FINAL REPORT

LAKE HELEN WATER QUALITY PROJECT

NDEQ Section 319 Project Number: 56-1187

NET Project Number: 13-115

NGPC Aquatic Habitat Project: Lake Helen Rehabilitation Project

Project Sponsor:

City of Gothenburg 409 9th Street Gothenburg, NE 69138

Total Cash Contributions:

NDEQ - Section 319 Funds: \$416,431 Section 319 Match: \$278,000

NGPC – Aquatic Habitat Funds: \$605,250

Nebraska Environmental Trust: \$308,301

Central Platte Natural Resources District: \$75,000

City of Gothenburg: \$404,077

Project Period:

May 1, 2013 - December 31, 2015

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Background

Lake Helen is comprised of 30 surface acres and is located in the City of Gothenburg, NE (Table 1). The lake has provided more than 100 years of benefits to the area through power generation, ice harvesting, irrigation, and most recently, public recreation. Lake Helen experienced significant water quality problems in recent years, most of which were related to excess sediment, nutrients and algae growth. In 2005, the lake experienced a major fish kill. While the cause of the kill was determined to be low dissolved oxygen, ammonia and pH were also exceeding Nebraska Surface Water Quality Standards (NDEQ, 2009). This fish kill renewed local efforts to improve water quality. Stakeholders attended a meeting held in the spring of 2011 to discuss water quality issues and agency priorities. Issues defined by the stakeholders included excess algae growth and extensive blooms, introduction of rough fish from the canal, water source quantity and quality, and safety concerns. As a result of this meeting, the City of Gothenburg (City) decided to move forward with water quality planning efforts.

In 2012, the City received funding through the Nebraska Department of Environmental Quality (NDEQ) Nonpoint Source Management Program and Nebraska Game and Parks Commission (NGPC) Aquatic Habitat Program to develop a water quality management plan for Lake Helen. The management planning process included the quantification of sediment and nutrient loadings by source, establishment of load reduction targets, and the recommendation of management measures with estimated costs. The plan was completed and approved by the NDEQ in 2013.

In 2012, funding applications to implement the management plan were submitted to the NDEQ, NGPC, Nebraska Environmental Trust (NET), and Central Platte Natural Resources District (CPNRD). In the spring of 2013, all funding applications were approved and construction plans were finalized. The construction project was completed in June 2015. The final component of the project was to apply aluminum sulfate (alum) to the lake to reduce water column phosphorus concentrations and phosphorus loading from the bottom sediment.

This report is intended to meet final reporting requirements for the NET.

Table 1. Lake Helen Background Information

State	Nebraska
County	Dawson
River Basin	Middle Platte
HUC Code	102001010406
Latitude	40°56'23.64" N
Longitude	100°09'47.97"
Legal	Section 10, 11N, 25W
NDEQ Water Quality Standard ID	MP2-L0650
NDEQ Monitoring Station ID	LMP2LHELEN04
Lake Surface Acres	21

Project Partners

Several entities provided technical and financial contributions to this project. Provided below is a list of project partners and their responsibilities.

<u>City of Gothenburg</u>: The City served as the sponsor of this project and provided staff for project administration, project management and oversight, and grant fund disbursement. The City also coordinated and participated in project outreach with project partners and public. In addition to

providing in-kind contributions, the City also provided cash to the project.

<u>NGPC:</u> The NGPC provided technical expertise throughout the planning and construction of this project. District office staff will continue to work with habitat and fisheries components. Funding for the project was awarded to the City through the NGPC - Aquatic Habitat Program.

<u>NDEQ</u>: The NDEQ provided technical and financial assistance throughout course of planning and implementing this project. Project funding was awarded to the City from the Section 319 Nonpoint Source Management Program.

<u>NET:</u> The NET provided financial assistance and assistance in grant fund disbursement and reporting.

<u>CPNRD:</u> The CPNRD provided financial assistance for project planning and construction. NRD staff provided assistance in fund disbursement.



Photo 1 – Signage was used for public outreach.

<u>Miller & Associates Consulting Engineers</u>: Miller & Associates provided engineering services, technical coordination, and construction oversight including construction observation, monitoring, and reporting.

<u>LakeTech Consulting</u>: LakeTech, Inc. provided water quality and grant expertise, grant budget tracking, grant fund disbursement, and reporting support to the City.

Project Goals and Objectives

Implementation goals and objectives were identified during the project planning process. The status of each are provided below:

Goal 1. Create a bio-swale to capture urban runoff.

Objective 1. Excavate 94,164 cubic yards of dry soil to create a bio-swale adjacent to the lake. STATUS: Completed (a total of

Goal 2. Increase Mean Lake Depth from 4.0 feet to 8.0 feet.

Objective 2. Move 197,916 cubic yards of phosphorus rich sediment from the lake bottom and spoil within the current boundary of the lake. STATUS: Actual amount removed was 171,773 cubic yards which achieved a mean depth of 10.0 feet.

Objective 3. Use sediment spoils to reduce current lake size from 30 acres to 21 acres and reshape banks to change lake configuration. STATUS: Completed

Objective 4. Establish bank grade to desired slope. STATUS: Completed

Goal 3. Install waterfowl deterrents in and around the lake.

Objective 5. Place fabric and 6,400 cubic yards of rip-rap along 3,391 linear feet of shoreline. Rip-rap will have a secondary benefit of shoreline stabilization. STATUS: Completed

Objective 6. Establish a 10 foot wide tall grass buffer around the lake perimeter using NRD recommended seed mixtures. STATUS: Completed

Objective 7. Evaluate and select a compliment of other waterfowl deterrents. STATUS: Ongoing

Goal 4. Eliminate rough fish introduction.

Objective 8. Install a Wedge Wire Diversion Screen in the canal inflow to "filter" rough fish eggs, larvae, and debris. STATUS: Not Completed

Goal 5. Reduce site erosion.

Objective 9. Seed the construction area with appropriate seed mixture. STATUS: Completed

Goal 6. Strip water column phosphorus and inactivate phosphorus in lake bottom sediment.

Objective 10. Apply aluminum sulfate via topical treatment to the entire lake bottom. STATUS: Completed

Goal 7. Keep stakeholders informed during the project.

Objective 11. Erect a project sign noting project partners. STATUS: Completed

Objective 12. Utilize existing media outlets to provide periodic updates to the public. STATUS: Completed

Objective 13. Provide periodic updates to the City Council. STATUS: Completed

Objective 14. Submit semi-annual Progress and Financial Status Reports to all project funding sources. STATUS: Completed

Goal 8. Meet all funding source reporting requirements.

Objective 15. Provide NDEQ with Semi-annual Progress and Financial Status Reports. STATUS: Completed

Objective 16. Provide the NET, NGPC, and CPNRD with Quarterly Progress and Financial Status Reports. STATUS: Completed

Project Description

In 2011, City officials assembled a project team to address water quality concerns in Lake Helen. This

team included representatives from the City, NDEQ, NGPC, Miller & Associates, and LakeTech Consulting. The planning efforts resulted in the preparation of a Water Quality Management Plan for Lake Helen which was prepared by JEO Consulting. The plan identified multiple watershed and in-lake management measures necessary to meet the desired water quality targets. These measures were implemented over a 30 month period beginning with draining the lake in December 2012. A significant portion of the 30 months were dedicated to getting permit approvals.



Photo 2 - Poor water quality pre-project.

Early in the project, the City made the decision to eliminate the use of irrigation canal water as a water source for the lake. This decision was based on several factors which included water quality. Water levels in the lake will now be maintained by runoff directly around the lake and the well that was previously used as a supplemental water source. Due to this change, the fish screen that was proposed for rough fish removal was not needed. NGPC funds dedicated for this activity were moved to other project components.

Lake Configuration/Size/Depth

The configuration of Lake Helen was rectangular. This shape was conducive for large flocks of waterfowl to land. In addition to helping deter waterfowl, the new more contoured configuration will enhance public access and provide shoreline protection. The size of Lake Helen was reduced from 30 to approximately 21 surface acres. While the maximum depth was not increased, mean depth was increased from 4 to more than 10 feet.

While the sediment removal target was not achieved, a desired mean depth greater than 8 feet was achieved. The increase in mean depth will provide extensive water quality benefits. Preliminary planning and the Project Implementation Plan (PIP) indicated a target sediment removal amount of 197,916 cubic yards. Final construction plans, completed after PIP approval, indicated 149,133 cubic yards of sediment would be removed. As construction progressed, the decision was made to remove 171,773 cubic yards of sediment which was the final excavated quantity. An additional one year drying time most likely explains the lower excavation quantity needed to achieve the desired mean depth.

The material from the lake bottom was strategically placed and graded to specifications. All spoils were used on-site. Rip-rap was placed along 3,391 linear feet of shoreline to deter waterfowl migration between the lake and park and will provide secondary benefits of shoreline stabilization.

Water Sources & Circulation

All supplemental water needs for the lake will be satisfied with the current well. Lake circulation from the well water was enhanced. The well pipe was extended and split into a "Y" as to deliver the water to different sections of the lake. The water now enters the lake several feet below the water surface and is directed towards the surface to increase mixing.

Fish Filtration & Community Structure

As mentioned, the City made the decision to eliminate the irrigation canal as a water source to the lake and use the current well for all supplemental water needs. This change will result in reductions of phosphorus, sediment, bacteria, and pesticides to the lake. Eliminating the canal as a water supply also excludes a significant source of rough fish to the lake. As a result, the fish screen that was planned for installation was removed from the project. Funding from the NGPC that was targeted for this activity was redirected to other project components.

Urban Runoff Diversion

Lake Helen currently receives runoff from 9 acres of urban residential ground and 29 acres of park land that produces approximately 20.5 acre feet of runoff. Runoff from this 9 acre area will be captured in a bio-swale that was constructed between the east shoreline of the lake and roadway. The swale will be designed to capture a 10-year storm event. Larger events may overtop the swale and enter the lake. As a result, annual sediment loads are expected to decrease from over 36,000 lbs/yr to less than 1,000 lbs/yr, and phosphorus loads are expected to decrease from 47 lbs/yr to 15 lbs/yr, depending on rainfall intensity and amounts.

Waterfowl Management

While some of the components listed above will help control waterfowl numbers, additional measures will be necessary. One effective control is tall grass management to increase their sensitivity to predators. A ten foot wide tall grass buffer was planted around the perimeter of the lake using a NRD recommended seed mixture. The seed mixture will provide native grass at least three feet tall to deter waterfowl migration between the lake and park.

In addition to tall grass buffers, 3,952 cubic yards of rip-rap was placed along 3,391 linear feet of shoreline. The rip-rap was approximately 12 inch rock which will also deter waterfowl movement between the park and lake. Rip-rap will provide secondary benefits by stabilizing shorelines and increasing diversity in habitat for aquatic insects and fish.

The City has already implemented a "no-feeding" policy for waterfowl at Lake Helen but continued education is necessary. No-feeding waterfowl signage will be posted in strategic parts of the park and public education will continue.

The city is currently implementing the use of "Bangers and Screamers" to scare off geese. Other nonstructural waterfowl controls including scent dispensers, dogs, controlled hunting and the promotion of predator bird species are being looked at as possible control methods.

Increased usage of the lake and park after project completion will also help reduce waterfowl numbers. In some cases, draining a lake can reduce waterfowl use in future years. The timing of the project allowed the lake to be drained for two migration seasons, improving the chances of reducing numbers.

Bottom Sealing

Given the sandy soil types in this region, water losses through seepage could be more than desired. While water supplies could offset bottom losses, 655 tons of bentonite was placed in the lake bottom to reduce these impacts. This will result in a long term cost savings to the city.

Whole Lake Alum Treatment

On October 14, 2015, approximately 9,114 gallons of aluminum sulfate and 4,557 gallons of sodium aluminate were applied to Lake Helen via topical treatment. The primary intent of the alum was to further reduce phosphorus concentrations in the water column. A secondary benefit will be realized through a reduction in phosphorus loading from the lakes bottom sediments.

Communication and Outreach

The City took advantage of every opportunity to promote this project and keep the public informed. The Gothenburg Times provided great coverage of the project by periodically updating the public on progress. Speaking engagements to groups like the Rotary Club also provided an avenue for communication and feedback on the project.

Pre-construction and construction site visits were conducted with funding agencies, technical

professionals, and the Gothenburg City Council to review the project approach, provide status updates, and in some cases address minor concerns that typically arise with these projects.

Since this project was partially funded by the NGPC, they were able to use their typical communication tools such as NebraskaLand Magazine and website blogs to promote the project.

The City of Gothenburg plans to hold a ribbon cutting ceremony in the spring of 2016.



Photo 3 - Project partners presenting to the Rotary Club.

Discussion & Conclusions

While there were unexpected delays in permitting, this project was completed with some approach modifications and funding changes. Myers Construction completed the construction activities in approximately 8 months. This included excavation, shoreline shaping, shoreline stabilization, grass swale construction, pier construction, and finish work such as site seeding. The City will continue to address minor maintenance issues such as erosion and weed control.

In September 2015, the City began exploring the option of installing a deeper well to find lower phosphorus groundwater. This was done outside the Section 319 project. The new well has been installed and initial tests taken by the City indicate phosphorus levels of $10\mu g/L$. This concentration is below Nebraska's Surface Water Quality Standard of $40\mu g/L$ for lakes and reservoirs meaning dilution will provide further assurances that the lake will maintain good water quality.

Given the significant water quality improvement that resulted from this project, it can be considered a tremendous success.

Project Issues

Most every large construction project encounters issues that could impact the project through delays, budget increases, or goals not being met. While the Lake Helen project was no different, all the issues that arose were properly dealt with in a timely manner. Funding source requirements in regards to reporting, documentation, procurement, and reimbursements can be overwhelming. It is recommended that sponsors of large projects that are not familiar with these requirements hire someone to assist them through the course of the project. Primary project issues are provided below.

• Availability of water quality data.

A minimal amount of water quality data was available for project design and planning. Expanded datasets for nutrient and sediment related parameters in the lake, well, and inflow would have increased confidence in load estimates, required reductions, and implementation strategies. In this case, the lack of information didn't negatively impact the project or water quality goals as the implementation strategy resulted in water quality targets and desired conditions being achieved.

 Modifications to the project approach were made throughout the project. Modifications resulted from activity changes, unit cost changes, and overall budget management decisions. Each modification required an evaluation of the impact to project goals. This resulted in additional time and resources for project management.

Modifications to the project approach included removing the irrigation canal as a water source, eliminating the rough fish screen, increasing bentonite quantities, and increasing sediment removal quantities. Funding changes did not impact approved budgets from the NDEQ or NET. Contributions from the NGPC, CPNRD, and City were increased to accommodate project change orders. Project modifications are expected with every project, however, it is essential that all pertinent entities are aware of modifications and associated budget changes.

• The alum treatment and Water Quality Standards Variance Request required an enhanced level of coordination and meetings with resource agencies, consultants, and public.

The NDEQ provided an approval of a variance to Nebraska's Surface Water Quality Standards for the alum treatment in August 2015. The topical treatment was conducted in October 2015. This was the final component of the project. The Variance Request process was new to the sponsor warranting additional education for decision makers and public. This was unexpected but also unavoidable.

• Permitting delays resulted in increased project costs.

The delay in the permit approval from the USACE was a significant impact to the project in respect to administrative costs. This delay resulted in an extensive amount of work related to budget revisions, budget and grant extensions, additional reporting, and additional meetings and coordination. While in this case permitting delays were not related to application quality or timing, it is recommended that permit applications be submitted as soon as possible.

Management Recommendations

- Maintaining good water quality will hinge on controlling resident and migratory waterfowl numbers. The City and project team realize the importance of managing waterfowl at Lake Helen. In order to be successful, both resident and migratory populations need to be significantly reduced. While rip-rap, tall grass buffers, feeding ordinances, and education will help, other measures are also needed. The City is currently using "bangers and screamers", which so far has been successful. The effectiveness of current controls should be continuously evaluated along with new options including scent dispensers, dogs, controlled hunting, and measures to attract predatory species of birds.
- 2. It is recommended that monitoring of the lake and well water be conducted to track nutrient concentrations and loads. Recommended parameters include total phosphorus, total nitrogen, chlorophyll-*a*, algae toxins, suspended solids, and water clarity.
- 3. Well pumping rates should be monitored and recorded. This can indicate potential problems with seepage in addition to estimating future electrical expenditures for water level maintenance.

References

2012. NDEQ. Water Quality Standards for Surface Waters of the State – Title 117. Nebraska Department of Environmental Quality, Lincoln, NE.68509

2013. Gothenburg. Water Quality Management Plan for Lake Helen. JEO Consulting. City of Gothenburg, NE.

Attachment A – Final Project Budget

The total cost of this project was \$1,777,699. Five funding sources were used to cover project costs which include NDEQ, NGPC, NET, CPNRD, and City of Gothenburg. The approved budgets are provided in Table A-1 with actual expenditures provided in Table A-2. Approved budgets for NDEQ and NET did not change while budgets for NGPC, CPNRD, and City of Gothenburg increased once the project was initiated. The approved budget for the alum treatment was \$130,000, all of which coming from NDEQ Section 319 Funding. The actual cost of the treatment was \$98,640 leaving \$31,360 in the Section 319 Grant from NDEQ. Upon NDEQ approval, this amount was utilized by the City to pay for sediment removal leaving the grant balance at zero. This was a shift of funds within approved budget categories.

Table A-1 Lake Helen Water Quality Project Approved Budget

Activity	Lake Helen Project Funding Sources					
	NET	NGPC	NDEQ	CPNRD	City of	
		(Aquatic Habitat)	(Section 319)		Gothenburg	TOTALS
Drain/Fill Lake					\$5,600	\$5,600
Configuration/ Size/Shape/Depth Changes						
Excavation to Grading	\$169,581 (a)	\$169,581	\$169,581		\$169,581	\$678,324
Bottom Sealing		\$55,000	\$50,000			\$105,000
Water Circulation						
Well Pipe Extension					\$30,000	\$30,000
Internal Phosphorus Loading						
Alum Treatment			\$130,000			\$130,000
Waterfowl Controls						
Rip Rap	\$130,000 (a)	\$125,000	\$33,000			\$288,000
Tall Grass Buffer/Constr. Site Seeding				\$31,000	\$10,400	\$41,400
"Other" Waterfowl Controls					\$40,000	\$40,000
Rough Fish Exclusion						
Wedge Wire Diversion Screen		\$20,000				\$20,000
Urban Runoff Treatment						
Grass Swale			\$25,100			\$25,100
Fish Community Establishment						
Fish Stocking		\$12,500				\$12,500
Boat Ramp		\$20,000				\$20,000
Pier		\$50,000				\$50,000
Const. Engineering/ Oversight/Permitting	\$8,720	\$8,750	\$8,750	\$4,000	\$4,780	\$35,000
Grant Reporting/Tracking/ Admin.				\$15,000	\$24,400	\$39,400
TOTALS	\$308,301	\$460,831	\$416,431	\$50,000	\$284,761	\$1,520,324

Table A-2 Lake Helen Water Quality Project Final Budget

Activity	NET	NGPC	NDEQ (Section	CONRD	City of	TOTALS
Configuration / Size /Shane /Denth Changes	INE I	(Aquatic Habitat)	319)	CPINRD	Gotnenburg	TUTALS
Configuration/ Size/Shape/Depth Changes	¢160 F91	6227.26F	¢200.041	¢26.072	ć94.040	ć719 000 20
Excavation to Grading	\$109,581	\$237,305	\$200,941	\$26,073	\$84,940	\$718,900.20
		\$69,210	\$50,000			\$119,210
Water Circulation		404.000				
Well Pipe Extension		\$21,665		\$4,927	\$40,364	\$66,956
Internal Phosphorus Loading						
Alum Treatment			\$98,640			\$98,640
Waterfowl Controls						
Rip Rap	\$130,000	\$154,375	\$33,000	\$30,513	\$41,038	\$388,926
Tall Grass Buffer/Constr. Site Seeding					\$17,393	\$17,393
"Other" Waterfowl Controls					\$0	\$0
Rough Fish Exclusion						
Wedge Wire Diversion Screen		\$0				\$0
Urban Runoff Treatment						
Grass Swale		\$35,155	\$25,100		\$5,572	\$65,826.96
Boat Ramp & Floating Dock		\$67,060				\$67,060
Fishing Pad		\$11,670				\$11,670
Fishing Pier					\$57,486	\$57,486
Repair Dam					\$28,865	\$28,865
Remove and Replace Rubble					\$9,340	\$9,340
Const. Engineering/ Oversight/Permitting	\$8,720	\$8,750	\$8,750	\$4,000	\$4,258	\$34,478
Grant Reporting/Tracking/ Admin.				\$9,487	\$28,413	\$37,900
Side Walk					\$43,028	\$43,028
Parking Lot					\$10,140	\$10,140
Park Bench					\$1,880	\$1,880
TOTALS	\$308,301	\$605,250	\$416,431	\$75,000	\$372,717	\$1,777,699

(a) NDEQ Section 319 Nonfederal Match (\$169,581), (b) NDEQ Section 319 Nonfederal Match (\$108,419)

Attachment B – Financial Partner Expenditure Summary

A. Nebraska Department of Environmental Quality – Nonpoint Source Management Program

Section 319 funding for this project totaled \$416,431. While all project activities and funds were approved under one Project Implementation Plan, the funds were split into two separate contracts between NDEQ and the City. Section 319 funding for the construction project was comprised of \$277,681 for construction components and \$8,750 for engineering and construction oversight services totaling \$286,431. The remaining \$130,000 was dedicated to the alum treatment, which was covered under the second NDEQ contract with the City. The actual cost of the alum treatment was \$98,640.00 leaving \$31,360.00 in the grant. With NDEQ approval the City used the \$31,360.00 to cover the Cities cost of additional dredging. This was only a shift of funds between approved budget categories.

The total amount of non-federal match needed for the approved Section 319 funds (\$416,431) was \$278,000. This match was generated through NET expenditures for excavation and shoreline stabilization as identified in the approved PIP. The NET funds for these activities totaled nearly \$300,000 exceeding the required match amount.

NDEQ Section 319 Reimbursement Requests

Five reimbursement requests were submitted to DEQ for this project

July 1, 2014 – October 1, 2014:

- 319 Amount = \$202,581.00
- Non-federal Match Reported = \$73,081.67

January 1, 2015 – March 31, 2015:

- 319 Amount = \$25,100.00
- Non-federal Match Reported = \$42,927.67

April 1 – June 30, 2015

- 319 Amount = \$58,750
- Non-federal Match Reported = \$161,991

October 16, 2015

- 319 Amount = \$98,640.00
- Nonfederal Match Reported = \$0.00

November 4, 2015

- 319 Amount = \$31,360.00
- Nonfederal Match Reported = \$0.00

NDEQ Invoice Summary

Contractor	Invoice Date	Invoice Amount	DEQ Reimbursement
Myers Construction	10/31/2014	\$281,266.67	\$202,581.00
Myers Construction	1/18/2015	\$171,097.20	\$25,100.00
Myers Construction	4/30/2015	\$244,281.86	\$50,000.00
Miller & Associates	6/19/2014	\$20,180.85	\$8,750.00
HAB Aquatic Solutions	10/28/2015	\$98,640.00	\$98,640.00
Myers Construction	4/30/2015	\$244,281.86	\$31,360.00
Totals		\$716,826.58	\$416,431.00

B. Nebraska Game and Parks Commission – Aquatic Habitat Program

NGPC Aquatic Habitat Program funding totaled \$605,250. Aquatic Habitat funding was used for engineering, construction observation, and construction activities related to excavation, circulation, public access, lake sealing, rip-rap, grass swale, and access enhancements.

NGPC Invoice Summary

Contractor	Invoice Date	City Invoice Amount	NGPC Reimbursement
Miller Engineering	6/19/2014	\$20,180.85	\$3,500.00
Myers Construction	10/31/2014	\$281,266.67	\$78,685.67
Miller Engineering	11/18/2014	\$2,478.75	\$2,478.75
Myers Construction	12/8/2014	\$205,134.12	\$35,553.12
Miller Engineering	1/6/2015	\$3,098.24	\$2,771.25
Myers Construction	1/18/2015	\$171,097.20	\$103,069.50
Myers Construction	4/30/2015	\$244,281.86	\$64,281.86
Myers Construction	5/20/2015	\$520,127.67	\$314,909.85
Totals		\$1,427,484.51	\$605,250.00

C. Nebraska Environmental Trust

NET funding totaled \$308,301. Funding was used for engineering, excavation, and rip-rap. Two reimbursement requests were submitted to and paid by the NET totaling \$308,301.00.

NET Invoice Summary

Contractor	Invoice Date	City Invoice Amount	NET Reimbursement
Myers Construction	12/8/2014	\$205,134.12	\$169,581.00
Myers Construction	4/30/2015	\$244,281.86	\$130,000.00
Miller and Associates	4/21/2015	\$8,720.00	\$8,720.00
Totals		\$458,135.98	\$308,301.00

D. Central Platte Natural Resources District

Funding from the CPNRD totaled \$75,000. Four reimbursement requests were submitted to and paid by the NRD totaling \$75,000.

CPNRD Invoice Summary

Contractor	Invoice Date	City Invoice Amount	CPNRD Reimbursement
LakeTech, Inc.	12/1/2014	\$5,435.00	\$5,435.00
LakeTech, Inc.	5/2/2015	\$4,075.00	\$4,052.00
Miller Engineering	6/9/2014	\$20,180.85	\$4,000.00
Myers Construction	5/20/2015	\$520,127.67	\$61,513.00
Totals		\$549,818.52	\$75,000.00

Attachment C – Lake Helen Project Area: Pre-project Aerial Photo



Attachment D – Products Outputs

Product/Output	Target Quantity	Actual Quantity
Sediment Removal (acre-feet)	197,916	171,773
Rock Placement – (cubic yards) (linear feet)	3,952 (cu-yds)	3,952 (cu-yds)
	3,391(lf)	3,391 (lf)
Circulation System	1	1
Bio-Swale (linear feet)	600	600
Bentonite Seal (tons)	275	655
Fish Barrier	1	0
Dam Repair	1	1
Seeding (acres)	12	8.5
Gravel Shoals (# of sites)	15	15
Fishing Pier	1	1
Boat Ramp & Dock	1	1
Alum Treatment	19 ac	19 ac

Attachment E – Pollutant Load Reductions and Water Quality Improvements

Pollutant Load Reductions

A majority of the project components were designed to address external pollutant loads to the lake. Due to the nature of the water quality problems, reductions of total phosphorus loads were the primary target and thus the only parameter that reductions for specific practices were determined. Total phosphorus load reductions based on implemented activities is estimated to be 6,522 pounds annually or 99.4 percent (Table E-1). Management practice implementation dates and associated reductions are provided in Table E-2.

A significant amount of phosphorus and nitrogen were removed along with the bottom sediment. The removal of this sediment will decrease internal nutrient loading over a long period of time. The amount of phosphorus and nitrogen removed with the sediment was estimated to be 72,826 pounds and 166,733 pounds respectively.

Source	Pre-Project Load (Ibs/yr)	Post Project Load (Ibs/yr)	% Reduction
Waterfowl	6488	10	99.8
Canal	6.3	0	100
Well(a)	1.5	8.7	-480
Urban Runoff	46.8	15	68
Lake Bottom Sediments	14	1.4	90
Direct Precipitation	2.7	1.9	29.6
Total Annual Load	6,559	37	99.4

Table E-1. Phosphorus Source Loads and Reductions

(a) More well water will be used since the canal was eliminated as a water source.

Table E-2.	BMPs ar	d Associated	Load F	Reductions
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Source	Date Implemented	Phosphorus Reduction	Nitrogen Reduction	Sediment Reduction
Sediment Removal	8/1/2015	72,826 lbs	166,733	171,773 cu-yds
Rock Placement (cubic yards)	9/1/2015	NA	NA	NA
Circulation System	8/1/2015	ND	ND	ND
Bio-Swale	9/1/2015	32 lbs/yr	ND	34,419 t/yr
Bentonite Seal (tons)	9/1/2015	NA	NA	NA
Removal of Canal Water Source	7/1/2015	6.3 lbs/yr	ND	599 t/yr
Dam Repair	7/1/2015	NA	NA	NA
Alum Treatment	10/15/2015	13.6 lbs/yr	ND	ND
Waterfowl Controls(a)	10/1/2015	6,478 lbs/yr	ND	ND

(a) Waterfowl controls include a combination of practices such as tall grass buffers, rip-rap, and harassment controls used by the City.

NA=Not Applicable, ND=Not Determined

Measured Water Quality Improvement

While loads will not be directly measured to evaluate project success, the resulting lake water quality will be used as a gage. Results of water quality monitoring conducted in 2011 and 2015 were utilized

to evaluate preliminary project benefits. Significant improvements were documented upon completion of in-lake enhancements and watershed controls. Watershed runoff controls and in-lake improvements resulted in a 75 percent decrease in total phosphorus, bringing the median concentration from 490μ g/L to 121μ g/L (Figure E-1). The post alum phosphorus concentration was 24μ g/L, bringing the overall lake phosphorus reduction to 95 percent. The phosphorus concentration in the lake is currently below Nebraska's Surface Water Quality Standard.



Lake Helen Water Sample 10/14/2015 Post Alum Treatment



