings. A discussion followed on whether that was an item that the Council could address or had authority to do anything about. Ron Rothmeyer reported that the City of Carter Lake and the City of Omaha are addressing that issue. They recognize it as a major public concern. The Watershed Council's focus is on water quality while realizing that water quantity is closely related to or connected to water quality. The consensus of the group was to address the water quality issue that they could influence and leave the water quantity issue to the cities. The Council will be greatly interested in the decision on how to stabilize the lake water level and how that impacts the water quality of the lake. Council members are asked to review the list of resource concerns prior to the next meeting. Paul Brakhage distributed a list of other issues outside water quality that may need to be forwarded to other agencies. Setting goals and objectives to meet the water quality related resource concerns is the responsibility of the Watershed Council. Steve Tonn distributed copies of goals established by other urban watersheds for the Council to review. The Council will work on setting goals at their next meeting. Paul Brakhage also handed out a list of watershed treatments to improve inflowing water quality and in lake treatments to improve water quality. These treatment suggestions will be used in the goal setting phase. Paul Brakhage gave Council members a sample list of Carter Lake Water Quality Goals with undetermined quantitative objectives for the Council members to review. Council members are asked to bring these lists to the next meeting.

The meeting adjourned at 9 p.m. The next Carter Lake Watershed Council meeting will be Wednesday, January 10, 2007 at 7 P.M. at the Carter Lake Library, 1120 Willow Drive, Carter Lake.

<u>Council Member Tasks for Next Meeting</u>

Peter Parkert - Contact North Omaha businesses and invite to serve on Council
Steve Wilbur – Contact Levi Carter Park caretaker and invite to serve on Council
Ron Rothmeyer – Contact fishermen and Boys Club representatives and invite to serve on Council
All Council members – Review resource concerns, example goals, in-lake and watershed treatment lists, ideas for group name, possible leadership team nominees
Steve Tonn – Contact Omaha Airport Authority and invite to serve on Council
Kevin Seevers – Contact Shoreline Golf Course greenskeeper and invite to serve on Council

Carter Lake Watershed Council Meeting
January 10, 2007 7 p.m.
Carter Lake Library, 1120 Willow Drive, Carter Lake,Iowa

AGENDA

1. Introductions

2. New Members Update - Peter Parkert, Kevin Seevers, Steve Tonn

3. Select Council Name

Suggestion by member: CLEAR Water Council

Carter Lake Environmental Assessment and Rehabilitation Water Council

Other suggestions??

4. Select Council Officers
   - Chairperson
   - Vice Chairperson
   - Secretary

5. Discuss and Set Qualitative Water Quality Goals - Council/TAT

6. Discuss forming Information and Education Sub Committee – Paul Brakhage

7. Stormwater runoff data collection and RFQ Update – Kevin Seevers

8. Set Next Meeting Date

CLEAR Water Council Meeting Minutes 1/10/07

Meeting held at 7 pm. On January 10, 2007, Carter Lake Library, 1120 Willow Drive, Carter Lake, Iowa
Participants attended:
Council members: Pam Christensen, Hani Haider, Merl Harder, Barbara Hawkins, Wayne Houston, Stephanie Kelley, Les Lundberg, Julie McKillip, Pam Parkert, Peter Parkert, Bill Van Trump, Doug Wallingford and Steve Wilbur.
Technical Advisory Team members: Steve Tonn (Douglas/Sarpy Counties Extension), Gerry Bowen (Papio-Missouri River NRD), Rollie Cape, Terry Hickman (Nebraska Dept. of Environmental Quality), Pat Slaven (Omaha Parks Dept.), Lynn Dittmer (Metro Area Planning Agency), Kevin Seevers (West Pott. Co. Soil & Water Conservation Dist.), Mark Porath (Nebraska Game and Parks Commission), Pat O'Brien, Paul Brakhage (Nebraska Dept. of Environmental Quality), Jeanne Eibes (Carter Lake Preservation Society) and Ron Rothmeyer (City of Carter Lake).

1. Introduction: This meeting was first chaired by Steve Tonn, who re-introduced the Watershed Council members and the Technical Advisory Team members for the benefit of newcomers.
2. Latest list of Members: Peter Parkert, Kevin Seevers and Steve Tonn introduced new members of the council. The full list is now included at the end of this document.
3. Liaison with the Airport Business Park Association: Peter Parkert will continue to approach the association to seek their active involvement. Meanwhile, Peter Parkert will serve as their interim representative to the CLEAR Water Council until the Airport Business Park Association meets to formally appoint a person for this position.
4. Council Name: A name was suggested by a council member as follows: <u>C</u>arter <u>L</u>ake <u>E</u>nvironmental <u>A</u>ssessment and <u>R</u>ehabilitation (CLEAR) Water Council. The short name echoes the major goal of the council discussed and decided in the previous meeting, which is to improve the lake water quality, most importantly manifested by its "clarity". No other names were suggested, and this name was chosen unanimously.
5. Selection of Council Officers: Steve Tonn introduced the need for members to elect a Chairperson, Vice Chairperson and Secretary for the Council. He presided over this process, which resulted as follows:
   - Hani Haider was nominated to chair the council. He reluctantly accepted the nomination, and on the condition that the workload will be largely shared by the group. He was unanimously elected.
   - Pater Parket was nominated to be Vice Chairperson, and unanimously elected.
   - Stephanie Kelley was nominated to act as secretary for the group and was unanimously elected.

   Hani Haider was requested to chair the remainder of the meeting.

6. Qualitative Water Quality Goals: Discussing these took most of the remaining time of the meeting, and they were all set with consensus reached on every item.

Goal 1. Achieve A "Full Support" Status for the Aquatic Life Use

Objective 1: Increase growing season median water clarity from 16 inches to 30 inches
Objective 2: Reduce growing season in-lake total phosphorus from 153ug/l to 75ug/l.
Objective 3: Reduce growing season in-lake total nitrogen from 2,140ug/l to 409ug/l.
Objective 4: Decrease growing season median chlorophyll a concentrations from 59mg/m3 to 21mg/m3.
Objective 5: Maintain water column average dissolved oxygen above 5.0mg/l through out the year.

Goal 2. Reduce Contaminant Levels In Fish To "Safe" Levels

Objective 6: Reduce and maintain contaminant levels below water quality standards in the Carter Lake inflows.

Goal 3. Maintain A "Full Support" Status For The Recreation Use

Objective 7: Maintain E.coli bacteria concentrations below 235 col./100mls during the recreation season.
Objective 8: Maintain algae toxin concentrations below 7 ppb for all 22 weeks of the recreation season and prevent level of algal toxins above 20 ppb in any measurement.

Goal 4. Maintain A "Full Support" Status For The Aesthetic Use

Objective 9: Keep the lake and park area free of trash and junk.
Objective 10: Stabilize areas of eroding shoreline.

7. Information and Education Sub Committee: Paul Brakhage introduced the merit of having such a Task Force and its benefit in similar past projects. The chair reminded the group of the valuable contribution of Barbara Hawkins on this issue in a previous meeting and how she would therefore be most qualified to lead this effort. Barbara Hawkins kindly accepted this role, and will kindly compile a list of nominees for this task force and will present in future meetings a list of initiatives proposed to this end.

8. Stormwater runoff data collection and RFQ Update: Kevin Seevers updated the group on this matter and related it to the requirements by the City of Carter Lake to comply with the upcoming federal requirements in this area.

9. Next Meeting: Will be 7-9pm Wed. 7th Feb. 2007 at the Carter Lake Library, 1120 Willow Drive, Carter Lake, Iowa.

10. Meeting adjourned at 9.30 pm.

Carter Lake Watershed Council
Name Address Phone Email
Dan Chipps 7325 N 106th Avenue, Omaha 402-551-5962 dchipps@creighton.edu
Pam Christensen 174 Carter Lake Club, CL 402-330-3088 twchristensen@ditol.com
Mike Dailey 510 Coronado Circle 712-847-0308 rdailey711@yahoo.com
Doug Dodson 1005 Shoals Point, CL 712-347-5808 gimisstex@cox.net
Hani Haider (Chairperson) Please send to this email too: hhaider@unmc.edu
4428 N 6th Street, CL 402-210-3340 haiderathome@cox.net;
Merl Harder 1010 Shoal Drive, CL 402-578-9533 merlharder@cox.net
Barb Hawkins 1220 Avenue O, CL 402-943-7892 barbara.hawkins@aquila.com
Wayne Houston 4105 N 17th Street, CL whouston@bgcomaha.org
Stephanie Kelley (Secretary)
10 Marina Court, CL 402-706-3933 stephanie.kelley@cbshome.com
Les Lundberg 3705 N 17th Street, CL 712-347-5267 bionoprene@cox.net
Julie McKillip 51 Carter Lake Club, CL 712-347-5404 julie.mckillip@conagrafoods.com
Peter Parkert Vice (Chairperson)
1418 Linwood Drive, CL 712-847-0217 Peter@hutchesonengineering.com
Pam Parkert 1418 Linwood Drive, CL 712-847-0217
Tracy Suess 801 Avenue P, CL 402-598-5935
Bill Van Trump 4420 N 17th Street, CL 712-347-5717 bevantru@up.com
Doug Wallingford 10 Marina Court, CL 402-510-5351 dougbldrguy@aol.com
Steve Wilbur 4412 N 17th Street, CL 712-847-0217 sswilbur1@aol.com

Carter Lake Technical Advisory Team
Paul Brakhage Nebraska Dept. of Environmental Quality paul.brakhage@ndeq.state.ne.us
Gerry Bowen Papio-Missouri River NRD gbowen@papionrd.org
Lynn Dittmer Metro Area Planning Agency ldittmer@mapacog.org
Dale Duval Natural Resources Conservation Service-Iowa Dale.Duval@ia.usda.gov
Jeanne Eibes Carter Lake Preservation Society carterlake@hotmail.com
Harald Flatoen Omaha Public Works Dept. hflatoen@ci.omaha.ne.us
Steve Gaul Nebraska Dept. of Natural Resources sgaul@dnr.ne.gov
Joan Harder Carter Lake Preservation Society joanharder@cox.net
Terry Hickman Nebraska Dept. of Environmental Quality Terry.Hickman@ndeq.state.ne.us
Pat Jesse Metro Area Planning Agency pjesse@mapacog.org
Chris Larson Iowa Dept. of Natural Resources chris.larson@dnr.state.ia.us
Josh Lear Nebraska Dept. of Natural Resources jlear@dnr.ne.gov
Mike McGhee Iowa Dept. of Natural Resources Mike.Mcghee@dnr.state.ia.us
Paul Mullen Metro Area Planning Agency Paul_Mullen@mapacog.org
Marlin Petermann Papio-Missouri River NRD mpetermann@papionrd.org
Jan Petersen Carter Lake Preservation Society tpetersen3@cox.net
Mark Porath Nebraska Game and Parks Commission Mark.Porath@ngpc.ne.gov
Brad Richardson West Pott. County Extension Service □maha□ds@iastate.edu
Ron Rothmeyer City of Carter Lake clmaint@cox.net
Steve Scarpello Omaha Parks Dept. sscarpello@ci.omaha.ne.us
Kevin Seevers West Pott. Co. Soil & Water Conservation Dist. Kevin.Seevers@ia.nacdnet.net
Pat Slaven Omaha Parks Dept. pslaven@ci.omaha.ne.us
Steve Tonn Douglas/Sarpy Counties Extension stonn2@unl.edu

CLEAR Water Council Meeting
February 7, 2007

AGENDA

1. Introduction of all members	Hani Haider, Chairperson
2. Book Keeping Matters	Hani Haider, Chairperson
3. Engineering Consultants for the CLEAR Water Council	Steve Tonn, UNL Extension
4. In- Lake Treatment Options	Paul Brakhage, NDEQ
5. Inclusion of Fisheries Objectives into CLEAR Council Goals	Mark Porath, NGPC
6. Any other Business	
7. Next Meeting Date	

CLEAR Water Council Meeting Minutes 2/7/07

Meeting held at 7 pm. on 7th Feb. 2007, Carter Lake Library, 1120 Willow Drive, Carter Lake, IA

Participants attended:

Council members: Pam Christensen, Doug Dodson, Hani Haider, Merl Harder, Wayne Houston, Stephanie Kelley, Les Lundberg, Julie McKillup, Peter Parkert, Doug Wallingford and Steve Wilbur.

Technical Advisory Team members: Steve Tonn (Douglas/Sarpy Counties Extension), Gerry Bowen (Papio-Missouri River NRD), Paul Brakhage (Nebraska Dept. of Environmental Quality), Lynn Dittmer (Metro Area Planning Agency), Jeanne Eibes (Carter Lake Preservation Society), Steve Gaul (Nebraska Dept. of Natural Resources), Joan Harder (Carter Lake Preservation Society, Chris Larson (Iowa Dept. of Natural Resources), Ron Rothmeyer (City of Carter Lake), Kevin Seevers (West Pott. Co. Soil & Water Conservation Dist.), Pat Slaven (Omaha Parks Dept.), Bob Waters (Iowa Div. of Soil Conservation).

Engineering consultants: Jason Farnsworth and Charles McFarland (Olsson Associates).

1. **Meeting was called to order by the Chairman, Hani Haider.**
2. **Minutes for January meeting were approved.**
3. **Book keeping matters:** Hani Haider requested that some secretarial and vice chairmanship support needs to materialize to split the administrative and book keeping load to maintain high momentum for this project. Peter Parkert was requested to ensure that draft minutes are produced soon after the meeting to enable finalization and circulation in good time after the meeting.
4. **Engineering consultants for the CLEAR Water Council:**

The City of Omaha and the City of Carter Lake, Carter Lake Watershed Project Sponsors, with the assistance of the Carter Lake Watershed Technical Advisory Team, had hired an engineering firm to serve as a consultant to evaluate alternatives for meeting the goals and objectives established by the CLEAR Water Council. The consultants were invited to attend the meeting to learn more about the council's vision.

Steve Tonn (Douglas/Sarpy Co. Ext. Office) introduced the two consultants Jason Farnsworth and Charles McFarland of Olsson Associates. They will be working with the CLEAR Water Council by means of a 319 grant from the NDEQ to offer implementation guidance to the water shed plan objectives.

Jason Farnsworth and Charles McFarland discussed the "vision" of CLEAR and explained that they would be offering alternatives to the implementation of our vision, assuring us of their intent to coordinate all of the CLEAR objectives into a comprehensive draft by August, 2007. Jason and Charles provided some background information about Olsson Engineering's experience in other water shed plans, as well as comments and advice throughout the remainder of the meeting.

5. **Inclusion of fisheries objectives into the CLEAR Water goals:** The council was invited to consider including the fisheries objectives into the water quality goals which were omitted at the previous meeting. Two extra objectives were proposed by Mark Porath of the Nebraska Game and Parks Commission, to be added among the ones adopted by the council in the previous meeting.

The two objectives were presented by Chris Larsen as "Maintain healthy diverse aquatic habitats that support balanced populations of fish, herps and invertebrates." and "Provide a sustainable recreational fishery by adopting regulations and management plans recommended by the Iowa Department of Natural Resources and the Nebraska Game and Parks Commission."
Both were discussed and approved by the council to be included among the CLEAR Water Council objectives, to make the full set now read as follows:

Goal 1. Achieve A "Full Support" Status For The Aquatic Life Use

- Objective 1: Increase growing season median water clarity from 16 inches to 30 inches
- Objective 2: Reduce growing season in-lake total phosphorus from 153ug/l to 75ug/l.
- Objective 3: Reduce growing season in-lake total nitrogen from 2,140ug/l to 409ug/l.
- Objective 4: Decrease growing season median chlorophyll *a* concentrations from 59mg/m3 to 21mg/m3.
- Objective 5: Maintain water column average dissolved oxygen above 5.0mg/l through out the year.
- Objective 6: Maintain healthy diverse aquatic habitats that support balanced populations of fish, herps and invertebrates.

Goal 2. Reduce Contaminant Levels In Fish To "Safe" Levels

- Objective 6: Reduce and maintain contaminant levels below water quality standards in the Carter Lake inflows.

Goal 3. Maintain A "Full Support" Status For The Recreation Use

- Objective 7: Maintain E.coli bacteria concentrations below 235 col./100mls during the recreation season.
- Objective 8: Maintain algae toxin concentrations below 7 ppb for all 22 weeks of the recreation season and prevent level of algal toxins above 20 ppb in any measurement.
- Objective 9: Provide a sustainable recreational fishery by adopting regulations and management plans recommended by the Iowa Department of Natural Resources and the Nebraska Game and Parks Commission.

Goal 4. Maintain A "Full Support" Status For The Aesthetic Use

- Objective 9: Keep the lake and park area free of trash and junk.
- Objective 10: Stabilize areas of eroding shoreline.

6. Watershed Treatments to Improve Water Quality – Discussion led by Paul Brakhage of the Nebraska Dept. of Environmental Quality. This item took most of the meeting, and centered around the matrix shown in the next page. The left-most column listed options (tools/techniques) which were suggested by the expert group as influential to solve the CLEAR main problems. The last three items in that column were suggested by the council members for exploration too. The headings of all the other columns represented the potential "effects/benefits" which the given options was expected to produce. An X in the body of the matrix indicates that that tool may be very effective in producing the corresponding benefit.

The options which were discussed most and commanded the major interest by the council were lake deepening and sediment removal (dredging). Removal of spoil was explored vs. rearrangement of spoil into unused or un-navigable areas of the lake. Discussion varied over whether or not there was any of the lake water body that could be sacrificed to make room for fill from the dredge. Trade-off ideas suggested giving up lake area in order to created fish habitat and fishing "holes". Habitats and wake breakers, rain garden construction, or wetlands development were also discussed.

Wayne Houston, the Boys Club representative volunteered to conference with his board of directors as to the viability of use of dredge material to create wetlands construction on their property. Possible pumping methods (although not the focus of the CLEAR water-shed plan) were mentioned including ongoing Omaha/Carter Lake joint efforts with Kiwanis pond well.

Stabilization concerns included recreational boating, no wake areas, fishing jetty's to break wakes and waves, and various seawall stabilization methods.

Goose deterrents were discussed with comments about Avian bird flu concerns, E. Coli concerns, depopulation of the flocks, and education of the general lake residents about the goose related contaminates.

Power boating influences on the water shed plan were discussed from both recreational and erosion perspectives. The Olsson Associates consultants asked for help with determining boating route habits of lake boaters in order for them to make suggestions for any shoreline or wetland shoreline alterations Steve Wilbur volunteered to gather information about boating use to present in a future meeting.

Trash removal was decided to remain in the domain of the Carter Lake Preservation Society annual clean-up events along with public awareness and education for ongoing lake trash patrol.

The council was encouraged by the chairman to "prioritize" among the above mentioned options to ensure that the effort was effective in bringing results. However, both the technical team and the consulting engineers advised that all items would be considered and worked on equally without regard to ranking.

The discussion on this topic was adjourned to be continued in the next meeting.

7. **Information and Education Committee:** Julie McKillup delivered (on behalf of Barb Hawkins, chair of the Education Committee of the CLEAR Council) information pamphlets to Steve Wilbur, Kevin Seevers and Paul Brakhage. The Education Committee will provide some more information at the March meeting.
8. **Next Meeting:** Will be 7-9pm Wed. 14th March 2007 at the Carter Lake Library, 1120 Willow Drive, Carter Lake, Iowa.
9. **Meeting adjourned at 9.30 pm.**

CLEAR Water Council Meeting
March 14, 2007

AGENDA

1. Introduction of all members	Hani Haider, Chairperson
2. Book Keeping Matters	Hani Haider, Chairperson
3. Education Task Force Report	Barb Hawkins, Task Force Chairperson
4. Carter Lake User Survey	Jeanne Eibes, Carter Lake Preservation Society
5. In-lake and Watershed Treatment Alternatives	Paul Brakhage, NDEQ
6. Any Other Items	
7. Next Meeting Date	

CLEAR Water Council Meeting Minutes 031407

Meeting held at 7 pm. on 14th March 2007, Carter Lake Library, 1120 Willow Drive, Carter Lake, Iowa

Participants attended:

Council members: Pam Christensen, Mike Daley, Doug Dodson, Hani Haider, Merl Harder, Wayne Houston, Stephanie Kelley, Les Lundberg, Julie McKillup, Peter Parkert, Pam Parkert, Doug Wallingford and Steve Wilbur.

Technical Advisory Team members: Steve Tonn (Douglas/Sarpy Counties Extension), Deana Barger (Nebraska Dept. of Environmental Quality), Paul Brakhage (Nebraska Dept. of Environmental Quality), Lynn Dittmer (Metro Area Planning Agency), Jeanne Eibes (Carter Lake Preservation Society), Harald Flatoen (Omaha Public Works Dept.), Joan Harder (Carter Lake Preservation Society, Barbara Hawkins (Carter Lake City Council), Bryan Hayes (Iowa Department of Natural Resources), Chris Larson (Iowa Dept. of Natural Resources), Mark Porath (Nebraska Game and Parks Commission), Ron Rothmeyer (City of Carter Lake), Kevin Seevers (West Pott. Co. Soil & Water Conservation Dist.), Pat Slaven (Omaha Parks Dept.).

Engineering consultants: Jason Farnsworth and Charles Ikenberry (Olsson Associates).

1. Meeting was called to order by the Chairman, Hani Haider. He welcomed Deana Barger, a new technical assistant from the Nebraska Dept. of Environmental Quality (NDEQ). Chairman Haider also accepted the resignation of Barbara Hawkins from the CLEAR Council to be able to fulfil her Carter Lake City Council obligations. Barbara Hawkins was thanked by the chairman and the whole CLEAR council for her efforts thus far, and was kindly invited to continue to contribute as chair of the CLEAR Council Educational task force.

2. Minutes for February meeting were approved.

3. Book keeping matters: Chairman Haider re-asserted the importance of accurate and detailed minutes as a comprehensive record of the CLEAR council discussions and actions. In the end, the history and reports from the whole effort, and the overall outcome may very largely depend on what was strictly documented.

4. User Survey:

Jeanne Eibes of the Carter Lake Preservation Society introduced a lake user's survey (two sheets attached below) that will gather recreational information and habitats through a multi seasonal pattern of personal interviews with boaters, fisherman and park users. She appealed for volunteers to perform a series of interviews using a standard format. She volunteered to manage the collection of these interviews to compile an objective bias-free database which will in turn be handed over to the technical team and Olsson Associates engineers. Paul Brakhage (NEDEQ) helped explain the usefulness of the survey which will help guide the lake use as it relates to the watershed plan.

5. Education/communication about the CLEAR Water Council mission and effort

Barbara Hawkins and Julie McKillup informed the Council that the sub-committee on education had had their first meeting on 20th of February. Their discussion included how

to disseminate the CLEAR Council main mission and accomplishments to the Carter Lake public. This would be augmented by incentive-driven programs with school children, side walk stencils to remind people to curb their dogs and back yard clean-ups etc. Such initiatives would add to the existing lake clean up success coordinated by the Carter Lake Preservation Society. Interest and involvement has been solicited from the Carter Lake Improvement Club and the Resource Center. The CLEAR Council discussed coordinating closely with existing programs already in place and using the blue channel to inform the public.
Barbara Hawkins promised to report more comprehensively on this effort in the following meeting, and introduce some preliminary proposals.

6. In-lake and Watershed Treatment Alternatives (continued from last meeting).

a. Paul Brakhage (NE Dept. of Env. Quality) continued his presentation and the council continued discussions on in-lake alternatives. (Table attached).

b. Boating usage patterns: Steve Wilbur summarized his findings from unofficial interviews he kindly performed with a number of people who have historically used Carter Lake for varying purposes. Among those interviewed were fisherman, boaters, members of Creighton rowing team, and ski club members. He synthesized his findings into a schematic diagram superimposed on a photograph of Carter Lake to illustrate where different parts of the lake could potentially be isolated for different uses. He presented this scheme for preliminary discussions.

The predominant outline of current usage of the lake showed it uniformly spread out. Steve Wilbur show one possible scheme for partitioning the lake for different activities. A rich discussion by the council demonstrated the usual passion from various activity interests. Many opinions were voiced regarding boat, jet skiing, and fishing preferences. Several technical team advisors echoed that allowing general use of the lake, although popular to some, may make it difficult to maintain the clarity and habitat objectives being discussed by the CLEAR Council. Isolated areas were deemed important, and having no boating regulations may prove counter productive. Steve Wilbur's interview and data gathering work and the portioning scheme he demonstrated for potential lake usage was gratefully acknowledged by the CLEAR council as a good instructional prelude to partly shape the expectations from the more formal Carter Lake Users Survey (of item 4 above).

c. Setting Boating Restrictions: Several technical advisors suggested that the CLEAR council would benefit from taking formal advice about lake boating impact from an expert. They promised to invite Mr. Herb Angel to address the Council in a future meeting with a separate agenda item. Jason Farnsworth (Olsson Associates) will include some evaluation of Carter Lake Boating for the May meeting.

Discussion followed about whether or not this meeting should be made open to the public. However, it was determined that it was too early in the watershed development process for a public meeting.

d. Overall comments and action from the consultants (Olsson Associates): Jason Farnsworth suggested that the initial draft of a preliminary watershed plan may be completed for preliminary presentation by Olsson Associates in approximately 6-8 weeks.

7. Chairman Haider proposed that the CLEAR Council should provide Olsson Associates the requested time to prepare this preliminary study/proposal before the council meets again. Once some coherence and sufficiently detailed goals emerge, the schedule could then accelerate. The advisory committee and all council members agreed.

8. Next meeting was scheduled for 7pm-9pm Wed. 16th May. 2007 at the Carter Lake Library.

CLEAR Water Council Meeting
May 16, 2007

AGENDA

1. Introduction
2. Minutes of the last meeting — Hani Haider, Chairperson
3. Greater Omaha Lakes Watersheds Group Meeting — Hani Haider, Chairperson
4. Newsletter from the Lake Candlewood Watershed Council — Steve Tonn, UNL Extension
5. Education Task Force Report — Barb Hawkins, Task Force Chair
6. Presentation of first considerations from Consultants to CLEAR Council
7. Additional Business Items — Hani Haider, Chairperson
8. Next Meeting

CLEAR Lake Water Council Meeting Minutes
May 16, 2007

The meeting was called to order by Chairperson Hani Haider. Council members present Pam Christiansen, Mike Dailey, Doug Dodson, Hani Haider, Merl Harder, Barb Hawkins, Wayne Houston, Stephanie Kelley, Les Lundberg, Julie McKillip, Peter Parkert, Pam Parkert, Doug Wallingford, and Steve Wilbur; Technical Advisory Team members present were Deana Barger, Paul Brakhage, Lynn Dittmer, Jeanne Eibes, Jason Farnsworth, Harald Flatoen, Joan Harder, Chris Larson, Mark Porath, Ron Rothmeyer, Kevin Seevers, Pat Slaven, Steve Tonn and Bryan Hayes. Chairperson Haider commented about the lake being full but also having a toxic algae bloom. The minutes of the March 14, 2007 meeting were distributed. It was agreed by consensus that everyone review the minutes and that approval of the minutes will be postponed until the next meeting.

Hani Haider commented on the Greater Omaha Lakes Watersheds Group meeting that was attended by Jeanne Eibes, Barb Hawkins, Julie McKillip and Hani Haider. Hani mentioned three points from the meeting: Carter Lake is an ox bow lake and needs a source of water to maintain itself; lakes have a natural turnover in spring and fall; phosphorus is a major pollutant of lakes and fertilizer is common source of phosphorus. Some cities have banned phosphorus fertilizer and Hani suggested this may be something the CLEAR Water Council may want to consider recommending for Carter Lake. Paul Brakhage commented that phosphorus also occurs naturally in the soil in many areas.

The Lake Candlewood watershed council newsletter was distributed to Council members. Hani Haider asked if the Council should consider some type of newsletter. Jeanne Eibes commented that it takes time and a committed person to do a newsletter. Barb Hawkins, education sub committee chairperson, suggested using current resources (existing group newsletters, etc.) to include short articles relating to runoff pollution prevention topics. The CLEAR Council's education sub committee will address the idea of a newsletter and report back at a later meeting. Jeanne Eibes noted that Steve Tonn had included news items in the Carter Lake News Letter.

Barb Hawkins, CLEAR Council education sub committee chairperson, gave a report on the sub committee's discussions to date. The power point presentation is included in the minutes. Chairperson Haider asked the education sub committee to prepare an education action plan and present it to the CLEAR Council. The proposed plan should also include a timeline. Hani also suggested the education sub committee discuss the idea of a media outreach plan (monthly contacts with media). The education sub committee will discuss the idea at their next meeting on June 5. Chairperson Haider requested that Kevin Seevers once again circulate his pamphlet on "Geese" contamination to the CLEAR Water Council members. It was mentioned that the Carter Lake Improvement Club has agreed to mention the "CLEAR" mission and objectives in their newsletter. Paul Brakhage informed the Council that a formal request for funding the Education Task Force Program Initiatives will take place after the watershed plan is completed. Barb Hawkins will notify Hani Haider after the Education Task Force meeting on June 5 if the Education Task Force Program will be available for discussion at the June 20th CLEAR meeting. Jason Farnsworth and Charles Ikenberry, Olsson Associates, gave a presentation on watershed treatment options. Their presentation is attached to the minutes. They focused on phosphorus loading to the lake. The existing phosphorus loading is 3,166 pounds of phosphorus per year. The CLEAR Lake Council water quality goal is to reduce the phosphorus loading to 977 pounds per year. This is a high goal to achieve. Existing phosphorus loading sources are 2,172 pounds from the watershed and 994 pounds from the lake. Farnsworth and Ikenberry discussed watershed treatments for targeted watershed loading areas. They will work on cost estimates and conceptual designs for these watershed treatment options including alum injection into stormwater. Chairperson Haider inquired as to when the stormwater runoff data gathering would be completed. Kevin Seevers explained that there are five more scheduled testing events. If all the testing events are not completed by the September watershed plan completion they will just use data that is available. Chairman Haider requested that the alum injection treatment for phosphorus control be included in Olsson's report about treatment options. Jason Farnworth and Charles Ikenberry indicated that they will have conceptual designs representing the appearance and costs of their recommended alternatives by the June meeting.

The next CLEAR Council meeting will focus on in-lake treatment alternatives. Olsson Associates will give a presentation on these treatment alternatives. The alternatives will include increased water volume, increased water input inflow rates, and reduction of phosphorus. Jason Farnsworth will visit with Wayne Houston, Boys and Girls Club, prior to the June meeting to discuss potential wetlands areas.

The next meeting is June 20, 7 p.m. at the Carter Lake Library.

Meeting adjourned.

CLEAR Water Council Meeting
June 20, 2007

AGENDA

1. Introduction and review of the agenda

2. Review and approval of minutes of the March 14, 2007 meeting Hani Haider, Chairperson

3. Review and approval of minutes of May 16, 2007 meeting Hani Haider, Chairperson

4. Report by Airport Business Park Association Liaison Peter Parkert

5. Potential Application to a Grant from the Watershed Improvement Review Board Jeanne Eibes

6. Education Task Force Report Barb Hawkins, Task Force Chair

7. Update by Consultants

8. Additional Business Items

9. Next meeting

CLEAR Water Council Meeting Minutes 062007

Meeting held at 7 pm. on 20th June 2007, Carter Lake Library, 1120 Willow Drive, Carter Lake, Iowa

Participants attended:

Council members: Pam Christensen, Doug Dodson, Hani Haider, Merl Harder, B.B. Hegwood, Julie McKillup, Peter Parkert, Pam Parkert and Steve Wilbur.

Technical Advisory Team members: Steve Tonn (Douglas/Sarpy Counties Extension), Deana Bargar (Nebraska Dept. Environmental Quality), Jeanne Eibes (Carter Lake Preservation Society), Harald Flatoen (Omaha Public Works Dept.), Joan Harder (Carter Lake Preservation Society), Chris Larson (Iowa Dept. of Natural Resources), Mark Porath (Nebraska Game and Parks Commission), Ron Rothmeyer (City of Carter Lake), Pat Slaven (Omaha Parks Dept.).

Engineering consultants: Jason Farnsworth, Charles Ikenberry and Sara Hanson (Olsson Associates)

1. The meeting was called to order by Chairperson Hani Haider. Conveyed apologies from Steve Scarpello, (Omaha Parks, Recreation and Public Property Dept. Director) and from Kevin Seevers, who was not able to attend do to a conflict with another watershed meeting.

2. A motion was made and seconded to accept the minutes of the March 14, 2007 Council meeting as printed. Motion passed.

3. The minutes of the March 14, 2007 meeting were distributed. A motion was made and seconded to accept the minutes of the May 16, 2007 meeting as printed. Motion passed.

4. Liaison with Airport Business Park Association. Peter Parkert gave an update on the Airport Business Park Association. Kevin Seevers and Peter Parkert attended the Association's first meeting. Approximately 10 businesses were represented at the meeting. Jim Suttle, Omaha City Councilman, and also a representative from the Omaha Chamber of Commerce were in attendance. Peter and Kevin informed the association about the work being done in developing a Carter Lake Watershed Management Plan. They told the Association about the goals and objectives of the CLEAR Water Council and they will keep the Association informed about the plan. The Association acknowledged the effort by the CLEAR Water Council. Chairperson Haider officially recognized Peter Parkert as the Airport Business Park Association representative on the CLEAR Lake Council. Peter Parkert will supply the active members of the Airport Business Park Association with the minutes from the CLEAR Water Council meetings.

5. Potential Application to a grant from the Watershed Improvement Review Board
Jeanne Eibes discussed the Watershed Improvement Review Board (WIRB) grant. The maximum granted per successful application is $500,000. She alerted the Council that the grant applications are due August 1. The Carter Lake Preservation Society has applied for a grant in the past and was denied. Jason Farnsworth noted that the WIRB grants are competitive and offered until the pool is exhausted, and that earlier unsuccessful applications are not necessarily detrimental to new applications. Jeanne Eibes had passed the information on to the Carter Lake Watershed Technical Advisory Team but didn't

receive a response. Ron Rothmeyer informed the Council that Kevin Seevers and he are writing a WIRB grant application on behalf of the City of Carter Lake. The application would apply to efforts to improve the watershed. Chris Larsen, Iowa DNR, and Mark Porath, NE Game and Parks Commission, both commented that the more agencies, entities and organizations that are working together on a grant, the better chance it has for being funded. Hani Haider reported to the council the email he was copied from Bill Van Trump (CLEAR Water Council member) to Jeanne Eibes: It seems to (Bill Van Trump) that issues like creating or improving a retention pond to settle contaminants prior to discharge to the lake in the industrial part of Carter Lake, rain gardens on public lands, etc. would be the type of thing that should appeal to the WIRB. Also, an application from the local watershed improvement council might carry more weight than one from the Preservation group. Bill Van Trump has offered his assistance in writing a grant. Ron Rothmeyer will contact Bill Van Trump to visit with him about how he can be of assistance to them in their grant application. Jeanne Eibes was also asked to serve as a reviewer for the application. She agreed. Deana Bargar (Nebraska Dept. of Environmental Quality) advised that grant reviewers will quickly focus on the budget heart of applications, and not particularly value any supporting peripheral information. She suggested that the City of Carter Lake be the primary applicant, with the CLEAR, CLPS etc as co-sponsors. Ron Rothmeyer agreed to update the CLEAR Council at its July meeting on the progress of the grant application. Peter Parkert is to email the attendance list with all contact information to Ron Rothmeyer to help Ron coordinate the grant writing effort.

6. Education sub-committee update: Goals and action points for education

Julie McKillip reported on progress and discussed the Education Task Force’s draft educational goals and action items which will be proposed for the watershed management plan. The goals and action items are still being finalized. Julie showed some educational items that are available for distribution to the public. Hani Haider thanked the education sub-committee and commended their efforts so far. He suggested one extra goal for consideration: that of how to disseminate the eventual CLEAR watershed “Plan” to the people of Carter Lake, and Omaha at the end of the project, and how to benefit from their feedback if any meanwhile. Hani Haider also offered that if an educational packet of materials is developed for elementary school students he will take the packet to the school principal for approval and distribution to students. Ron Rothmeyer stated that the City of Carter Lake is obliged to meet certain educational requirements which he believed could be integrated into education sub-committee objectives. He offered to work with the committee (their next meeting was scheduled for July 10^{th}).

7. Update from Olsson Associates (consultants): Sara Hanson, Charles Ikenberry and Jason Farnsworth (Olsson Associates) presented information about in-lake treatments to reduce phosphorus in Carter Lake. Treatments discussed were alum injection of stormwater; alum in-lake application; fish management (removing bottom feeding fish); watercraft management and shoreline protection measures. These treatments were discussed by the Council. Do to a time restriction, Olsson Associates briefly discussed other options such as dredging. They will discuss dredging in more detail along with other options at a future Council meeting. The will present cost estimates for all the watershed and in-lake treatments at a future meeting too.

8. It was decided by the CLEAR Council members, the technical advisers and the consultants (at the meeting) to dedicate the July meeting to Olsson Associates to continue the presentation of in lake treatments and costs of watershed and in-lake treatments. Meanwhile, the Technical Advisory Team expressed their wish to meet with Steve Wilbur regarding watercraft management prior to the next clear meeting.

Subsequent to the meeting, it was suggested by the consultants and the advisory team to invite Mr. Herb Angell (the NGPC Boating Law Administrator) to give a presentation to the council in the next meeting instead, before and not after Olsson Associates continue/complete presenting their preliminary study. Mr. Herb Angell would kindly describe the pros and cons, options and past experience of other local watershed councils on curbing/regulating boating activities to improve/preserve water quality.

Mr. Mark Porath (Nebraska Game and Parks Commission) afterwards elaborated by email the reasons behind this switch in order. His email was copied as an addendum to these minutes because it provided some useful information, which is much appreciated.

9. Next Meeting: Will be 7-9pm Tuesday 17th July 2007 at the Carter Lake Library, 1120 Willow Drive, Carter Lake, Iowa.

10. Meeting adjourned at 9.00 pm.

CLEAR Water Council Meeting
July 17, 2007

AGENDA

1. Introduction and review of minutes of June 20, 2007 meeting
2. Invited presentation by Herb Angell, NGPC Boating Law Administrator
3. Additional Business Items
4. Next Meeting

CLEAR Water Council Meeting Minutes 071707

Meeting held at 7 pm. on 17th July 2007, Carter Lake Library, 1120 Willow Drive, Carter Lake, Iowa

Participants attended:

Council members: Pam Christensen, Doug Dodson, Hani Haider, Merl Harder, B.B. Hegwood, Les Lundberg, Julie McKillup, Peter Parkert, Pam Parkert and Steve Wilbur.

Technical Advisory Team members: Steve Tonn (Douglas/Sarpy Counties Extension), Paul Brakhage (Nebraska Dept. of Environmental Quality), Lynn Dittmer (Metro Area Planning Agency), Brian Hayes and Chris Larson (Iowa Dept. of Natural Resources), Mark Porath (Nebraska Game and Parks Commission), Ron Rothmeyer (City of Carter Lake), Kevin Seevers (West Pott. Co. Soil & Water Conservation Dist). .

Engineering consultants: Charles Ikenberry (Olsson Associates)

Special guests attended: Russ Kramer (Mayor, City of Carter Lake), Herb Angell (Nebraska Game and Parks Commission Boating Law Administrator)

1. The meeting was called to order by Chairperson Hani Haider. He warmly welcomed City of Carter Lake Mayor Russ Kramer to the meeting and Mr. Herb Angell, who was invited as an expert on boating laws. The chairperson also conveyed apologies for absence from Jeanne Eibes who was out of town and could not attend.

2. A motion was made and seconded to accept the minutes of the June 20, 2007 Council meeting as printed. The motion was passed.

3. Invited presentation by Mr. Herb Angell, the NGPC Boating Law Administrator

Herb Angell, Nebraska Game and Parks Commission Boating Law Administrator, was introduced as a featured meeting speaker. Mr. Angell discussed the Nebraska State Boat Act of 1978, Nebraska Game and Parks Special Rules and Regulations, and Real Estate Covenants which apply to Nebraska lakes. The Nebraska State Boat Act defines a water vessel as anything that transports 1 or more people across water. A vessel with a motor is considered a motor boat. Nebraska Game and Parks Commission special rules and regulations are based on the configuration of the lake. The Commission Conservation Officers and Nebraska Peace Officers have the authority (and duty) to enforce the Nebraska boating laws and regulations. For example, the Douglas County Sheriff's Dept., Omaha Police Dept. as well as Nebraska Conservation Officers can enforce Nebraska boating laws and regulations. Similar authority is given to Iowa peace officers by Iowa law. Local peace officers are sometimes reluctant to enforce boating laws and regulations due to unfamiliarity with the laws and regulations. Mayor Kramer interjected that the City of Carter Lake police officers have a high interest in the lake, and are willing to help when requested. It is sometimes difficult to determine who has jurisdiction because of the uncertainty of the in-lake dividing line between Iowa and Nebraska. The Iowa counterpart to Herb Angell is Randy Edwards, Iowa Dept. of Natural Resources Assistant Chief for Law Enforcement. Special rules and regulations for a specific lake must relate mostly focus on "safety) issues. These special rules would need to be approved by the Nebraska Game and Parks Commission and the Iowa Department of Natural Resources. Special rules and regulation could pertain to no wake zones, speed limits, distance from shore that boating is allowed, etc. Other rules might deal with watercraft motor types as they relate to environmental concerns.

After Herb Angell's presentation, he generously offered a comprehensive question and answer session. Chairman Haider encouraged comments and questions from each of the attending council members. Haider voiced concern that without a coherent Water Shed Plan our work, and any resulting lake quality regulations, may cause a divisive reaction in the community. Technical Advisory Team members reminded the council that this "draft" plan will be forwarded to a third public meeting (the final one of a three public meeting process that began in the fall of 2006) where it will be reviewed and adjusted according to public opinion. Some changes in the Plan at that juncture would be possible and should be expected. Watercraft management was then generally discussed by the CLEAR Council. Managing watercraft on the lake would help to reduce shoreline erosion, suspension of bottom sediments and improve safety on the lake. Lengthy discussion followed regarding no-wake practicality in narrow or shallow lakes. Technical Advisory Team (TAT) members stressed a consensus, compromise approach to the many alternatives to meet lake quality goals. The CLEAR Council indicated a willingness and openness to consider watercraft management as a water quality treatment option. It was pointed out that the CLEAR Council is a consensus of a two state group of stake holders and technical advisors. It is therefore essential that a conscientious consensus discussion must take place in order to eventually bring a Water Shed Plan to a public with numerous lake usage preferences. All agreed that the CLEAR Council mission was to bring the best, objectively guided plan forward with all fair considerations to these discussions. Charles Ikenberry, Olsson Associates, indicated the discussion by the CLEAR Council was helpful and will enable Olsson Associates to better develop watercraft management and shoreline protection as a treatment options.

4. Potential Applications to grants from the Watershed Improvement Review Board and elsewhere

Ron Rothmeyer informed the CLEAR Water Council members that the Watershed Improvement Review Board grant application is not appropriate at this time because a watershed management plan has not been written. Therefore no grant application will be submitted at this time.

Paul Brakhage, NDEQ, mentioned that he discussed with EPA officials the Carter Lake Project and the possibility of getting funds to initiate some aspects of the project this fall before a comprehensive watershed management plan is completed. Paul indicated that EPA thought some funding may be available. Sept. 7 is the deadline for applying for the funds for this fall. He suggested possibly some information and education projects could be used for applying for funds. The Education Task Force was asked to bring ideas to the next meeting that might qualify for EPA funds. Julie McKillip, Education Task Force member, said that the Education Task Force meets on August 7 and will bring ideas for consideration to the CLEAR meeting on August 14.

5. Update from Olsson Associates (consultants):

Charles Ikenberry (Olsson Associates) presented information continued the presentation and preliminary discussion of in-lake treatments to reduce phosphorus in Carter Lake. He circulated a summary of the discussion that took place at the Technical Advisory Team (TAT) meeting of July 11th, a copy of which is included at the end of these minutes. It was suggested that Olsson Associates briefly go over this summary as part of the agenda for the next meeting.

Charles Ikenberry asked the Clear water council to note that the summary of suggested treatment alternatives included in this discussion was not necessarily all-inclusive. At the same time, none of the options listed were set in stone. However, the list of suggested alternatives did represent the type and combinations of treatments that would be necessary to meet the water quality goals.

Olsson Associates, working with the TAT, will further assess these items (and any others that would suggested in the near future) to determine which alternatives would be recommended by the TAT for inclusion into the watershed management plan. He emphasized that input from the CLEAR Water Council was a vital part of this process to avoid recommendations that would be politically unacceptable, and to develop compromises that help reach the our ultimate goal of improving water quality without alienating desirable patrons of Carter Lake.
6. Next Meeting: Will be 7-9pm Tuesday 14th August 2007 at the Carter Lake Library, 1120 Willow Drive, Carter Lake, Iowa.
7. Meeting was adjourned.

CLEAR Water Council Meeting
August 14, 2007

AGENDA

1. Introduction and Review of Minutes from July 17, 2007 Meeting   Hani Haider, Chairperson

2. Review of Agenda   Hani Haider, Chairperson

3. Perspective from an Invited Guest about Alum Injection Treatment   Larry Synder, Lake Ventura

4. Education Task Force Report   Barb Hawkins, Task Force Chair

5. Watershed and In-Lake Treatment Options   Consultants

6. Additional Business Items

7. Next Meeting

CLEAR Water Council Meeting Minutes 081407

Meeting held at 7 pm. on 14h August 2007, Carter Lake Library, 1120 Willow Drive, Carter Lake, Iowa

Participants attended:

Council members: Pam Christensen, Doug Dodson, Hani Haider, Merl Harder, B.B. Hegwood, Les Lundberg, Julie McKillup, Peter Parkert, Pam Parkert.

Technical Advisory Team members: Steve Tonn (Douglas/Sarpy Counties Extension), Deana Bargar Paul Brakhage (Nebraska Dept. of Environmental Quality), Lynn Dittmer (Metro Area Planning Agency), Brian Hayes and Chris Larson (Iowa Dept. of Natural Resources), Mark Porath (Nebraska Game and Parks Commission), Ron Rothmeyer (City of Carter Lake), Kevin Seevers (West Pott. Co. Soil & Water Conservation Dist).

Engineering consultants: Charles Ikenberry (Olsson Associates)

Guests attended: Barbara Hawkins (Carter Lake City Council Member and chair of the education sub-committee of the CLEAR Council), Larry Snyder (Lake Ventura Property owners)

1. Chairperson Hani Haider called the meeting to order. He welcomed Larry Snyder, special guest invited.

2. A motion was made to approve the July 17, 2007 meeting minutes as printed. Motion seconded and passed.

3. Boating Law and regulations

Pam Christensen reported that she saw some Nebraska Game and Parks conservation officers enforcing boating safety on the lake since the last meeting.

4. Perspective from an invited guest about Alum Injection treatment - Mr. Larry Snyder, a resident of Lake Ventura

The CLEAR water council invited Mr. Larry Snyder, a resident of Lake Ventura (near Fremont) to kindly talk about his experience with Alum treatment of that lake, and kindly take questions. Mr. Snyder had gone through the understanding and decision process similar to the one faced by the CLEAR water council. He agreed to share his educated/experienced view of how this technique was applied and speculate on its potential effectiveness to Carter Lake.

Mr. Snyder provided a map, treatment result report and copied coards/contact details for potential experts (all items copies attached/below). He explained that Lake Ventura is a 110 acre sand pit lake. It is 40 years old. The lake averages 12-15 feet in depth. Their lake committee studied various treatment options including copper sulfate treatment, dredging, aeration/agitation, etc. They chose whole lake alum treatment and worked with Fresh Water Consulting who used 14 semi loads of non-toxic alum that was applied to the lake over a 1 week period in May 2006. The lake was closed during application and for approximately week after application in order to let the floc settle to the bottom of the lake. Samples were taken at various depths throughout the lake to determine effectiveness.

Fish kill was determined to be minimal. Cost was about $170,000 paid by issuing bonds. They are very pleased with the results. Water clarity has improved dramatically. The treatment should last for 10-12 years. Considerable discussion followed Snyder’s presentation. He explained that there was no evidence of re-suspension of the sequestered phosphorous in Lake Ventura because of its depth. He also explained that Ventura has I.O. HP restrictions and that wave runners are banned. Since Cater Lake has average depths less than half of Ventura’s, and since there are currently no restrictions, some council members wondered about water craft causing continuous re-suspension, and possibly even worse turbidity should we elect to use alum treatment. Rough calculations suggested that Carter Lake has about double the acre-feet of water than Lake Ventura which would suggest an expense of roughly double what was spent at Ventura to treat Carter Lake with alum. TAT member Jeanne Eibes encouraged the council to stop the alum treatment discussion and move forward with the meeting agenda. Chairman Haider thanked Mr. Snyder and presented him with a "thank you" gift for taking time to meet with us.

5. Grants and the educational project

Barb Hawkins gave a report on the educational and informational task force's ideas for a grant application. Barb Hawkins will provide Chairperson Haider with a copy of the activities to be included with this meeting's minutes. The application for Nebraska 319 funds for the education and informational activities is due in early Sept. Paul Brakhage, NDEQ, is working with the task force on the application. Educational and informational proposed activities include signage on sidewalks, trails and parks on preventing pollution; educational pollution prevention materials for recreational users, a rain garden fair; auto waste disposal amnesty collection; lake clean up day; educational materials on lawn care, soil testing. The Council supported applying for a grant.

6. Update from Olsson Associates (consultants):

The next agenda item was scheduled as "**continued presentation of watershed and in-lake treatment options…**". Several council members were under the impression that more information was to be offered on the option of dredging. However there was some misunderstanding on the scope of the presentation by Olsson Associates. Charles Ikenberry, and Paul Brackhage explained that further discussion on dredging as an "in-lake" treatment alternative had been determined as not feasible from a financial perspective, but that "spot dredging" or partial dredging would be considered in the recommendations. Charles said that Olsson Associates is preparing a packet or notebook containing fact sheets and recommendations on the alternatives. They were planning to present the notebooks at the Sept. meeting. Charles Ikenberry did list the alternatives and a brief discussion was held. There was some confusion on the part of the council members as to what to do with the alternatives – rank them; discuss them in more detail, etc. It was agreed to wait until the information from Olsson Associates was available for review before any action on the alternatives was taken. Charles then offered to forward the "packet" to all council members prior to the Sept. meeting in order to give everyone an opportunity to review it ahead of the meeting. Mr. Ikenberry has explained that he will base his Sept. meeting presentation on the packet information. Again, Jeanne Eibes urged Chairman Haider to end specific alternative treatment discussion and to proceed with other agenda items stressing the need to rank and decide on treatment alternatives. The meeting attention then turned to types of ranking, grid style alternatives, etc., etc. The TAT tried to explain where the council currently stands in the Watershed Planning Procedure, and what was expected of the council as the information is continually condensed and filtered. They suggested that ranking at this time was premature.

7. Other business

Chairperson Haider expressed a concern that several of the original members of the CLEAR Water Council are not attending the meetings. If they had lost interest, we need to know why and improve our workings. If they simply had not been well informed of the dates of the meeting, we need to do better to maintain their kind help and participation in our effort. Chairperson Haider asked Vice-Chairperson Peter Parkert to contact those members who had missed a few meetings to see if there is a way in which we can still benefit from their kind help. Peter agreed to contact the inactive members by email. It was also suggested that Council members be informed/reminded of the next meeting at an earlier date. This may help to improve attendance.

8. Next Meeting: Will be 7-9pm Tuesday 18th Sept. 2007 at the Carter Lake city Hall, 950 East Locust, Carter Lake, Iowa. (Notice new venue for this meeting only).

9. Meeting was adjourned.

10. Events following the meeting

a. Following the meeting, Steve Tonn sent an email to CLEAR Council members explaining the role of the TAT and the Council. A reply with thanks and comment from Hani Haider also attached.

b. Following the meeting, Vice-Chairperson Peter Parkert spoke with Charles Ikenberry, Sara Hanson, and their associate manager Mike Sotak at Olsson Associates concerning the Sept. presentation. They have asked Steve Tonn to give a brief introduction which would review the roles of the council, TAC and the consulting engineer (Olsson). This would be followed by the Olsson presentation. They ask that the following items be included in our minutes:

i. Olsson presents the alternatives and provides their recommendations (45 minutes).

ii. Please take notes and prepare questions to be addressed after the presentation.

iii. Answer questions and conduct open discussion to select alist of alternatives that are agree upon by the council, TAC and Olsson (45 minutes).

They plan to have the packet in the hands of the TAT and the council members 1 week prior to the meeting.

CLEAR Water Council Meeting
Sept. 18, 2007

AGENDA

1. Introduction and approval of August meeting minutes	Peter Parkert
2. Education Task Force review	Barb Hawkins
3. Review of Watershed Management Planning Process	Steve Tonn
4. Presentation and discussion of in-lake and watershed alternatives	Consultants
5. Other Business	
6. Next Meeting	

CLEAR Water Council Meeting Minutes
September 18, 2007

Chairperson Peter Parkert called the meeting to order. He thanked past chairperson Hani Haider for his leadership service in guiding the CLEAR Water Council to this point in the planning process. Members and guests present were Watershed Council- Peter Parkert, Pam Parkert, Doug Dodson, Bob Hegwood, Merl Harder, Pam Christiansen, Les Lundberg, Julie McKillip, Hani Haider, Steve Wilbur, Doug Wallingford, Mike Daily;Technical Advisory Team – Mark Porath, Gerry Bowen, Sara Hanson, Charles Ikenberry, Pat O'Brien, Tim Gokie, Paul Mullen, Steve Tonn, Bryan Hayes, Pat Slaven, Paul Brakhage, Harald Flatoen, Deana Barger, Ron Rothmeyer, Jeanne Eibes, Kevin Seevers; guests – Terry Petersen, Jan Petersen. It was moved and seconded that the minutes from the August 14, 2007 meeting be approved as presented. Motion carried.

Paul Brakhage, NDEQ, reported that the Education Task Force had supplied come cost estimates for the information and education grant application. The application will be submitted on Wednesday, Sept. 19.

Steve Tonn, Douglas/Sarpy Extension, made some comments on the planning process. He reminded the Council about the watershed vision statement and project goals. The Council's role at this meeting is to decide if the alternatives presented fit the watershed based on the Council members' knowledge of the social, economic and political factors of the watershed. The Council is not asked to prioritize the alternatives but to determine if they are appropriate for the watershed.

Charles Ikenberry and Sara Hanson, Olsson Associates, presented the recommended watershed and in lake treatment alternatives. They discussed the advantages and disadvantages of the alternatives and how they might be applied in the watershed. The recommended alternatives discussed were: Watershed Alternatives- No Phosphorus Fertilizer, Pet Waste Management, Wet Detention Ponds, Bioretention Features, Septic System Inspection, Vegetated Bioswales, Filter Strips, Grass Swales, Vegetated Buffer Strips; Optional Watershed Alternatives – Water Quality Inlets for Stormwater drains and Street Sweeping; In-Lake Alternatives –Alum Stormwater Injection, Fish Renovation, Shoreline Stabilization, Targeted Dredging, Sediment Forebays, Wetland Enhancement/Creation, Watercraft Management, Whole-Lake Alum Treatment and Increased Lake Inflow. The Council voted on each alternative either to move forward to concept design or to hold for more discussion. No Phosphorus Fertilizer, Pet Waste Management, Wet Detention Ponds, Bioretention Features, Septic System Inspection, Vegetated Bioswales, Filter Strips, Grass Swales, Vegetated Buffer Strips, Water Quality Inlets, Street Sweeping, Alum Stormwater Injection, Fish Renovation, Shoreline Stabilization, Targeted Dredging, Sediment Forebays, Whole Lake Alum Injection and Increased Lake Inflow alternatives were approved by hand vote to move forward to concept design. Wetland Enhancement/Creation and Watercraft Management were held for more discussion.

Discussion was held on the Wetland and Watercraft Management Alternatives. The main objection to the use of wetland enhancement/creation was the possible locations for the wetlands around the lake. The potential wetlands could restrict the use of the lake by water skiers. The

Wetlands Alternative was approved by a hand vote to move to concept design with the considerations, comments and objections to be considered. The Watercraft Management Alternative was also discussed. Objections to the watercraft management alternative centered on the impact it would have on water skiing, boating lanes, and recreational use of the lake. After much discussion, the Watercraft Management Alternative was approved by hand vote to move to concept design with the agreement that Olsson Associates and Peter Parkert would meet with the ski clubs and boat owners prior to preparing a concept design for the watercraft management alternative. This meeting will also be helpful in regards to the wetland enhancement/creation alternative.

The concept design for all the approved recommended alternatives will include estimated costs. This information will be presented at the November CLEAR Water Council meeting.

The next meeting will be November 13, 7 p.m. at the City Hall Meeting Room.

CLEAR Water Council Meeting
December 4, 2007

AGENDA

1. Introductions

2. Approval of Sept. 18, 2007 Meeting Minutes

3. Update on Education Task Force 319 Grant Application

4. Traditional Boaters Committee Update

5. Presentation by Consultant

6. New Business

7. Next Meeting

CLEAR Water Council Meeting Minutes for December 4, 2007

Peter Parkert, acting Council Chairman, called the meeting to order. Present were TAT Members Mark Porath, Daryl Bauer, Paul Brakhage, Lynn Dittnar, Harold Flatoen, Charles Ikenberry, Pat Slaven, Steve Tonn, Sara Hanson, Gerry Bowen, Ron Rothmeyer, Kevin Seevers, Bryan Hayes, Deana Barger.
CLEAR Council Members Peter Parkert, Pam Christensen, Bob Hegwood, Doug Dobson, Julie McKillip, Barb Hawkins, Hani Heider, Merle Harder, Steve Wilber.
Guests Vic Skinner, Steve and Janice Prociw, Rick Riley, Al Cannia, Karen Almquist, John and MaryJo Pinkerton.

The Chairman reviewed the meeting agenda and explained to the Council members and guests that until the Traditional Boaters Committee presents a recommendation for watercraft management to the Watershed Council the discussion of the in lake alternative of watercraft management will be tabled.

The Sept. CLEAR Council meeting minutes were amended to include the following additions:
1. An email to Doug Dodson, CLEAR Council member, from Mulhall's Nursery on their policy of using no phosphorus fertilizer near lakes and streams
2. A document from Paul Brakhage, NDEQ, on the education plan for adoption into the watershed management plan and the 319 grant project application to fund the educational plan. Paul Brakhage updated the CLEAR Council on the grant application for the educational plan. The grant application has been approved by NDEQ based on the approval of a completed watershed management plan.
3. an email to the council from Hani Haider

Julie McKillip moved that the minutes be accepted with the three attachments. Motion seconded and passed.

Vic Skinner, Traditional Boaters Committee chair, reported that the committee met on Nov. 14 and they have submitted some ideas to Olsson Associates and will meet with them to discuss the ideas.

Charles Ikenberry, Olsson Associates, gave a review of the phosphorus loading issues for Carter Lake. He discussed that watershed alternatives and in-lake alternatives that were taken to the concept development stage which includes proposed locations, possible configuration and cost estimate. It does not include the design of the alternatives.

Charles Ikenberry and Sara Hanson, Olsson Associates presented the Watershed Alternatives that were taken to concept development. Each alternative was reviewed again briefly along with corresponding preliminary budget estimates.

1. Fertilizer management
2. Pet waste management
3. Septic systems inspection
4. Bioretention
5. Bioswales

6. Vegetated buffer strips
7. Prefab stormwater treatment/filter systems
8. Wet detention pond enhancement (with second pond construction) with Alum stormwater injection at various areas in the lake.
9. Water quality inlets.
10. Fish renovation
11. Targeted Dredging to include filling hole northeast of the island.
12. Increased lake Inflow

Merle Harder moved that these alternatives to be included in the watershed plan. Motion seconded and passed.

Whole Lake Alum Application was also discussed. Cost $500,000 - $700,000

Chairman Parkert explained that the Traditional Boaters Committee would be meeting again prior to the January CLEAR meeting. He expressed a desire by the council that the committee would be able to come to an agreement with the no-wake alternatives in order to best meet the goals of the council and still serve the interests of the boaters. He further explained that the final decisions of the committee would be brought forward at the February meeting at which point the council would vote on Watercraft management alternatives and all other related alternatives that had been tabled for adoption to the Watershed Plan.

Next meeting Wednesday, January 23, 7 p.m. at the City Library.

Meeting adjourned.

RESULTS OF THE TRADITONAL BOATERS COMMITTEE MEETING

The Traditional Boaters Committee met Dec. 19 at the Carter Lake Library. There was a strong participation from both ski clubs, and active discussion concerning the no-wake areas. Although many ideas were discussed, the committee was unable to find a compromise between the 100 acres of no wake recommended by the TAT consultants, and the preferred ski /boating areas normally used by the boaters. The meeting ended without a committee recommendation for the CLEAR Council.

CLEAR Water Council
Jan 23, 2008
Carter Lake Library

Meeting Agenda

I. Approval of January Minutes
II. Traditional Boaters Committee report
III. Chairman comments
IV. Chris Larson, Iowa DNR…ISU Iowa Lakes Valuation Project
V. Paul Brakhage, NDEQ…Carter Lake user survey
VI. Vote on Watercraft Management, Whole-lake alum treatment, Shoreline stabilization, and Wetland enhancement/creation
VII. Sara Hanson, Olsson Associates, and Paul Brakhage
Presentation and discussion of Watershed Management Draft
VIII. Steve Tonn, public meeting discussion and scheduling

CLEAR Council Watershed Meeting Minutes
January 23, 2008

Peter Parkert, Council chairperson, called the meeting to order. Peter welcomed the guests. Present were Council members Les Lundberg, Doug Dodson, Pam Christiansen, Merl Harder, Steve Wilbur, Wayne Houston, Hani Haider; Technical Advisory Team members Jeanne Eibes, Deana Barger, Pat Slaven, Sara Hanson, Chris Larson, Harald Flatoen, Steve Tonn, Joan Harder, Lynn Dittmer, Paul Brakhage, Mark Porath, Ron Rothmeyer; guests present were Vic Skinner, Jerre Hunter, Mark Hunter, Leslie Sanders, Mark Eibes, Scott Taylor, Kevin Moffit, Steve ???, Janice Prociw, James Shaffer, Karen Almquist, Greg ???, Larry ???, DeDe Hedlund, Lyle Hedlund, Ross ??. A motion to approve the December CLEAR Council meeting minutes was made, seconded and carried.

Vic Skinner, Boating Committee Chair, reported that the boating committee could not decide on a recommendation regarding watercraft management so therefore no recommendation is being presented to the Council for their consideration. The current alternative is to have 100 acres of no wake zone in the lake and that the project sponsors will determine where the 100 acres will be established. Les Lundberg, CLEAR Council member, proposed that a no-wake zone be established 10-20 feet from the shoreline on the north shore of the lake (NE shoreline) and possibly also along the shoreline on the Boys Club property to meet the requirement for a no wake area . This way the ends of the lake would not be closed and skiing could be done in those areas too. Peter thanked Les for his comments and suggestion.

Peter stated that the objective of tonight's meeting was to decide if the watercraft management, whole lake alum treatment, shoreline stabilization and wetland enhancement alternatives should be included in the management plan. Peter read a prepared statement he composed to the Council (see attached statement).

Peter asked for a show of hands favoring the inclusion of the watercraft management alternative of a 100 acre no wake zone with the location of the 100 acres being determined by the project sponsors in the watershed management plan. Approved by a majority decision.

Chris Larson, Iowa DNR, gave a presentation on the Iowa Lake Valuation Project conducted by Iowa State University. He reported 6 out of 10 Iowa residents visit lakes 8 times per year. 25 million visits per year. People consider the water quality of the lakes more than the available facilities when deciding which lake to visit. There is a strong relationship between water quality and lake use. Chris Larson reported that $2,507,166 is spent yearly by visitors to Carter Lake (see link http://www.card.iastate.edu/lakes_demo/lake_economic.aspx?id=1) .

Paul Brakhage, Nebraska Department of Environmental Quality, reviewed the Carter Lake Users Survey results. The user survey was taken from April 2007 to September 2007. 2352 users were counted with the top three uses being 67.1% picnickers/sunbathers; 10.8% shoreline fishermen; and 7.4% hikers/joggers/bikers (see attached study)

Sara Hanson, Olsson Associates, gave a review of the phosphorus loading problem and the alternatives already approved by the CLEAR Council for inclusion in the management plan-fertilizer management, pet waste, septic system, bioretention, bioswales/filter strips, vegetated buffer strips, wet detention ponds, alum stormwater injection, water quality inlet filters, fish renovation and targeted dredging. Sara Hanson then discussed in more detail the additional alternatives of wetland creation/enhancement, sediment forebays, shoreline stabilization and whole lake alum treatment. Peter Parkert asked for show of hands favoring each of these alternatives and their inclusion in the watershed management plan. Whole lake alum treatment approved for inclusion in the plan; Shoreline stabilization approved for inclusion in the plan; Wetland creation/enhancement approved for inclusion in the plan; and Sediment forebays approved for inclusion in the plan.

Steve Tonn, University of Nebraska-Lincoln Extension in Douglas/Sarpy Counties, discussed the third public meeting for the presentation of the management plan for comments by watershed stakeholders. This would be a meeting where the Council members would lead the meeting and the presentation of the plan. The Council selected March 11, 2008 for the third public meeting. Wayne Houston, Boys and Girls Club, offered the use of the Boys and Girls Club gym for the meeting.

Deana Barger, Nebraska Department of Environmental Quality, shared a draft of the cover page of the management plan with the Council and Technical Advisory Team (see attached).

Meeting adjourned.

CLEAR Water Council

Carter Lake
Environmental Assessment
& Rehabilitation

Please attend a **Public Meeting** to learn about and comment on the proposed **Water Quality Management Plan**

Learn about the plan to **HEAL THE LAKE!**

March 11, 2008   7:00 p.m. – 8:30 p.m.
Shoreline Golf Course Clubhouse
210 East Locust Street in Carter Lake, Iowa

Doors open at 6:30 p.m.   Meeting will begin at 7 p.m.

For more information go to: www.carterlakepreservation.org

(Post card mailed to Carter Lake Watershed residents and businesses)

Please attend a **Public Meeting** to learn about and comment on the proposed

Water Quality Management Plan

Learn about the plan to

HEAL THE LAKE!

March 11, 2008
7:00 p.m. – 8:30 p.m.
Shoreline Golf Course Clubhouse

210 East Locust Street in Carter Lake, Iowa

Doors open at 6:30 p.m. Meeting will begin at 7 p.m.

For more information go to:
www.carterlakepreservation.org

Appendix B

Total Maximum Daily Load For Algae and Turbidity Carter Lake, Iowa and Nebraska

June 2007

Nebraska Department of Environmental Quality

Planning Unit, Water Quality Division

Iowa Department of Natural Resources
Watershed Improvement Section
2007

Acknowledgements

Special acknowledgements are made to the following people for the completion of this study:

Jack Generaux, USEPA Region 7
Bruce Perkins, USEPA Region 7
Debby White, USEPA Region 7
Patrick O'Brien, Nebraska Department of Environmental Quality
Chris VanGorp, Iowa Department of Natural Resources
Larry Bryant, Iowa Department of Natural Resources
Harry Zhang, Parsons
Gretchen Miller, Parsons
Randall Patrick, Parsons

TMDL INFORMATION SHEET

Total Maximum Daily Load for Carter Lake

Waterbody: Carter Lake
Parameters Addressed by TMDL: Algae/Algal Toxins, Chlorophyll *a*, Total Phosphorus and Total Nitrogen and pH

	Iowa	Nebraska
County	Pottawattamie	Douglas
Impaired Uses[1]	Primary Contact Recreation	Primary Contact Recreation
	Aquatic Life	Aquatic Life
	Aesthetics	Aesthetics
TMDL Parameter(s) of Concern	Algae	Algal toxins, chlorophyll *a*, nitrogen, phosphorus, pH
Water Quality Targets	TSI: Total P <70 TSI: Chlorophyll <65 TSI: Secchi <65	Total P = 133 µg/l Total N = 1460 µg/l Chl-*a* = 44 µg/l pH = 6.5-9.0 su Algal Toxins = 20 µg/l (measured as microcystin concentration)

[1] Impaired uses are based on Iowa's 2004 Integrated Report and Nebraska's 2006 Integrated Report

Summary of TMDL Results for Total Phosphorus

TMDL (lbs/yr)	**1,462**
WLA (lbs/yr)	**1,301**
LA (lbs/yr)	**15**
MOS (lbs/yr)	**146**
Existing Load (lbs/yr)	**3,166**
% Reduction	**53.8%**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Introduction and Problem Identification

1.1 Waterbody Description

Carter Lake, an oxbow lake adjacent to the Missouri River near Omaha, Nebraska is unique in that the waterbody is wholly contained in the geographical State of Nebraska but is shared by the State of Iowa. This situation is a result of the channelization of the main stem Missouri River. Carter Lake is located in the metropolitan area of Omaha, Nebraska on the outer perimeter and by the City of Carter Lake, IA along the interior perimeter.

Carter Lake has been identified as impaired by excessive nutrients, algae blooms, PCBs and fecal coliform bacteria. Table 1 lists key features of Carter Lake.

Table 1: Carter Lake Features

Waterbody Name:	Carter Lake
Hydrologic Unit Code:	10230006
IDNR Waterbody ID:	IA 06-WEM-00265-L
NDEQ Waterbody ID:	MT1-L0090
Location:	Section 23 T75N R44W
Latitude:	41.29 N
Longitude:	95.92 W
Iowa Water Quality Standards Designated Uses:	Primary Contact Recreation Aquatic Life Support
Nebraska Water Quality Standards Designated Uses:	Primary Contact Recreation Aquatic Life-WWA Agriculture Water Supply Aesthetics
Tributaries:	None
Receiving Waterbody:	Missouri River
Lake Surface Area:	315 acres
Maximum Depth:	28 feet
Mean Depth:	8 feet
Volume:	2520 acre-feet
Length of Shoreline:	35,376 feet
Watershed Area:	2722 acres
Watershed/Lake Area Ratio:	8.6:1
Estimated Detention Time:	3.04 years

Samples collected from Carter Lake during the 2005 recreation season (May 1 – September 30) by the Nebraska Department of Environmental Quality were analyzed for *E. coli* bacteria and indicate full support of the primary contact recreation uses. Based on this data, Nebraska has removed the bacteria indicator parameter from the list of impairments in the 2006 Integrated Report. Iowa's assessment is also based on data collected by Nebraska, and therefore will result in removal of the bacteria impairment.

In 2004, Nebraska prepared a document supporting a category 4b listing for all waters with impairments due to PCBs in fish tissue with Iowa supporting this action for Carter Lake. The issue remains unresolved with EPA Region 7. At this time no TMDL will be prepared for PCBs

Therefore, contained in this document is a TMDL that targets excess phosphorus to address the remaining pollutant impairing the waterbody.

Morphometry

Carter Lake has a mean depth of 8 feet and a maximum depth of 28 feet. The lake surface area is 315 acres and the storage volume is 2,520 acre-feet.

Hydrology

Average rainfall in the area is 31.9 inches. The annual average detention time for Carter Lake is 3.04 year based on outflow. The methodology and calculations used to determine the detention times are shown in Appendix A.

1.2 Land Use

Carter Lake has a watershed area of 2,722 acres and has a watershed to lake ratio of 8.6 to 1. Land use data was obtained from aerial photos and a reconnaissance of the watershed. Land uses for Carter Lake are listed below in Table 2.

There are no continuously discharging point sources or confined animal feeding operation (CAFO) within the Carter Lake watershed.

There are storm sewer outlets that discharge to the lake. The City of Omaha, Nebraska and the City of Carter Lake, Iowa have been issued Municipal Separate Storm Sewer Systems (MS4) permits.

Figure 1 shows the location of Carter Lake. Figure 2 illustrates the land use in the watershed.

Table 2: Land Use in Carter Lake Watershed

Land Use	**Area (acres)**	**Percent**
Residential Curb and Gutter	532	19.5%
High Density Residential Overland	250	9.2%
Low Density Residential Overland	113	4.2%
Park	212	7.8%
Open Space	395	14.5%
Water	358	13.1%
Wetland	26	0.9%
Deciduous Forest	32	1.2%
Golf Course	122	4.5%
Commercial/Industrial	683	25.1%
TOTAL	2722	100%

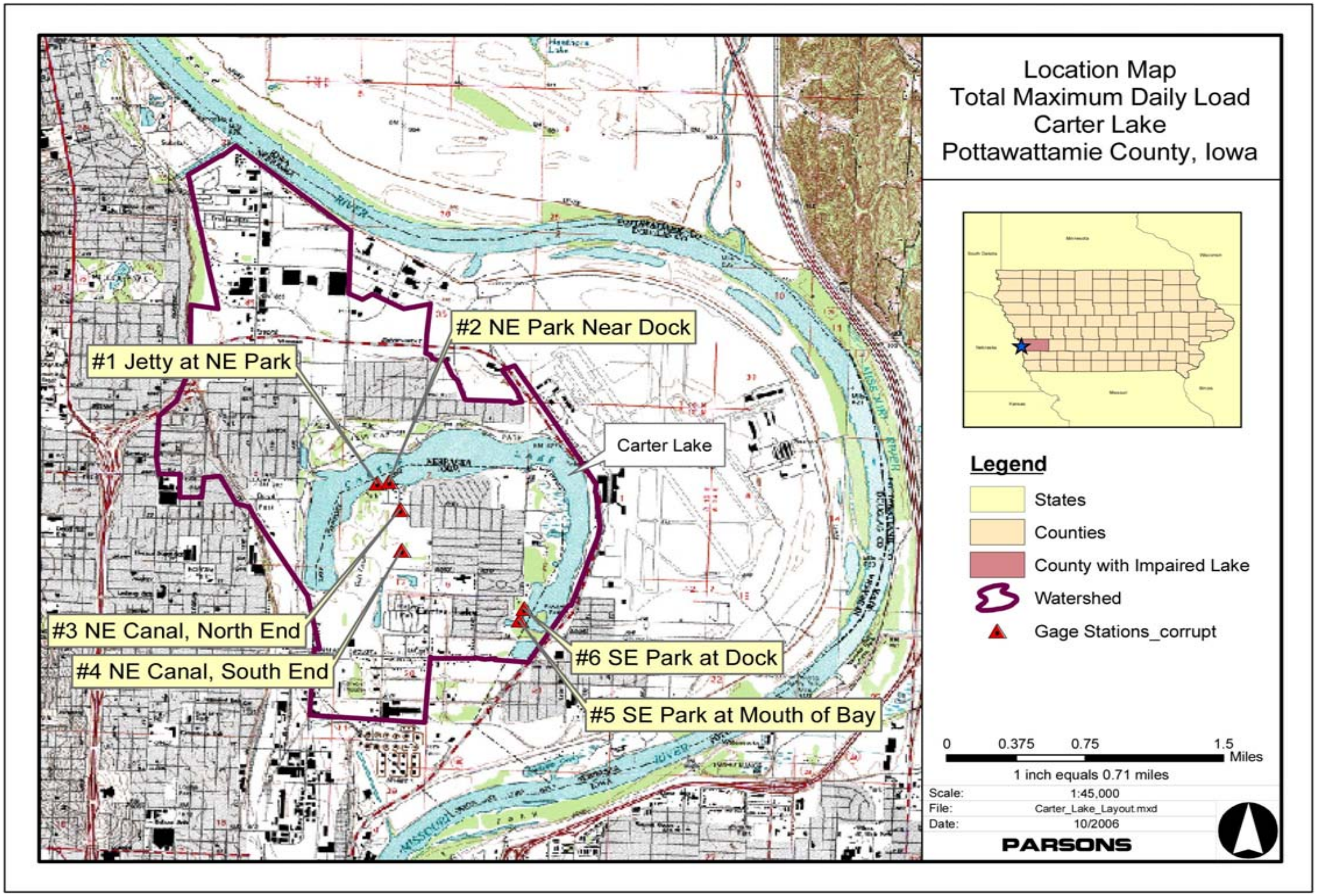


Figure 1: Location Map for Carter Lake

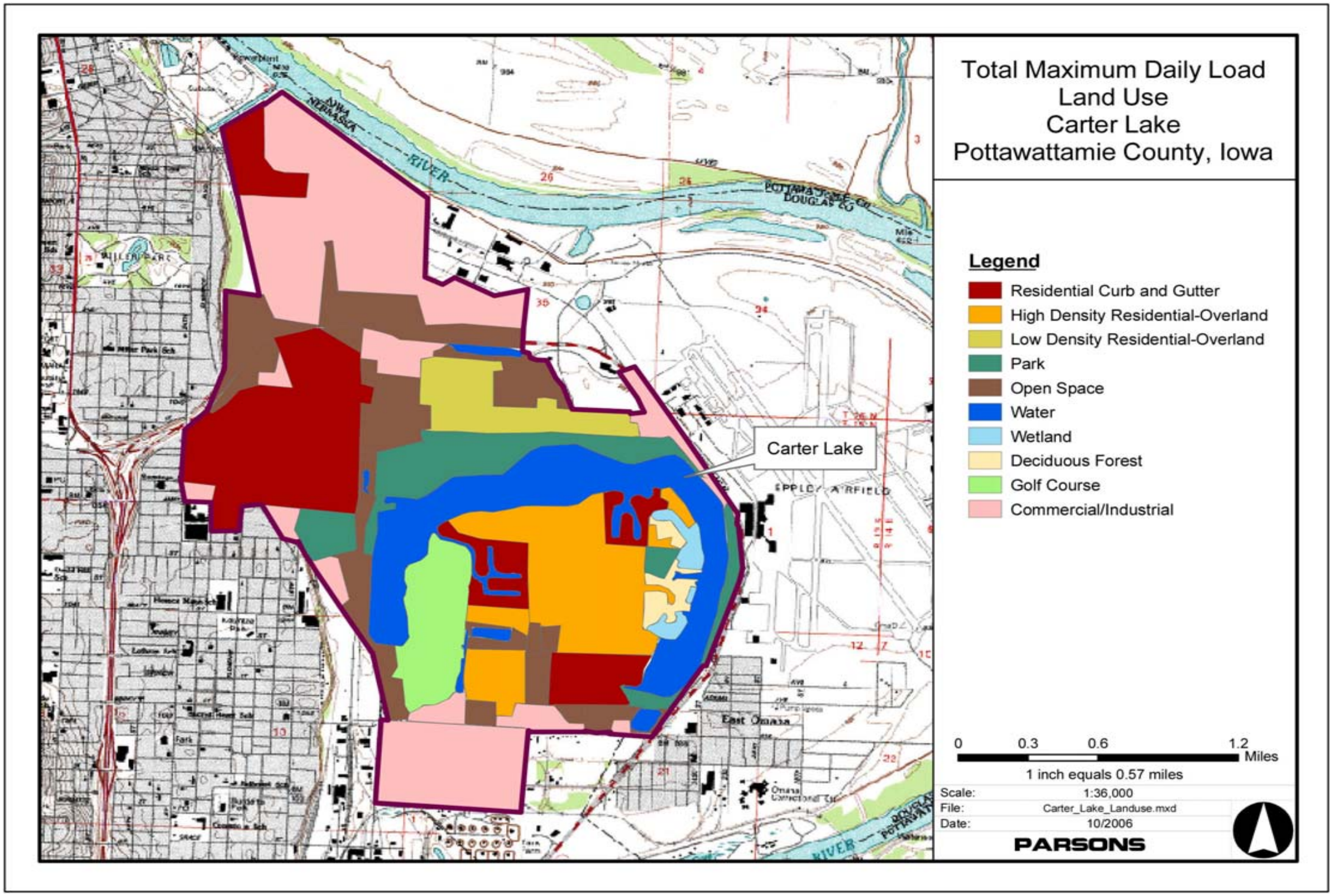


Figure 2: Land Use Map for Carter Lake

1.3 Problem Identification and Current Conditions

Section 303(d) of the Clean Water Act and the USEPA Water Quality Planning and Management Regulation (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies not meeting applicable water quality standards or designated uses under technology-based controls. TMDLs identify the maximum amount of a pollutant that a waterbody can assimilate and still meet water quality standards.

The Iowa Water Quality Standards (IAC 567-61) list the designated uses for Carter Lake as Primary Contact Recreational Use (Class A) and Aquatic Life (Class B(LW)). Carter Lake was included on the impaired waters list due to algae and turbidity impairments. The Class A (primary contact recreation) uses are assessed (monitored) as "partially supported" due to elevated levels of algal and non-algal turbidity at Carter Lake. The Class B(LW) aquatic life uses are assessed (evaluated) as "fully supporting / threatened" due to algae and non-algal turbidity (IDNR, 2004).

The 2006 Nebraska Surface Water Quality Report included Carter Lake on Part 5 (Section 303(d) List) for algal toxins, total phosphorus, total nitrogen, chlorophyll a, and pH (NDEQ, 2006). Excessive algal toxins have been assessed under the primary contact recreation beneficial use using a numeric water quality goal. pH criteria are included in the aquatic life beneficial use.

While several parameters are included, in the listing all can be categorized and addressed through the development of nutrient loading (e.g. total phosphorus). For example, algal toxins produced by blue green algae have been shown to be correlated to phosphorus, measures of transparency and overall chlorophyll concentrations. In addition, high concentrations of algae can lead to high pH in surface waters. During photosynthesis, the phytoplankton uptake carbon dioxide and give off oxygen. In this reaction, water molecules are cleaved. The organism takes up the hydrogen cation, and the remaining hydroxyl anion remains in solution. The pH value increases with the decrease in available hydrogen cations. Peaks in pH should occur in the afternoon, when the greatest amount of radiant energy reaches the river.

<u>Data Sources</u>

The sources of data for Carter Lake 305(b) assessment include: (1) results of Iowa State University (ISU) lake surveys in starting from 2000, (2) surveys by IDNR Fisheries Bureau, (3) ISU report on lake plankton communities in summer 2000 (Downing et al., 2003) and (4) the listing of fish consumption advisories for the state of Nebraska.

The primary data used to assess Carter Lake water quality and develop this TMDL are from Iowa State University Lake Study begun in 2000 and data from NDEQ. The study data were collected from 2000 to 2005 and during sampling visits in summer growing seasons. The samples were analyzed for variables including chlorophyll, secchi depth, the important forms of phosphorus and nitrogen, and suspended solids. Please refer to Appendix B for data summary.

Carter Lake Water Quality Assessment

Carlson's trophic state index (TSI) has been used to relate TP, algae (as measured by chlorophyll) and transparency (as measured by secchi depth) to set water quality targets. TSI values for monitoring data are shown in Table 3. Using the median values from this survey from 2000 through 2005, Carlson's TSI values for TP, chlorophyll-a, and secchi depth are 75, 71, and 77, respectively. A detailed explanation on the TSI can be found in Appendix C.

Table 3: Carter Lake TSI Values Based on Lake Survey Data

	Sample Data				TSI Values		
DATE	**SOURCE**	**Secchi Depth (m)**	**Chlorophyll (µg/l)**	**Total Phosphorus (µg/l)**	**Secchi Depth**	**Chlorophyll**	**Total Phosphorus**
average		0.5	97	168	71	75	78
median		**0.4**	**59**	**153**	**75**	**71**	**77**
TARGETS		**> 0.7**	**< 33**	**< 96**	**< 65**	**< 65**	**< 70**

These index values suggest: (1) high levels of total phosphorus, (2) high levels of chlorophyll-a in the water column, and (3) low transparency as secchi depth.

Plots that compare the three TSI variables are shown in Figures 3 and 4.

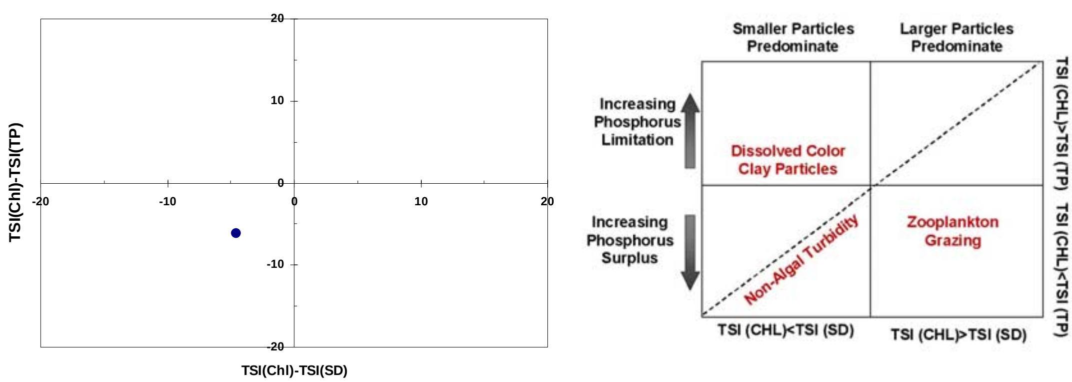


Figure 3: Carter Lake Median TSI Multivariate Comparison Plot
(Plotted Point: -4.6, -6.0)

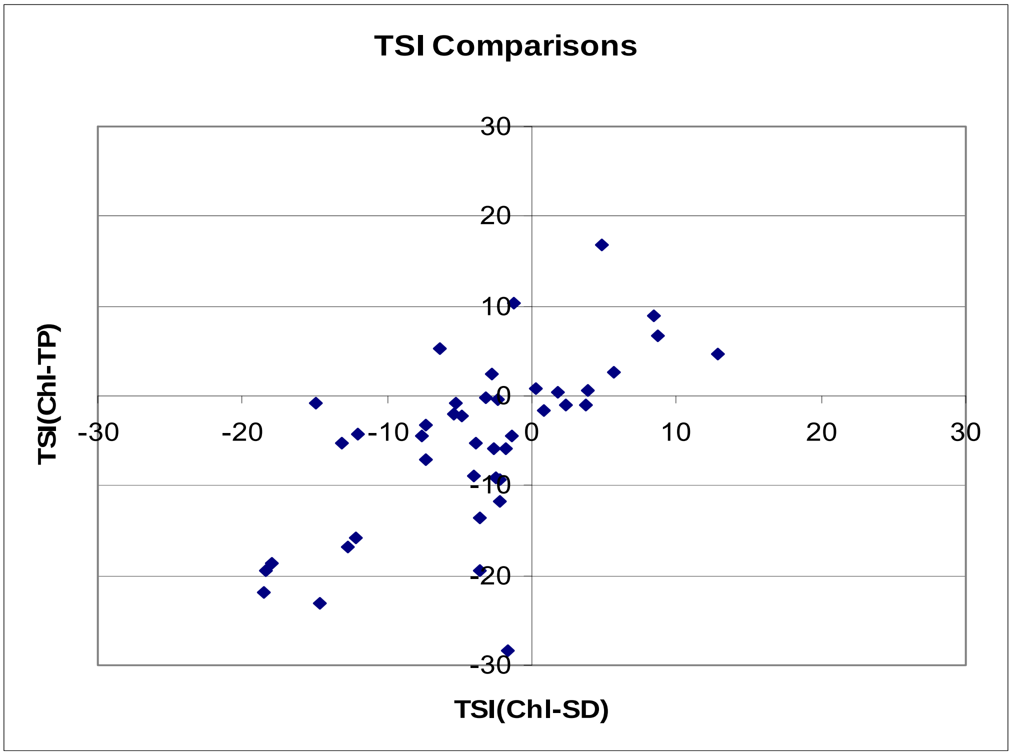


Figure 4: Carter Lake TSI Comparison Plot

Although results of ISU plankton monitoring in 2000 show a moderately large zooplankton population at Carter Lake (Downing et al., 2003), a relatively small percentage of the zooplankton are grazers on algae. The 2000 average summer mass of Cladocerans (6.9 mg/l) was the 41st lowest of the 131 lakes sampled (IDNR, 2004).

Based on median values from ISU sampling from 2000 through 2005, the ratio of total nitrogen to total phosphorus for Carter Lake is 16, which suggests the possibility that algal production at this lake is limited by nitrogen availability.

The TSI value for TP is higher than TSI for chlorophyll, which implies there could be limitations to algae growth besides phosphorus (e.g. non-algal particulates). Based on results of the ISU monitoring from 2000-2005, the primary non-phosphorus limitation to algal production appears to be inorganic suspended solids. In Figure 4, the data points for TSI (Chl-SD) and TSI (Chl-TP) are scattered along both axis. The median TSI (Chl-TP) and TSI (Chl-SD) are (-4.6, -6.0).

Data from the ISU survey suggest that this lake has marginally high levels of inorganic suspended solids and thus has potential problems with high levels of non-algal turbidity. The median level of inorganic suspended solids in the 131 lakes sampled for the ISU lake survey from 2000 through 2002 was 4.8 mg/l. The median level of inorganic suspended solids at Carter Lake was 6.4 mg/l, thus suggesting that non-algal turbidity may present some light-limitation to the production of suspended algae and may contribute to the poor water transparency at this lake.

Bluegreen algae (Cyanophyta) dominate the phytoplankton community of Carter Lake. Sampling in summer 2000 showed that greater than 95% of the wet mass of phytoplankton in the three summer samples from this lake was in bluegreen algae. The 2000 average summer mass of bluegreen algae at this lake (51.3 mg/l) was the 19th highest of the 131 lakes sampled. The presence of this very large population of bluegreen algae suggests an impairment of designated uses of this lake due to violation of Iowa's narrative water quality standard protecting against presence of nuisance aquatic life (Downing et. al., 2003).

Overall, Carter Lake is in the range of hyper-eutrophic lakes and suggests extremely high levels of phosphorus in the water column, extremely high levels of chlorophyll-a, and poor water transparency.

1.4 TMDL Endpoint

The ultimate goal of this TMDL is to reduce the excessive algae and nutrients in Carter Lake. A TMDL target has been established to link water chemistry, particularly phosphorus, to the characteristic of an ecosystem (e.g. lake) that may be affected by exposure, or in this case cause observed algae blooms and lake transparency problems. Water quality targets are quantifiable measures that are protective of water use attainment similar to water quality standards.

Iowa does not have numeric water quality criteria for algae or turbidity. The cause of Carter Lake algae and turbidity impairments is algal blooms caused by excessive nutrient loading to the lake and potentially inorganic suspended solids due to re-suspension of sediment. The TSI is used as a guideline to relate phosphorus loading to the algal and turbidity impairment for TMDL development. It describes and explains nutrient conditions that will allow a waterbody to meet Iowa's narrative water quality standards.

Typically, a total phosphorus TSI of less than 70, which is related through the trophic state index to chlorophyll a and secchi depth, defines the nutrient-loading target. Thus the targets for lake TMDLs in Iowa are normally a median TSI value of less than 70 for TP, median TSI value of less than 65 for both chlorophyll and secchi depth. These values are equivalent to TP and chlorophyll concentrations of 96 and 33 µg/L, respectively, and a secchi depth of 0.7 meters. Table 4 describes TMDL existing and target values for TSI and concentrations in Carter Lake.

Table 4: Carter Lake Existing versus Target Values

Parameter	2000-2005 Median TSI	2000-2005 Median Value	Target TSI	Target Value	Water quality improvements needed, as defined by TSI
Total Phosphorus	77	153 µg/l	<70	<96 µg/L	37% Reduction
Chlorophyll a	71	59 µg/l	<65	<33 µg/L	44% Reduction
Secchi Depth	75	0.4 m	<65	>0.7 meters	75% Increase

Nebraska does not have numeric water quality criteria for lakes that include total phosphorus, total nitrogen and chlorophyll *a* however, values submitted to EPA Region 7 for a review and approval/disapproval will be used to assess the aesthetics water quality criteria. The values applied to Carter Lake being, 133 µg/l, 1460 µg/l and 44 µg/l, respectively. These correspond to TSI values of 74.7 and 67.7 for total phosphorus and chlorophyll a, respectively. As shown in table 4, the target values for total phosphorus (96 µg/l) and chlorophyll *a* (33 µg/l) will meet the Nebraska targets.

Reductions in phosphorous loading through BMP implementations will also result in reductions in chlorophyll and nitrogen and an increase in Secchi depth, thereby achieving the TMDL targets. Blue green alga, which produce algal toxins, has also been shown to be correlated to phosphorus, measures of transparency and overall chlorophyll concentrations. Blue-green algae blooms are most commonly associated with the production of microcystin (algal toxins). Reductions in blue green algae would be expected as phosphorus levels are decreased. However, future monitoring will be needed to determine if phosphorus loading reductions will result in full compliance of the TSI target for chlorophyll-a and Secchi depth as well as the applicable Nebraska water quality criteria for Carter Lake.

2. Calculation of Total Maximum Daily Load

The following equation was used to calculate the TMDL.

TMDL = WLA + LA + MOS (Eq. 1)

where:

TMDL: Total Maximum Daily Load
WLA: Waste Load Allocation (for point sources)
LA: Load Allocation (for non-point sources)
MOS: Margin of Safety (to account for uncertainties in TMDL development)

2.1 TMDL Calculation

TMDL is defined as the maximum pollutant load that a waterbody can assimilate and still attain water quality standards. The TMDL for Carter Lake calculates the maximum allowable phosphorus loading that will meet narrative standards for nuisance algal blooms and turbidity, thus provide water quality fully supporting the lake's designated uses. The relationship of total phosphorus to chlorophyll a (algae indicator) and secchi depth (turbidity indicator) is made by using Carlson's Trophic State Index.

The Lake Phosphorus Worksheet developed by the Iowa Department of Natural Resources was used as the modeling tool for this TMDL analysis.

2.1.1 Modeling Procedures and Results

The procedures used to estimate TP loads to Carter Lake consist of:

1. Estimates of the delivered loads from the point and non-point sources in the watershed using three different methods. They are the Loading Function Model component of EUTROMOD, EPA export coefficients, and WILMS export coefficients.
2. Estimates of the annual TP load to Carter Lake using measured in-lake phosphorous concentrations, estimated hydraulic detention time, and mean depth as inputs for eleven different empirical models.
3. Comparison of the estimated TP loads based on watershed sources and the empirical models to select the best-fit empirical model for existing loads.
4. Estimates of the allowable TP loads at the target concentration (TP = 96 µg/L) for the lake, using the selected empirical model.

Table 5 lists the watershed and lake response models used to evaluate the existing and targeted Carter Lake water quality conditions. The models and the modeling procedures are included in the spreadsheet "*Carter Lake Phosphorus Worksheet.xls*". This spreadsheet also includes individual worksheets containing the hydrological calculation and the TSI calculator.

Watershed Load Estimates

The three watershed load estimates are different because the procedures and assumptions about loads from different land uses and the way that these are accounted for are different.

The loading function procedure is based on the Annual Loading Function Model within the EUTROMOD Watershed and Lake Model by Reckhow (1990) to evaluate nutrient load delivered to lakes. It incorporates approximations of both soluble phosphorous in the runoff to Carter Lake and the sediment attached phosphorus derived from erosion modeling and an estimated delivery ratio that considers watershed size and ecoregion. Export coefficients in EPA and WILMS methods are unit area annual averages for phosphorous loads associated with a particular land use.

The estimated annual average TP load by Loading Function Method, EPA Export Coefficient Method and WILMS Export Coefficient Model is 4,320 lbs/year, 1,647 lbs/year and 2,100 lbs/year.

Lake Response Load Estimates

In-lake monitoring data is used in conjunction with empirical mass balance models to estimate total phosphorus loads delivered to the lake that would cause the observed concentrations. These loads include the watershed nonpoint and point source loads, phosphorus recycled by re-suspension of sediment, and phosphorous from direct rainfall and dry deposition.

The high total phosphorus (153 µg/L) and marginally high inorganic suspended solids (6.4 mg/L) at Carter Lake are indications of potential internal loading. Given lack of site-specific data for lake sediment, the internal load for Carter Lake was not separated from the total point and nonpoint loads in the TMDL calculation.

Table 5: Model Results for Carter Lake

Watershed Load Estimates	Predicted Existing Annual TP Load (lbs/yr)[1]	Comments	All Parameters In Range
Loading Function Method	4,320	Reckhow (Eutromod)	
EPA Export Coefficient Method	1,647	EPA 440-5-80-011	
WILMS Export Coefficient Model	2,100	"most likely" export coefficients[3]	
In-lake response load estimates			
1. Canfield-Bachmann 1981 Natural Lake	3,166	Growing Season Mean (GSM) model	YES
2. Canfield-Bachmann 1981 Artificial Lake	8,004	GSM model	YES
3. Reckhow Natural Lake	5,401	GSM model	NO
4. Reckhow Anoxic Lake	568	GSM model	YES
5. Reckhow Oxic Lake (Z/Tw < 50 m/year)	1,883	GSM model	NO
6. Vollenweider 1982 Combined OECD	1,672	Annual Model[2]	YES
7. Vollenweider 1982 Shallow Lake and Reservoir	1,836	Annual Model[2]	YES
8. Walker Reservoir	4,472	Annual Model[2]	NO
9. Simple First Order (Walker)	814	Annual Model[2]	
10. First Order Settling	814	Annual Model[2]	
11. Nurnberg 1984 Oxic Lake - Lake response external load when internal load = zero	1,705	Annual Model[2]	NO

(1) For in-lake GSM concentration TP = ANN TP = 153 µg/L (median).

(2) Note that P annual = P growing season for polymictic lakes.

(3) There are three values estimates for the WILMS export coefficients, low, most likely, and high.

After verifying whether all model parameters are in range, the applicable in-lake response models whose parameters are within the range in Table 5 are:

- Canfield-Bachmann 1981 Natural Lake, 3,166 lbs/year
- Vollenweider 1982 Combine OECD, 1,672 lbs/year
- Vollenweider 1982 Shallow Lake and Reservoir, 1,836 lbs/year

Canfield-Bachmann Natural Lake model is preferred because it is closet to the estimate by Loading Function Method, which is the primary methodology for watershed load estimates. It is also within the general range of estimates by all three watershed loading methods. In addition, it is a growing season mean (GSM) model, which is suitable to address requirement of "critical condition" in the TMDL development. In comparison, EPA Export Coefficient Method is based on Nationwide Urban Runoff Program (NURP) in early 1980s. WILMS Export Coefficient Model is based on Wisconsin Lake Modeling Suite. The ranges of estimates by these two methods are used as general reference.

The equation for the Canfield-Bachmann Natural Lake model is:

$$P = \frac{L}{z[0.162(L/z)^{0.458} + p]}$$

where,

P = predicted in-lake total phosphorus concentration (µg/L)

L = areal total phosphorus load (mg/m^2 of lake area per year)

z = lake mean depth (meters)

p = lake flushing rate (yr^{-1})

The calculations for the existing total phosphorus load to Carter Lake are as follows:

$$P(153ug/L) = \frac{1127}{2.44[0.162(1127/2.44)^{0.458} + 0.329]}$$

The calculations for the loading capacity of total phosphorus for Carter Lake are as follows:

$$P(96.2ug/L) = \frac{520}{2.44[0.162(520/2.44)^{0.458} + 0.329]}$$

The annual total phosphorus is obtained by multiplying the areal load (L in mg/m^2) by the lake area (in square meters) and converting the resulting value to pounds. The loading capacity of total phosphorus for Carter Lake is 1,462 lbs/year.

The chlorophyll a and secchi depth objectives are related through the Trophic State Index to total phosphorus. The loading capacity for this TMDL is the annual amount of total phosphorus that Carter Lake can receive but still meet its designated uses.

Based on selected lake response model and a target TSI (TP) value of less than 70 (corresponding to an in-lake average TP concentration of 96 µg/L), the TMDL for total phosphorus is 1,462 lbs/year.

2.1.2 Estimate of Existing Loads:

There are three quantified phosphorus sources for Carter Lake in this TMDL. The first is the phosphorus load from regulated storm water discharges within MS4 areas (the corporate limits of the City of Omaha, NE and City of Carter Lake, IA). The second source is nonpoint source phosphorus load from the watershed areas outside of the corporate limits of the City of Omaha. The third source is atmospheric deposition. Potential load contributions from phosphorus recycled from lake sediments (internal load) was not separated from total point and nonpoint source loads.

Existing Load

The existing annual total phosphorus load to Carter Lake is estimated to be 3,166 lbs/year, based on the selected lake response model.

Departure from Loading Capacity

The loading capacity of total phosphorus for Carter Lake is 1,462 lbs/year. The existing watershed load is estimated as 3,166 lbs/year. Therefore, a load reduction of 1,704 lbs/year is needed in order to achieve water quality goals and protect the designated uses.

Identification of Pollutant Sources

There is no continuously discharging point source in the Carter Lake watershed. Most phosphorous is delivered to the lake from stormwater discharges or nonpoint sources. The Loading Function Model estimates 63% of the load to originate from urban and industrial land uses.

Linkage of Pollution Sources to TMDL Target

The pollutant sources of TP from the watershed have been linked to the water quality impairment through the use of Loading Function model, EPA and WILMS export coefficient models, along with selected in-lake response model in Lake Phosphorus Worksheet by IDNR.

2.2 Consideration of Critical Condition and Seasonal Variations

(1) Critical Condition

The Clean Water Act [40 CFR 130.7(c)(1)] and USEPA'S TMDL regulations require that in developing TMDLs, one must "*take into account the critical conditions for stream flow, loading, and water quality parameters*". The "critical condition" is generally defined as the condition when the physical, chemical, and biological characteristics of the receiving water environment interact with the effluent to produce the greatest potential adverse impact on aquatic biota and existing or characteristic water uses. The intent of this requirement is to ensure that the water quality of the receiving water body is protected during times when it is most vulnerable.

The critical condition for this TMDL study is during the growing season (May through September) when nuisance algal blooms and low transparency in the lake are most likely to occur. As well, Nebraska's nutrient criteria for lakes and impounded waters are based on seasonal average from April 1 through September 30.

The existing and target total phosphorus loadings to the lake are expressed as annual averages. The model selected for estimating phosphorus loading to the lake utilizes growing season mean (GSM) in-lake total phosphorus concentrations to calculate an annual average total phosphorus loading.

(2) Considerations of Seasonal Variations

The TMDL target was derived using May through September data when nuisance algal blooms and low transparency in Carter Lake were most likely to occur. By using data from this most problematic period instead of the entire year, the target is meant to prevent nuisance algal blooms and low transparency occurrences year-round. If a phosphorus limit were instituted for the growing season only, it would ignore the effects of nutrient re-suspension in the water column within Carter Lake.

2.3 Margin of Safety

The Margin of Safety (MOS) is included to account for uncertainties associated with TMDL development including WLA, to protect water quality in the event that the "true" TMDL (or WLA) is underestimated, and to assure that the watershed is adequately protected. EPA's TMDL guidelines (USEPA, 1999) suggest using an implicit or explicit approach to estimate the MOS. The implicit approach is to incorporate MOS using conservative model assumptions to develop allocations while the explicit approach is to reserve a portion of the total TMDL for MOS.

Based on data availability for this TMDL study and guidance from EPA and IDNR, an explicit margin of safety of 10% of the loading capacity is reserved for a MOS.

2.4 Waste Load Allocation:

The Waste Load Allocation (WLA) is the maximum allowable amount of the pollutant that can be assigned to point sources. There is no continuously discharging point source in the Carter Lake watershed.

EPA's stormwater permitting regulations require municipalities to obtain permit coverage for all stormwater discharges from an urban municipal separate storm sewer system. For the City of Omaha, NE and the City of Carter Lake, IA, the areas within the corporate limits (98.9% of the total watershed area) are covered under the MS4 NPDES permit and make up the WLA. The areas outside of the corporate limits (1.1% of total area) are included in the Load Allocation described below.

WLA = 98.9% * (TMDL – MOS) = 98.9% * (1,462 – 10%*1,462) = 1,301 lbs/yr

Based on relative land use size between the City of Omaha, NE and the City of Carter Lake, IA, the individual WLA for the City of Omaha and the City of Cater Lake is 904 lbs/yr and 397 lbs/yr, respectively.

2.5 Load Allocation:

The Load Allocation (LA) can be calculated from (Eq. 1) by subtracting the WLA and MOS from the TMDL.

TMDL = WLA + LA + MOS

LA = TMDL – MOS – WLA (Eq. 2)
= 1,462 – 10%*1,462 – 1,301 = 15 lbs/yr

The LA for this TMDL is further divided into watershed non-point sources and atmospheric deposition. TP loading from atmospheric deposition is estimated as 5.6 lb/yr, based on wet deposition value of 0.02 Kg/ha/yr in Zaimes and Schultz (2002) and lake surface area. Because 98.9% of Carter Lake watershed is in the MS4 area, atmospheric deposition composes 37% of LA, which is larger than watershed without MS4. Therefore, the watershed nonpoint source load is:

15 lbs/yr –5.6 lbs/yr = 9.4 lbs/yr

2.6 Conversion to Daily Loads

The TMDL has established an annual average phosphorus load that if achieves should meet the water quality targets. A recent court decision often referred to as Anacostia decision have dictated that TMDL include a "daily" load (*Friends of the Earth, Inc. v. EPA, et al.)*

Expressing this TMDL in daily time steps could mislead the reader by implying a daily response to a daily load. It is important to recognize that the growing season mean is affected by many factors such as the following: internal lake nutrient loading, water residence time, wind action and the interaction between light penetration, nutrients, sediment load and algal response.

As stated, the TMDL does set a total phosphorus allocation of 1,462 lbs/year. To translate the long term average to maximum daily values EPA Region 7 has suggested the approach described in the Technical Support Document for Water Quality Based Toxics Control (EPA/505/2-90-001) (TSD). The maximum daily load (MDL) equals the long term average (LTA) * exp(z*sigma-0.5*sigma^2). The data used in the TMDL has a coefficient of variation (CV) of 0.5. From the TSD, the 99th percentile occurrence probability for a CV of 0.5 is 2.68. Using these assumptions, the MDL = LTA*2.68. Therefore, the total phosphorus would be:

1,462 lbs/year ÷365 days/year * 2.68 = 10.7 lbs/day.

2.7 Percentage of Reduction:

Estimating required percentage of reduction is given as follows:

Determination of Required Load Reduction
% TP Reduction = (Existing Load – LA) / Existing Loading (Eq. 3)
= (3,166 – 1,462) / 3,166 = 53.8%

A TP load reduction of 53.8% is needed in order to achieve water quality goals and protect the designated uses.

Table 6: Summary of TMDL Results for Total Phosphorus

TMDL (lbs/yr)	**1,462**
WLA (lbs/yr)	**1,301**
LA (lbs/yr)	**15**
MOS (lbs/yr)	**146**
Existing Load (lbs/yr)	**3,166**
% of Reduction	**53.8%**

3. Reasonable Assurance

Reasonable assurance of the TMDL established for Carter Lake will require a comprehensive approach that addresses:

- regulated stormwater discharges under MS4 NPDES permit
- non-point source pollution outside MS4 area
- existing and potential future sources
- regulatory and voluntary approaches

There is reasonable assurance that the goals of the TMDL for Carter Lake can be met with proper watershed planning, implementation of BMPs, and strong financial mechanisms. As can be seen in the development of the TMDL, there are three major components to the phosphorous inputs for Carter Lake: the regulated stormwater discharges, nonpoint source loading from the watershed areas outside the corporate limits of the City of Omaha, NE and City of Carter Lake, IA, and the load from atmospheric deposition.

Carter Lake and most of the lake watershed is located within the corporate limits of the City of Omaha. The city of Omaha is authorized to discharge from a Municipal Separate Storm Sewer System (MS4) under NPDES permit. This MS4 permit requires development of a Stormwater Pollution Prevention & Management Program (SWMP). The SWMP includes requirements for implementation of BMPs including controls to reduce pollutants in discharges from municipal application of fertilizers and operation of a public environmental information and education program to inform the public about the proper use of fertilizes.

Reaching the reduction goals for nonpoint source loads established by this TMDL will only occur through changes in current land use practices, including the incorporation of best management practices (BMPs). BMPs would be helpful in lowering the amount of nutrients and sediments reaching Carter Lake. Determining the most appropriate BMPs, where they should be installed, and actually putting them into practice will require the development and implementation of a comprehensive watershed restoration plan. Development of any watershed restoration plan will involve the gathering of site-specific information regarding current land uses and existing conservation practices. Successful implementation of the activities necessary to address current use impairment in the Carter Lake watershed will require local citizens' active interest in the watershed and cooperation of other relevant entities. By developing a nutrient TMDL for Carter Lake, the stage has been set for local citizens to design and implement restoration plans to correct current use impairments.

Because of the uncertainty as to how much of the phosphorus load originates in the watershed and how much is recycled from lake bottom sediment, an adaptive management approach to phosphorous reduction is recommended. In this approach management practices to reduce both watershed loads and recycled loads are incrementally applied and the results monitored to determine if water quality goals have been achieved. Practical methods are needed to evaluate the magnitude of the phosphorus load from internal recycling, preferably by direct measurement of re-suspension and recycling from lake bottom sediment. Based on the Lake Restoration Report and Plan by IDNR (IDNR, 2006a) and NDEQ, feasibility studies prior to lake restoration (e.g. dredging) will be underway at Carter Lake in the near future.

4.0 Monitoring Plan

Since the response in water quality to in-lake and watershed treatments are only speculative, a long term monitoring program will be required to evaluate the progress in meeting the water quality goals and objectives identified in this plan. It should be noted that it may take several years after project completion before the biological communities and chemical constituents reach stability.

Information provided through the monitoring activities will be distributed to the project stakeholders. The monitoring results will be used, as appropriate, to revise the monitoring strategies, implementation strategies, and/or the project goals and objectives.

Since water quality goals and objectives pertain to in-lake conditions, monitoring activities will be focused in the lake. Monitoring activities will encompass a combination of physical, chemical, and biological elements. Specific monitoring approaches will be designed annually through a coordinated effort among several agencies. All monitoring activities will follow existing protocols established by the respective agencies and will be documented in an annual monitoring plan. Proposed monitoring parameters, collection frequency and responsibilities are provided in Table 7.

5.0 Public Participation

The availability of the TMDL in draft form was published in the Omaha World Herald by NDEQ with the public comment period running from May 14, 2007 to June 18, 2007. These TMDLs were also made available to the public on the IDNR and NDEQ’s Internet sites and interested stakeholders were informed via email of the availability of the draft TMDL. No public comments were received by NDEQ or IDNR on the Draft Carter Lake TMDL.

Table 7. Proposed Monitoring At Carter Lake

Parameter	**Frequency**	**Responsible Party (a)**
Lake Water Levels	??????	CLPS
User Surveys	Annually	CLPS
Water Clarity	Monthly During Growing Season	NDEQ
Total Suspended Solids	Monthly During Growing Season	NDEQ
Total Phosphorus	Monthly During Growing Season	NDEQ
Kjeldahl Nitrogen	Monthly During Growing Season	NDEQ
Nitrate/Nitrite Nitrogen	Monthly During Growing Season	NDEQ
Chlorophyll	Monthly During Growing Season	NDEQ
Atrazine	Monthly During Growing Season	NDEQ
Alachlor	Monthly During Growing Season	NDEQ
Metolachlor	Monthly During Growing Season	NDEQ
Dissolved Oxygen	Monthly During Growing Season	NDEQ
Temperature	Monthly During Growing Season	NDEQ
pH	Monthly During Growing Season	NDEQ
Conductivity	Monthly During Growing Season	NDEQ
Algae Toxins	Weekly During Recreation Season	NDEQ
e.coli bacteria	Weekly During Recreation Season	NDEQ
Dissolved Copper	Annually	NDEQ
Dissolved Zinc	Annually	NDEQ
Dissolved Lead	Annually	NDEQ
Dissolved Mercury	Annually	NDEQ
Dissolved Iron	Annually	NDEQ
Dissolved Manganese	Annually	NDEQ
Total Selenium	Annually	NDEQ
Fish Tissue	1 Time Every Five Years	NDEQ
Fish Communities	??????????	IDNR/NGPC

(a) CLPS = Carter Lake Preservation Society, NDEQ = Nebraska Department of Environmental Quality, IDNR = Iowa Department of Natural Resources, NGPC = Nebraska Game and Parks Commission

References

Alexander, R. B., Smith, R. A., and Schwarz, G. E. (2004). Estimates of Diffuse Phosphorus Sources in Surface Wastes of the United States using a spatially referenced watershed model, *Water Sciences and Technology*, 49(3): 1-10

Bachmann, R.W., M.R. Johnson, M.V. Moore, and T.A. Noonan (1980). Clean lakes classification study of Iowa's lakes for restoration. Iowa Cooperative Fisheries Research Unit and Department of Animal Ecology, Iowa State University, Ames, Iowa. 715 p.

Bachmann, R.W., T.A. Hoyman, L.K. Hatch, and B.P. Hutchins (1994). A classification of Iowa's lakes for restoration. Iowa State University, Ames, Iowa. 517 p.

Canfield, D. E. Jr., and R. W. Bachmann (1981). Prediction of total phosphorus concentrations, chlorophyll a, and secchi depths in natural and artificial lakes. Can. J. Fish. Aquat. Sci. 38: 414-423

Carlson, R. E. (1977). A trophic state index for lakes. Limnology and Oceanography 25:378-382.

Carlson, R.E. and J. Simpson (1996). A Coordinator's Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society, 96p. http://dipin.kent.edu/tsi.htm

Downing, J. A., Ramstack, J. M., Haapa-aho, K., and Lee, K. (2003). Iowa Lakes Survey, Department of Ecology, Evolution, and Organismal Biology, Iowa State University

Graham, J. L. (2004). Environmental Factors Influencing Microcystin Distribution and Concentration in Midwestern Lakes, Ph.D. Dissertation, University of Missouri – Columbia, MO.

Iowa General Assembly (2004). Iowa Administrative Code, Chapter 567-61: Water Quality Standards, http://www.legis.state.ia.us/IAC.html

Iowa Department of Natural Resources (IDNR) (2002). Natural Resources Geographic Information Systems Library - Land Cover of the State of Iowa in the Year 2002, http://www.igsb.uiowa.edu/nrgislibx/

Iowa Department of Natural Resources (IDNR) (2004). Iowa Section 303(d) Impaired Waters Listings, http://wqm.igsb.uiowa.edu/WQA/303d.html

Iowa Department of Natural Resources (IDNR) (2004a). National Pollutant Discharge Elimination System (NPDES) Permit No. 78-12-0-00

Iowa Department of Natural Resources (IDNR) (2004b). Total Maximum Daily Loads for Nutrients and Siltation – Easter Lake, Polk County, Iowa

Iowa Department of Natural Resources (IDNR) (2005). Iowa State University Statewide Lake Study, http://limnology.eeob.iastate.edu/lakereport/

Iowa Department of Natural Resources (IDNR) (2006). Water Quality Improvement Plans – Publications and Report, http://www.iowadnr.com/water/watershed/pubs.html

Iowa Department of Natural Resources (IDNR) (2006a). Lake Restoration Report and Plan 2006, http://www.legis.state.ia.us/lsadocs/Docs_Filed/2006/DFJYD152.PDF

Iowa State University (2005). Center for Agricultural Research and Rural Development (CARD) Resource and Environmental Policy Division. Iowa Lakes Valuation Project. Available at http://www.card.iastate.edu/lakes/

Miller, S. M., Sweet, C. W., Depinto, J. V., Hornbuckle, K. C. (2000). Atrazine and Nutrients in Precipitation: Results from the Lake Michigan Mass Balance Study, *Environmental Science & Technology*, 34(1): 55-61

Nebraska Department of Environmental Quality (NDEQ) (2004). 2004 Surface Water Quality Integrated Report, http://www.deq.state.ne.us/SurfaceW.nsf/Pages/TMDL

Nebraska Department of Environmental Quality (NDEQ) (2006). Title 117 – Nebraska Surface Water Quality Standards, http://www.deq.state.ne.us/RuleAndR.nsf/pages/117-TOC

Reckhow, K. H. (1990). EUTROMOD Watershed and Lake Modeling Software Tech. Transfer. North American Lake Management Society.

Schemmer Associates Inc (1997). Carter Lake Water Level Control – Preliminary Design Report.

Renard, K. G., G. R. Foster, G. A. Weesies, D. K. McCool, and D. C. Yoder (1997). Predicting soil erosion by water: A guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). U.S. Department of Agriculture, Agriculture Handbook No. 703. 404 pp.

Toy, T. J. and Foster, G. R. (1998). Guidelines for the Use of the Revised Universal Soil Loss Equation (RUSLE) Version 1.06 on Mined Lands, Construction Sites, and Reclaimed Lands, Western Regional Coordinating Center, Office of Surface Mining, Denver, Colorado..

U.S. Army Corps of Engineers (2004). Review of Published Export Coefficient and Event Mean Concentration (EMC) Data, Report ERDC TN-WRAP-04-3

U. S. Department of Agriculture (USDA) (2000). Predicting Rainfall Erosion Losses, the Revised Universal Soil Loss Equation (RUSLE), Natural Resources Conservation Service - Field Office Technical Guide.

U. S. Department of Agriculture (USDA) (2005). National Handbook of Conservation Practices (NHCP), http://www.nrcs.usda.gov/technical/standards/nhcp.html

USEPA (1980). Modeling Phosphorus Loading and Lake Response under Uncertainty: A Manual and Compilation of Export Coefficients, EPA Report 440-5-80-011

USEPA (1998). Lake and Reservoir Bioassessment and Biocriteria, EPA Report 841-B-98-007

USEPA (1999). Protocol for Developing Nutrient TMDLs (First Edition), EPA Report 841-B-99-007

USEPA (1999a). Draft Guidance for Water Quality-based Decisions: The TMDL Process (Second Edition), EPA Report 841-D-99-001

USEPA (2005). Stormwater Phase II Final Rule – Who's Covered? Designations and Waivers of Regulated Small MS4s (revised December 2005), http://www.epa.gov/npdes/pubs/fact2-1.pdf

USEPA (2005a). Stormwater Phase II Final Rule – Urbanized Areas: Definition and Description (revised December 2005), http://www.epa.gov/npdes/pubs/fact2-2.pdf

Wisconsin Department of Natural Resources (2003). Wisconsin Lake Modeling Suite Program Documentation and User's Manual. 2003 PUBL-WR-363-94

Zaimes, G. N, and Schultz, R. C. (2002). Phosphorus in Agricultural Watersheds – A Literature Review, Department of Forestry, Iowa State University, http://www.buffer.forestry.iastate.edu/Assets/Phosphorus_review.pdf

Appendices

Appendix A – Carter Lake Hydrologic Calculations

Appendix B – Sampling Data

Appendix C – Trophic State Index

Appendix A – Carter Lake Hydrologic Calculations

Lake	Carter	
Type	Impoundment	
Inlet(s)	None	
Outlet(s)	None	
Volume	2520	acre-feet
Surface Area	315	acres
Watershed Area	2713	acres
Mean Annual Precipitation	31.9	inches
Average Basin Slope	1.2	%
% Forest (2000 Land Cover)		
% Corn (2000 Land Cover)		
% Rowcrop (2002 Land Cover)	2.0	
Basin Soils Average % Sand	20.0	
Soil Permeability	0.1	inches/hour
Mean Annual Class A Pan Evaporation	58	inches
Evaporation Coefficient	0.74	
Optional User Input Inflow Estimate		acre-feet/year
Optional User Input Runoff Component		acre-feet/year
Optional User Input Baseflow Component		acre-feet/year
Mean Depth	8.0	feet
Drainage Area	2398	acres
Drainage Area	3.7	square miles
Drainage Area/Lake Area	7.6	
Mean Annual Lake Evaporation	42.9	inches
Mean Annual Lake Evaporation	1127	acre-feet/year
Annual Average Inflow	1.5	cfs
Annual Average Inflow	1118	acre-feet/year
Runoff Component	1446	acre-feet/year
Baseflow Component	-328	acre-feet/year
Direct Precipitation on Lake Surface	837	acre-feet/year
Inflow + Direct Precipitation	1955	acre-feet/year
% Inflow	57.2	
% Direct Precipitation	42.8	
Outflow	828	acre-feet/year
HRT Based on Inflow + Direct Precipitation	1.29	year
HRT Based on Outflow	3.04	year

Appendix B – Sampling Data

Table B-1. Data collected in 1980 Bachmann Report.

Lake Survey Year	1979
Secchi Disk Depth (m)	0.6
Chlorophyll a (µg/l)	39.4
TOT Phosphorus (µ/l)	86.3
Kjeldahl Nitrogen (mg/l)	0.9
Ammonia Nitrogen (mg/l)	0.2
Nitrate + Nitrite Nitrogen (mg/l)	0.1
Seston Dry Weight (mg/l)	11.9
Turbidity (NTU)	9.8
TOT Hardness (mg/l) as $CaCO_3$	219
Calcium Hardness (mg/l) as $CaCO_3$	107.3
TOT Alkalinity (mg/l) as $CaCO_3$	218.4
Dissolved Oxygen (mg/l)	7.5
Specific Conductance (microhmes/cm) at 25°C	541.1
Sulfate (mg/l)	60.2
Chloride (mg/l)	24.8
Sodium (mg/l)	45
Potassium (mg/l)	8.5

Table B-2. Data collected in 1994 Bachmann Report.

Lake Survey Year	1992
Secchi Disk Depth (m)	0.05
Chlorophyll a (µg/l)	43.8
TOT Phosphorus (µg/l)	89
TOT Nitrogen (mg/l)	1.19
Ammonia Nitrogen (mg/l)	0.011
Nitrate + Nitrite Nitrogen (mg/l)	0.04
TOT Alkalinity (mg/l) as $CaCO_3$	196
Organic Suspended Solids (mg/l)	4.18
TOT Hardness (mg/l) as $CaCO_3$	227
Inorganic Suspended Solids (mg/l)	7.28
TOT Suspended Solids (mg/l)	11.46

Table B-3. Data collected in 2000 by Iowa State University and Iowa Department of Natural Resources.

Parameter	6/15/2000	6/21/2000	7/13/2000	7/19/2000	8/7/2000	8/9/2000
Lake Depth (m)	5.5	7.0	5.2	7.3	5.5	7.0
Thermocline Depth (m)	NIL	NIL	4	NIL	NIL	5
Secchi Disk Depth (m)	0.8	0.4	0.9	0.3	0.7	0.2
Temperature(^{o}C)	20.3	23.4	28	25.8	26	28.3
Dissolved Oxygen (mg/L)	8.4	7.7	7.7	5.9	9	9.1
Dissolved Oxygen Saturation (%)	93	90	98	73	111	117
Specific Conductivity (µS/cm)	437.5	755	-	665.8	400	658.7
Turbidity (NTU)	6	47.6	17	60.1	21	61.5
Chlorophyll a (µg/L)	19.4	53.5	-	120.2	27.1	167.6
Total Phosphorus as P (µg/L)	182	240	124	153	113	209
Total Nitrogen as N (mg/L)	1.63	1.61	1.55	2.52	1.57	2.62
Nitrate + Nitrite (NO_3 + NO_2) as N (mg/L)	0.36	0.15	0.25	0.11	0.17	0.17
TN:TP ratio	9	7	13	17	14	13
pH	8	8.2	8.2	8.2	8.3	8.5
Alkalinity as $CaCO_3$ (mg/L)	181	249	186	207	172	193
Inorganic Suspended Solids (mg/L)	10	7	12	6	14	2
Volatile Suspended Solids (mg/L)	10	6	2	11	12	8
Total Suspended Solids (mg/L)	20	13	14	18	26	10
Carlson Trophic State Index (Secchi)*	63		62		66	
Carlson Trophic State Index (Chl a)*	60		-		63	
Carlson Trophic State Index (TP)*	79		74		72	

Table B-4. Data collected in 2001 by Iowa State University and Iowa Department of Natural Resources.

Parameter	5/17/2001	5/22/2001	6/14/2001	6/20/2001	7/19/2001	7/24/2001
Lake Depth (m)	6.2	7.9	5.5	7.9	6.1	7.8
Thermocline Depth (m)	3	6.5	3.8	4.9	2.7	2.3
Secchi Disk Depth (m)	2.1	0.6	0.9	0.4	1.1	0.3
Temperature(^{o}C)	20.3	18.7	21.7	23.5	27.7	30.2
Dissolved Oxygen (mg/L)	8.9	10.7	8.1	5.8	9.4	8.5
Dissolved Oxygen Saturation (%)	99	114	92	69	120	113
Specific Conductivity (µS/cm)	370.7	581.7	371	596.3	591.3	639.2
Turbidity (NTU)	61.2	50	24.4	59.6	20.2	69.4
Chlorophyll a (µg/L)	5.7	157.1	17.9	60	28.5	78.4
Total Phosphorus as P (µg/L)	146	141	67	191	19	227
Total Nitrogen as N (mg/L)	2.37	2	3.29	1.74	2.32	2.14
Nitrate + Nitrite (NO_3 + NO_2) as N (mg/L)	1.37	0.21	2.18	0.09	0.96	0.28
TN:TP ratio	16	14	49	9	121	9
pH	7.8	8.7	8	7.9	8.8	9.1
Alkalinity as $CaCO_3$ (mg/L)	138	196	144	195	124	203
Inorganic Suspended Solids (mg/L)	15	8	12	8	2	1
Volatile Suspended Solids (mg/L)	4	17	8	12	9	19
Total Suspended Solids (mg/L)	19	24	20	20	10	20
Carlson Trophic State Index (Secchi)*	49		62		59	
Carlson Trophic State Index (Chl a)*	48		59		63	
Carlson Trophic State Index (TP)*	76		65		47	

Table B-5. Data collected in 2002 by Iowa State University and Iowa Department of Natural Resources.

Parameter	5/23/2002	5/29/2002	6/20/2002	6/25/2002	7/25/2002	7/30/2002
Lake Depth (m)	5.8	7.3	4.3	7.1	5.5	6.7
Thermocline Depth (m)	2.8	1.7	NIL	1	NIL	1.7
Secchi Disk Depth (m)	0.7	0.3	0.4	0.2	0.6	0.2
Temperature(^{o}C)	21.9	22.6	22.4	27.8	25.7	28.3
Dissolved Oxygen (mg/L)	9.1	8.4	7.8	9.4	8	9
Dissolved Oxygen Saturation (%)	104	97	89	119	97	116
Specific Conductivity (µS/cm)	424.6	667.9	547.8	686.8	457.2	595.9
Turbidity (NTU)	8	6.2	51.2	68.9	31.3	107.5
Chlorophyll a (µg/L)	9.8	84.3	35.6	125.4	50.8	309.9
Total Phosphorus as P (µg/L)	88	130	97	177	88	332
Total Nitrogen as N (mg/L)	1.74	0.15	2.18	1.66	1.44	3.16
Nitrate + Nitrite (NO_3 + NO_2) as N (mg/L)	0.46	0.12	0.83	0.1	0.2	0.11
TN:TP ratio	20	1	23	9	17	10
pH	8.4	7.9	8.2	9	8.4	8.9
Alkalinity as $CaCO_3$ (mg/L)	151	192	172	208	167	182
Inorganic Suspended Solids (mg/L)	11	1	26	2	13	13
Volatile Suspended Solids (mg/L)	6	15	7	25	13	25
Total Suspended Solids (mg/L)	17	16	34	26	27	38
Carlson Trophic State Index (Secchi)*	65		75		67	
Carlson Trophic State Index (Chl a)*	53		66		69	
Carlson Trophic State Index (TP)*	69		70		69	
SRP as P (µg/L)	3	3	6	2	2	7
Ammonia Nitrogen (NH_3 + NH_4^+) as N (µg/L)	337		389		300	
Ammonia Nitrogen (NH_3) as N (un-ionized)(µg/L)	34		29		40	
Silica as Si (mg/L)	1.52	3.22	2.09	8.77	6.15	15.49
Dissolved Organic Carbon (mg/L)	-		-		14.12	10.03

Table B-6a. Data collected in May and June, 2003 by Iowa State University, Iowa Department of Natural Resources, and Nebraska Department of Environmental Quality.

Parameter	5/22/2003	5/28/2003	5/29/2003	6/19/2003	6/24/2003	6/25/2003
Lake Depth (m)	6.5	7.0		6.4	6.7	
Thermocline Depth (m)	NIL	3.1		5	1.8	
Secchi Disk Depth (m)	0.6	0.3	0.1	0.5	0.3	0.1
Temperature(^{o}C)	15.7	22.7	22.45	22.8	26.8	26.45
Dissolved Oxygen (mg/L)	8.5	8.7	5.55	7.6	9.8	6.5
Dissolved Oxygen Saturation (%)	86	101		89	123	
Specific Conductivity (µS/cm)	521.9	665.8	679	472.7	684.2	703.5
Turbidity (NTU)	42.1	67.2		26.7	63.7	
Chlorophyll a (µg/L)	20.1	18.1		31.9	32.1	128.53
Total Phosphorus as P (µg/L)	79	172	140	76	214	180
Total Nitrogen as N (mg/L)	3.14	1.62	2.14773	3.8	2.07	2.84145
Nitrate + Nitrite (NO_3 + NO_2) as N (mg/L)	2.64	0.01	0.05	2.1	0.02	0.05
TN:TP ratio	40	9	15.3409	50	10	15.78583
pH	8.3	8.9	8.2	8.3	8.7	8.475
Alkalinity as $CaCO_3$ (mg/L)	150	165		128	145	
Inorganic Suspended Solids (mg/L)	19	9		21	11	
Volatile Suspended Solids (mg/L)	6	20		9	24	
Total Suspended Solids (mg/L)	25	29		30	34	
Carlson Trophic State Index (Secchi)*	67			72		
Carlson Trophic State Index (Chl a)*	60			65		
Carlson Trophic State Index (TP)*	67			67		
SRP as P (µg/L)	4	2		4	2	
Ammonia Nitrogen (NH_3 + NH_4^+) as N (µg/L)	620			579		
Ammonia Nitrogen (NH_3) as N (un-ionized)(µg/L)	31			47		
Silica as Si (mg/L)	2.2	6.46		1.8	9.9	
Dissolved Organic Carbon (mg/L)	13.71	11.83		11.96	11.05	

Table B-6b. Data collected in July, August, and September, 2003 by Iowa State University, Iowa Department of Natural Resources, and Nebraska Department of Environmental Quality.

Parameter	7/23/2003	7/30/2003	7/30/2003	8/28/2003	9/25/2003
Lake Depth (m)	5.2	7.1			
Thermocline Depth (m)	1.3	NIL			
Secchi Disk Depth (m)	0.4	0.2	0.3	0.1	0.3
Temperature(^{o}C)	27.1	26		28	19.225
Dissolved Oxygen (mg/L)	12.6			4.6	13.475
Dissolved Oxygen Saturation (%)	158				
Specific Conductivity (µS/cm)	417.6	693.6		676.33	692
Turbidity (NTU)	20.3	96.2			
Chlorophyll a (µg/L)	40.5	32.2	94.32	173.9	26.5
Total Phosphorus as P (µg/L)	54	303	310	280	290
Total Nitrogen as N (mg/L)	1.63	3.81	5.15012	4.67557	5.91957
Nitrate + Nitrite (NO_3 + NO_2) as N (mg/L)	0.13	0.01	0.05	0.05	0.05
TN:TP ratio	30	13	16.61327	16.69847	20.41232
pH	9	8.4		8.76667	9.15
Alkalinity as $CaCO_3$ (mg/L)	100	134			
Inorganic Suspended Solids (mg/L)	4	9			
Volatile Suspended Solids (mg/L)	14	37			
Total Suspended Solids (mg/L)	18	45			
Carlson Trophic State Index (Secchi)*	73				
Carlson Trophic State Index (Chl a)*	67				
Carlson Trophic State Index (TP)*	62				
SRP as P (µg/L)	1	2			
Ammonia Nitrogen (NH_3 + NH_4^+) as N (µg/L)	298				
Ammonia Nitrogen (NH_3) as N (un-ionized)(µg/L)	112				
Silica as Si (mg/L)	3.04	13.98			
Dissolved Organic Carbon (mg/L)	10.98	11.27			

Table B-7. Data collected in 2004 by Iowa State University and Iowa Department of Natural Resources.

Parameter	5/20/2004	5/25/2004	6/17/2004	6/22/2004	7/21/2004	7/27/2004
Lake Depth (m)	6.2	7.3	6.0	7.3	6.6	7.5
Thermocline Depth (m)	5.6	5	NIL	0.8	0.7	NIL
Secchi Disk Depth (m)	1.0	0.3	0.7	0.4	0.4	0.3
Temperature(^{o}C)	17.3	20.9	21.6	25.7	29.1	24.9
Dissolved Oxygen (mg/L)	10.5	8.2	7.2	12.6	11.3	6.2
Dissolved Oxygen Saturation (%)	109	92	82	154	147	74
Specific Conductivity (µS/cm)	485.5	599.8	467.6	743	403	700.9
Turbidity (NTU)	16.9	54.7	53.9	29.5	26.5	71.1
Chlorophyll a (µg/L)	35.6	18.8	42.8	83.7	57.7	102.2
Total Phosphorus as P (µg/L)	59	168	87	142	84	199
Total Nitrogen as N (mg/L)	1.95	2.06	5.94	2.51	5.05	2.17
Nitrate + Nitrite (NO_3 + NO_2) as N (mg/L)	0.55	0.12	4.35	0.15	2.08	0.18
TN:TP ratio	33	12	68	18	60	11
pH	8.6	8.6	8.5	8.8	8.8	8.3
Alkalinity as $CaCO_3$ (mg/L)	127	170	160	209	132	208
Inorganic Suspended Solids (mg/L)	4	6	21	8	7	10
Volatile Suspended Solids (mg/L)	7	19	11	15	20	22
Total Suspended Solids (mg/L)	11	25	32	23	27	32
Carlson Trophic State Index (Secchi)*	61		66		73	
Carlson Trophic State Index (Chl a)*	66		67		70	
Carlson Trophic State Index (TP)*	63		69		68	
SRP as P (µg/L)	1	1	1	3	1	2
Ammonia Nitrogen (NH_3 + NH_4^+) as N (µg/L)	127	10.2	145	369.2	36	9.5
Ammonia Nitrogen (NH_3) as N (un-ionized)(µg/L)	15	1.4	19	77.4	9	1
Silica as Si (mg/L)	2.02	7.44	3.33	7.86	4.35	11.97
Dissolved Organic Carbon (mg/L)	12.8	8.46	43.82		12.81	4.25
Microcystin (ng/L)	9.9	361.59	19.8	148.12	96	150.44

Table B-8a. Data collected in May and June, 2005 by Iowa State University, Iowa Department of Natural Resources, and Nebraska Department of Environmental Quality.

Parameter	5/2/2005	5/26/2005	6/1/2005	6/22/2005	6/28/2005
Lake Depth (m)		6.3	7.0	6.3	6.1
Thermocline Depth (m)		NIL	5.7	1.5	1.2
Secchi Disk Depth (m)		0.5	0.3	0.8	0.1
Temperature(^oC)		17.7	20.4	26.5	27.1
Dissolved Oxygen (mg/L)		7.5	6.7	10.5	6.9
Dissolved Oxygen Saturation (%)		78	75	131	87
Specific Conductivity (µS/cm)		515	731.6	496.2	705.9
Turbidity (NTU)		54.6	53.2	6.9	48.6
Chlorophyll a (µg/L)		37.6	97.6	67.3	521.1
Total Phosphorus as P (µg/L)	150	106	212	69	215
Total Nitrogen as N (mg/L)	2.72245	5.79	2.05	4.59	0.29
Nitrate + Nitrite (NO_3 + NO_2) as N (mg/L)	2.16	4.23	0.16	3.1	
TN:TP ratio	18.14965	56	10	66	1
pH		8.3	8.2	8.3	8.6
Alkalinity as $CaCO_3$ (mg/L)		209	200	194	193
Inorganic Suspended Solids (mg/L)		18	8	12	19
Volatile Suspended Solids (mg/L)		19	22	11	26
Total Suspended Solids (mg/L)		36	30	23	44
Carlson Trophic State Index (Secchi)*		70		64	
Carlson Trophic State Index (Chl a)*		66		72	
Carlson Trophic State Index (TP)*		71		65	
SRP as P (µg/L)		-	3	1	1
Ammonia Nitrogen (NH_3 + NH_4^+) as N (µg/L)		14.7	25.2	247.6	
Ammonia Nitrogen (NH_3) as N (un-ionized)(µg/L)		0.8	1.2	27.1	
Silica as Si (mg/L)		1.93	8.45	4.04	12.5
Dissolved Organic Carbon (mg/L)		6.63	0.04	5.91	9.19
Microcystin (ng/L)		1.39	54.73	14.67	27.66

Table B-8b. Data collected in July, August, and October, 2005 by Iowa State University, Iowa Department of Natural Resources, and Nebraska Department of Environmental Quality.

Parameter	7/6/2005	7/25/2005	8/1/2005	8/18/2005	10/18/2005
Lake Depth (m)	6.9	6.0	6.8	6.9	6.8
Thermocline Depth (m)	0	2	NIL	0	1.9
Secchi Disk Depth (m)	0.1	0.4	0.2	0.1	0.2
Temperature(^{o}C)	26.9	29.5	25.1	24.4	18
Dissolved Oxygen (mg/L)	4.2	11.8	2.1	4	9.3
Dissolved Oxygen Saturation (%)		155	25		
Specific Conductivity (µS/cm)	691	423.4	784.5	694	710
Turbidity (NTU)	85	23.2	70.5	102	113
Chlorophyll a (µg/L)	155	181.8	316.2	280	130
Total Phosphorus as P (µg/L)	280	116	303	360	200
Total Nitrogen as N (mg/L)	4.8	2.19	4.45	6.6	4
Nitrate + Nitrite (NO_3 + NO_2) as N (mg/L)	0.05	0.57	0.12	0.05	0.05
TN:TP ratio		19	15		
pH	8.1	8.6	8.1	8.3	8.8
Alkalinity as $CaCO_3$ (mg/L)	180	147	186	180	180
Inorganic Suspended Solids (mg/L)		-	3		
Volatile Suspended Solids (mg/L)	33.5	-	45	38	44
Total Suspended Solids (mg/L)	39	-	48	43	54
Carlson Trophic State Index (Secchi)*		73			
Carlson Trophic State Index (Chl a)*		82			
Carlson Trophic State Index (TP)*		73			
SRP as P (µg/L)		1	1		
Ammonia Nitrogen (NH_3 + NH_4^+) as N (µg/L)	760	60.2	759.9	1600	50
Ammonia Nitrogen (NH_3) as N (un-ionized)(µg/L)	70	14.4	117.2	190	10
Silica as Si (mg/L)	18	4.69	16.39	20	15
Dissolved Organic Carbon (mg/L)		7.55	0.05		
Microcystin (ng/L)		5.81	9.43		

Additional lake sampling results and information can be viewed at: http://limnology.eeob.iastate.edu/

Table B-9. 2000-2005 Phytoplankton Data.

Division	2000 Wet Mass (mg/l)	2001 Wet Mass (mg/l)	2002 Wet Mass (mg/l)	2003 Wet Mass (mg/l)	2004 Wet Mass (mg/l)	2005 Wet Mass (mg/l)
Bacillariophyta	0.026	0.179	0.207	0.723	0.001	0.000
Chlorophyta	0.401	0.522	0.015	0.058	2.626	0.000
Cryptophyta	0.266	0.042	0.262	0.124	0.070	0.191
Cyanobacteria	102.4	69.8	68.6	857.7	52.8	39.9
Dinophyta	0.00	0.29	0.00	0.00	0.00	0.00
Euglenophyta	0.58	0.40	0.20	0.00	0.00	0.00
Total	103.7	71.2	69.3	858.6	55.5	40.1

Table B-10. 2000-2005 Carter Lake Trophic State Index* Values.

	Sample Data				TSI Values		
DATE	SOURCE	Secchi Depth (m)	Chlorophyll (µg/l)	Total Phosphorus (µg/l)	Secchi Depth	Chlorophyll	Total Phosphorus
6/15/2000	IA St. Univ.	0.8	19.4	182	63	60	79
6/21/2000	IA-DNR	0.4	53.5	240	73	70	83
7/13/2000	IA-DNR	0.9		124	62		74
7/19/2000	IA-DNR	0.3	120.2	153	77	78	77
8/7/2000	IA St. Univ.	0.7	27.1	113	66	63	72
8/9/2000	IA-DNR	0.2	167.6	209	83	81	81
5/17/2001	IA St. Univ.	2.1	5.7	146	49	48	76
5/22/2001	IA-DNR	0.6	157.1	141	67	80	76
6/14/2001	IA St. Univ.	0.9	17.9	67	62	59	65
6/20/2001	IA-DNR	0.4	60.0	191	73	71	80
7/19/2001	IA St. Univ.	1.1	28.5	19	59	63	47
7/24/2001	IA-DNR	0.3	78.4	227	77	73	82
5/23/2002	IA St. Univ.	0.7	9.8	88	65	53	69
5/29/2002	IA-DNR	0.3	84.3	130	77	74	74
6/20/2002	IA St. Univ.	0.4	35.6	97	75	66	70
6/25/2002	IA-DNR	0.2	125.4	177	83	78	79
7/25/2002	IA St. Univ.	0.6	50.8	88	67	69	69
7/30/2002	IA-DNR	0.2	309.9	332	83	87	88
5/22/2003	IA St. Univ.	0.6	20.1	79	67	60	67
5/28/2003	IA-DNR	0.3	18.1	172	77	59	78
5/29/2003	NE-DEQ	0.1		140	97		75
6/19/2003	IA St. Univ.	0.5	31.9	76	72	65	67
6/24/2003	IA-DNR	0.3	32.1	214	77	65	82
6/25/2003	NE-DEQ	0.1	128.5	180	97	78	79
7/23/2003	IA St. Univ.	0.4	40.5	54	73	67	62
7/30/2003	IA-DNR	0.2	32.2	303	83	65	87
7/30/2003	NE-DEQ	0.3	94.3	310	80	75	87
8/28/2003	NE-DEQ	0.1	173.9	280	90	81	85
9/25/2003	NE-DEQ	0.3	26.5	290	77	63	86
5/20/2004	IA St. Univ.	1.0	35.6	59	61	66	63
5/25/2004	IA-DNR	0.3	18.8	168	77	59	78
6/17/2004	IA St. Univ.	0.7	42.8	87	66	67	69
6/22/2004	IA-DNR	0.4	83.7	142	73	74	76
7/21/2004	IA St. Univ.	0.4	57.7	84	73	70	68
7/27/2004	IA-DNR	0.3	102.2	199	77	76	80
5/2/2005	NE-DEQ			150			76
5/26/2005	IA St. Univ.	0.5	37.6	106	70	66	71
6/1/2005	IA-DNR	0.3	97.6	212	77	76	81
6/22/2005	IA St. Univ.	0.8	67.3	69	64	72	65
6/28/2005	IA-DNR	0.1	521.1	215	93	92	82
7/6/2005	IA-DNR	0.1	155.0	280	93	80	85
7/25/2005	IA St. Univ.	0.4	181.8	116	73	82	73
8/1/2005	IA-DNR	0.2	316.2	303	83	87	87

		Sample Data			TSI Values		
DATE	**SOURCE**	**Secchi Depth (m)**	**Chlorophyll (µg/l)**	**Total Phosphorus (µg/l)**	**Secchi Depth**	**Chlorophyll**	**Total Phosphorus**
8/18/2005	IA-DNR	0.1	280.0	360	93	86	89
10/18/2005	IA-DNR	0.2	130.0	200	83	78	81
average		0.5	97	168	71	75	78
median		**0.4**	**59**	**153**	**75**	**71**	**77**
TARGETS		**> 0.7**	**< 33**	**< 96**	**< 65**	**< 65**	**< 70**

*Index values generally range between 0 and 100, with increasing values indicating more eutrophic conditions.

Table B-11. Summary of Carter Lake data.

Parameter	Units	*n*	Median	Mean	Standard Error
Secchi Depth	m	44	0.40	0.46	0.06
Temperature	degrees C	43	25.0	24.1	0.6
pH	neg. log H^+ conc.	43	8.44	8.46	0.05
Total Alkalinity	mg/L as $CaCO_3$	39	176	173	5
Dissolved Oxygen	mg/L	42	8.5	8.3	0.4
Total Suspended Solids	mg/L	38	26.0	26.8	1.8
Inorganic Suspended Solids	mg/L	35	9.0	10.1	1.1
Chlorophyll *a*	µg/L	42	58.9	97.1	15.9
Ammonia-Nitrogen	mg/L as N	20	0.27	0.34	0.09
Total Nitrogen	mg/L as N	45	2.44	2.88	0.23
Nitrate-Nitrogen	mg/L as N	44	0.16	0.71	0.17
Total Phosphorous	µg/L as P	45	152	168	13
Turbidity	NTU	39	53.6	48.6	4.6

Appendix C – Trophic State Index

Carlson's Trophic State Index

Carlson's Trophic State Index is a numeric indicator of the continuum of the biomass of suspended algae in lakes and thus reflects a lake's nutrient condition and water transparency. The level of plant biomass is estimated by calculating the TSI value for chlorophyll-a. TSI values for total phosphorus and Secchi depth serve as surrogate measures of the TSI value for chlorophyll.

The TSI equations for total phosphorus, chlorophyll and Secchi depth are:

$$TSI(TP) = 14.42\ln(TP) + 4.15$$

$$TSI(CHL) = 9.81\ln(CHL) + 30.6$$

$$TSI(SD) = 60 - 14.41\ln(SD)$$

TP = in-lake total phosphorus concentration, μg/L
CHL = in-lake chlorophyll-a concentration, μg/L
SD = lake Secchi depth, meters.

The three index variables are related by linear regression models and *should* produce the same index value for a given combination of variable values. Therefore, any of the three variables can theoretically be used to classify a waterbody.

Table C-1. Changes in temperate lake attributes according to trophic state (modified from USEPA (2000), Carlson and Simpson (1995), and Oglesby et. al. (1987))

TSI Value	Attributes	Primary Contact Recreation	Aquatic Life (Fisheries)
50-60	eutrophy: anoxic hypolimnia; macrophyte problems possible	[none]	warm water fisheries only; percid fishery; bass may be dominant
60-70	blue green algae dominate; algal scums and macrophyte problems occur	weeds, algal scums, and low transparency discourage swimming and boating	Centrarchid fishery
70-80	hyper-eutrophy (light limited). Dense algae and macrophytes	weeds, algal scums, and low transparency discourage swimming and boating	Cyprinid fishery (e.g., common carp and other rough fish)
>80	algal scums; few macrophytes	weeds, algal scums, and low transparency discourage swimming and boating	rough fish dominate; summer fish kills possible

Table C-2. Summary of ranges of TSI values and measurements for chlorophyll-a and Secchi depth used to define Section 305(b) use support categories for the 2004 reporting cycle.

Level of Support	TSI value	Chlorophyll-a (µg/l)	Secchi Depth (m)
fully supported	≤ 55	≤ 12	> 1.4
fully supported / threatened	55 → 65	12 → 33	1.4 → 0.7
partially supported (evaluated: in need of further investigation)	65 → 70	33 → 55	0.7 → 0.5
partially supported (monitored: candidates for Section 303(d) listing)	65 → 70	33 → 55	0.7 → 0.5
not supported (monitored or evaluated: candidates for Section 303(d) listing)	> 70	> 55	< 0.5

Table C-3. Descriptions of TSI ranges for Secchi depth, phosphorus, and chlorophyll-a for Iowa lakes.

TSI value	Secchi description	Secchi depth (m)	Phosphorus & Chlorophyll-a description	Phosphorus levels (ug/l)	Chlorophyll-a levels (ug/l)
> 75	extremely poor	< 0.35	extremely high	> 136	> 92
70 - 75	very poor	0.5 - 0.35	very high	96 - 136	55 - 92
65 - 70	poor	0.71 - 0.5	high	68 - 96	33 - 55
60 - 65	moderately poor	1.0 - 0.71	moderately high	48 - 68	20 - 33
55 - 60	relatively good	1.41 - 1.0	relatively low	34 - 48	12 - 20
50 - 55	very good	2.0 - 1.41	low	24 - 34	7 - 12
< 50	exceptional	> 2.0	extremely low	< 24	< 7

The relationship between TSI variables can be used to identify potential causal relationships. For example, TSI values for chlorophyll that are consistently well below those for total phosphorus suggest that something other than phosphorus limits algal growth. The TSI values can be plotted to show potential relationships as shown in Figure C-1.

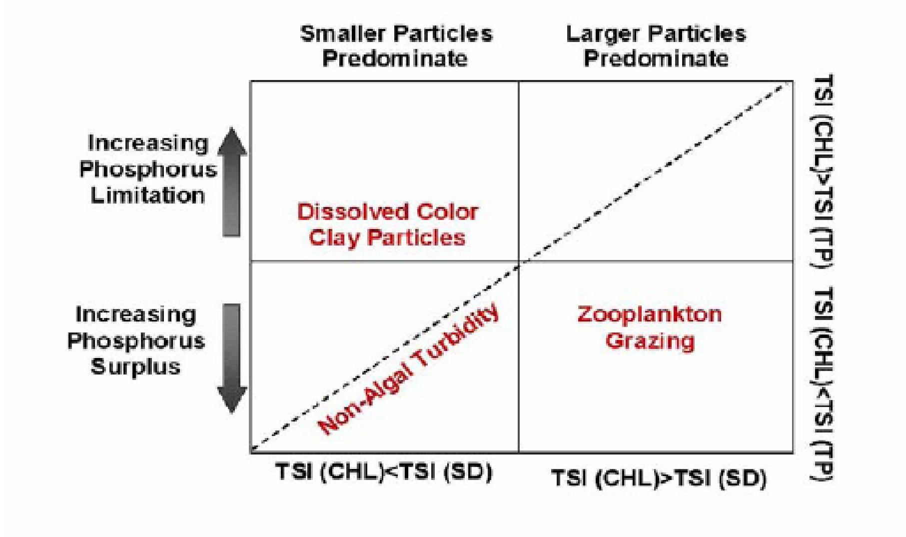


Figure C-1. Multivariate TSI Comparison Chart (Carlson)