APPENDIX A

Lower Penn Lake Management Plan
Public Information Meeting

City of Bloomington Public Works
Department Training Room
1700 West 98th Street

Tuesday, April 17, 2007

6:00 PM to 7:30 PM

WHY ARE WE HERE?

- DNR has indicated intent to terminate the augmentation well Permit #75-6273 (beginning February of 2008)
- Public/resident concerns over water level, wildlife, and fish

Tonight's Agenda

- Introductions
- Why are we here?
- Purpose of Survey and Tonight's Meeting
- Tentative Schedule
- Chronological History of Construction/Well/Management Practices
- Summary of Comments
- Other Agency Comments
- Next Steps

Request for Comments

- Mailed request for comments (survey questions) on February 15, 2007
  - All lakeside residents
  - All properties within 500 feet from lakeshore
- Public Notice in Bloomington Sun Current February 22, 2007
- City's web site main page
- Comments due by March 23, 2007

City of Bloomington Engineering Division Staff

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PURPOSE OF COMMENTS

- To learn about public concerns/desires
- Provide guidance to establish a direction for future management

TENTATIVE SCHEDULE

February 15 – March 23	Solicit comments/input
April 17	Information meeting
April 30 – May 18	Agency Input DNR Waters, DNR Fisheries, DNR Wildlife, Nine Mile Creek Watershed District, Bloomington Park & Rec, Park Maintenance, Environmental Health, Hennepin County, others??

TENTATIVE SCHEDULE

May 21- June 18	Develop draft management plan based on public and agency review
June 18	City Council review of draft plan
June 19 – June 23	Public comment on draft management plan
July 23	Public Hearing
July 23 – August 24	Incorporate comments and revise plan

TENTATIVE SCHEDULE

September 24	Final plan to City Council for approval
October 1	Plan submission to DNR and agencies
January 1, 2008	Plan implementation

LOWER PENN LAKE HISTORY

- **Pre-1958** – Landlocked natural depression reported to have been cultivated at times
- **1958** – Trunk storm sewer system from I-494 to Upper Penn Lake constructed
  - Original outlet elevation = 807.0
  - At unknown date, normal elevation raised to 808.0 and later to 809.0
- **1971** – Trunk storm sewer from 35W constructed
- **1974** – Long dry period lowered lake elevation and exposed mud flat areas

LOWER PENN LAKE HISTORY

- **1974** – Braun report investigating dredging and lake bottom seal
- **1974** – DNR survey of lake (max depth at that time 3 ½ feet)
- **1976** – Lower Penn Lake improvements
  - Excavation at north end to provide deeper water
  - Construction of well and aeration system
  - Provided public access w/parking
  - Provided picnic area
  - DNR Stocked fish (sunfish, bass, northern pike)
  - Construction of fishing pier
  - Construction of sediment ponds at storm water inlets

LOWER PENN LAKE HISTORY

- **1976** – Established the normal level at 808.0
- **1977** – Homes along south end of lake flooded due to Aug 30-31 rain event
- **1981** – Pump motor on well replaced
- **1982** – Well screen cleaning
- **1984** – DNR amended augmentation permit from 60.5 MGY to 200 MGY

LOWER PENN LAKE HISTORY

- **1987** – Homes flooded due to July 1987 rain event
- **1988** – Storm sewer improvements to address rain event of July 1987
  - New outlet re-establishing normal level at 807.0
  - Equalizer connection between Adelmann Pond and Upper Penn
- **1988** – Floodproofing project to some homes on Lower Penn Lake (and other locations in City)
- **1989** – Augmentation permit issued from DNR to maintain water level at 807.0

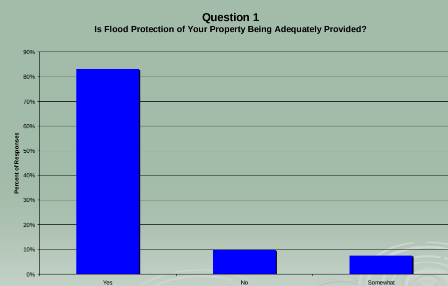
LOWER PENN LAKE HISTORY

- **2005** – DNR evaluations concluded that augmenting Lower Penn Lake with ground water is not effective for fisheries management under the current plan. Permit to remain in effect for up to three years to allow time for re-evaluation of lake management.

LOWER PENN LAKE HISTORY

- **1990** – DNR suspended appropriation of ground water for maintaining the level of Lower Penn Lake (April)
- **1990** – DNR reinstated augmentation permit at the City's request to maintain the gamefish population (September)
- **1991** – DNR authorized winter aeration to prevent winterkill of fish

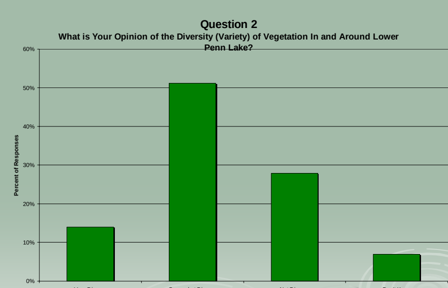
SUMMARY OF COMMENTS

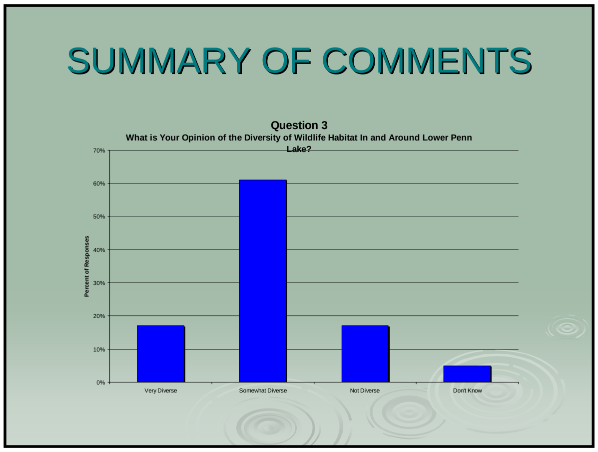


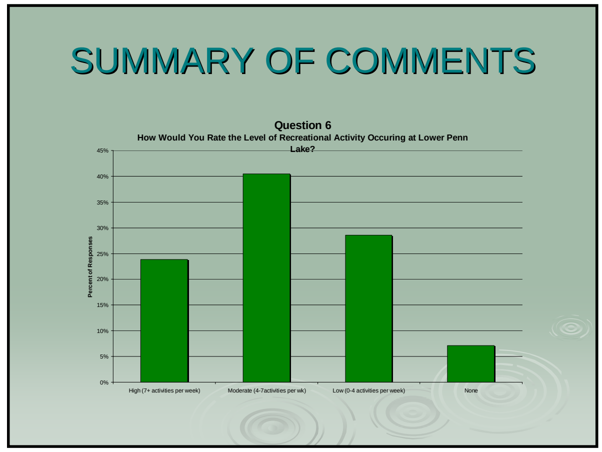
LOWER PENN LAKE HISTORY

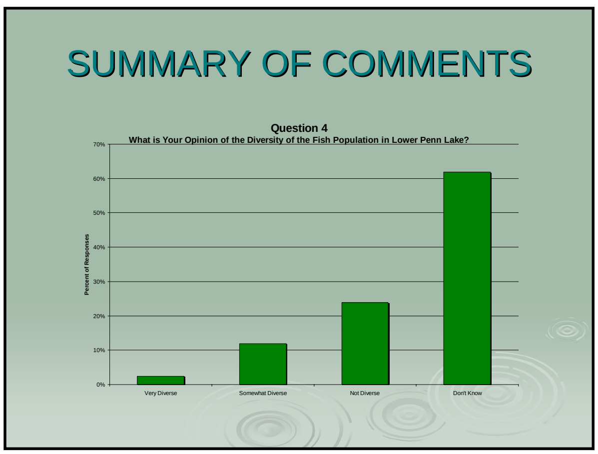
- **1994** – State Statute 103G.271 Subd. 5a
  - *Except as provided in subdivision 5, paragraph (b), the commissioner shall, by January 31, 1994, revoke all existing permits, and may not issue new permits, for the appropriation or use of groundwater in excess of 10,000,000 gallons per year for the primary purpose of maintaining or increasing surface water levels in the seven-county metropolitan area…*

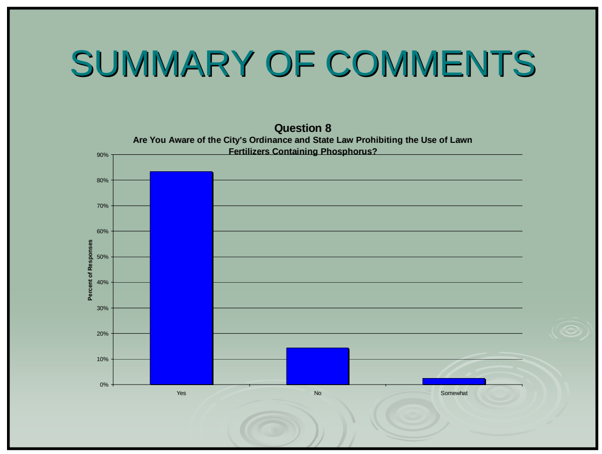
SUMMARY OF COMMENTS

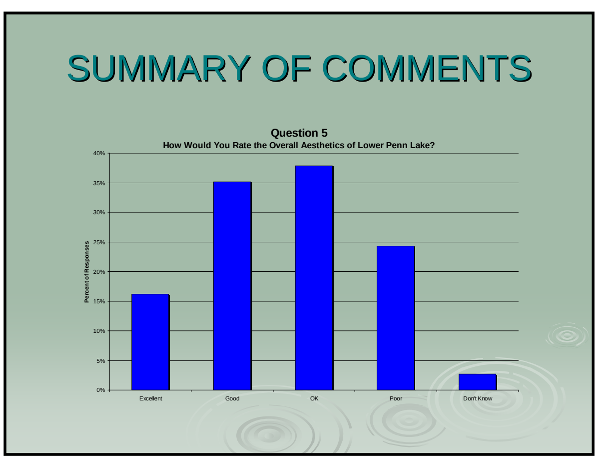


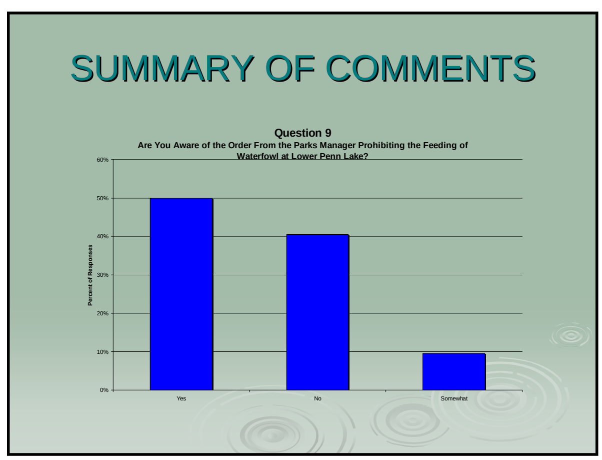

SUMMARY OF COMMENTS
Question 3
What is Your Opinion of the Diversity of Wildlife Habitat In and Around Lower Penn Lake?
Percent of Responses
70%
60%
50%
40%
30%
20%
10%
0%
Very Diverse
Somewhat Diverse
Not Diverse
Don't Know


SUMMARY OF COMMENTS
Question 6
How Would You Rate the Level of Recreational Activity Occuring at Lower Penn Lake?
Percent of Responses
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
High (7+ activities per week)
Moderate (4-7activities per wk)
Low (0-4 activities per week)
None

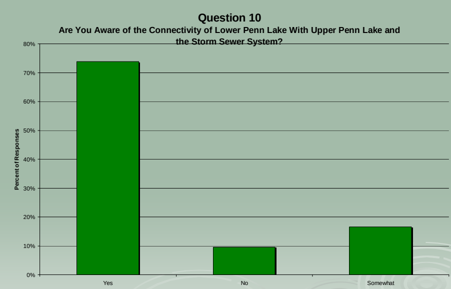

SUMMARY OF COMMENTS
Question 4
What is Your Opinion of the Diversity of the Fish Population in Lower Penn Lake?
Percent of Responses
70%
60%
50%
40%
30%
20%
10%
0%
Very Diverse
Somewhat Diverse
Not Diverse
Don't Know


SUMMARY OF COMMENTS
Question 8
Are You Aware of the City's Ordinance and State Law Prohibiting the Use of Lawn Fertilizers Containing Phosphorus?
Percent of Responses
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Yes
No
Somewhat


SUMMARY OF COMMENTS
Question 5
How Would You Rate the Overall Aesthetics of Lower Penn Lake?
Percent of Responses
40%
35%
30%
25%
20%
15%
10%
5%
0%
Excellent
Good
OK
Poor
Don't Know


SUMMARY OF COMMENTS
Question 9
Are You Aware of the Order From the Parks Manager Prohibiting the Feeding of Waterfowl at Lower Penn Lake?
Percent of Responses
60%
50%
40%
30%
20%
10%
0%
Yes
No
Somewhat

SUMMARY OF COMMENTS



SUMMARY OF COMMENTS
Vegetative/Wildlife Diversity

- Too many rough fish in the lake
- Very little vegetative diversity, mostly lawn to the edge of the lake
- More wildflowers/natural vegetation should be located on NE corner of lake
- Too many geese
- Too many raccoons
- Good raptor populations
- Bald eagles, golden eagles, deer, fox, egrets

SUMMARY OF COMMENTS

- Improve the fishing
- Better water level and clarity
- Dredge the lake and start over with the fish, poison the rough fish
- Keep the water level up.
- Provide waterfowl feed boxes
- Is there any way to reduce the number of geese

SUMMARY OF COMMENTS
Fishery

- Mostly rough fish
- Carp have taken over
- Carp, Sunfish, Crappies
- All I see are Bullheads
- Stock with panfish
- We see people fishing all of the time
- Poor water quality/garbage does not help the fish

SUMMARY OF COMMENTS

- Stock walleye and other edible fish
- Make property owners clean up their fallen trees to make shoreline look nicer
- Clean water to make it swimable
- Control the geese
- More water plants to attract more birds
- Consistency with the water level
- Fishing dock

SUMMARY OF COMMENTS
Recreation/Aesthetics

- Too much trash along shoreline
- Park is nice, too much goose droppings
- Scenic cornerstone of neighborhood
- Overall I think the aesthetics are very good
- When water is up it looks good, when water is low, it looks poor
- Fishing activity high, canoeing low
- How about ice skating
- Hard to have activity when you don't have water

SUMMARY OF COMMENTS Waterfowl Feeding

- I think it's ok to feed the geese
- How can you feed the birds, but not the geese
- Don't feed geese
- Enforce waterfowl feeding ban
- The geese are a huge annoyance
- Please write what I can or can't feed to the ducks

SUMMARY OF COMMENTS Phosphorus Fertilizer Ordinance

- **Article VIII. PHOSPHORUS FERTILIZER**
- **Added by Ord. No. 2002-28, 7-1-2002**
- **Sec. 10.51. Restrictions on application of fertilizer.**
- **a) No person shall apply a fertilizer containing the plant nutrient phosphorus to turf within the City except under the following conditions:**
- **(1) A tissue, soil or other test by a laboratory or method approved by the Minnesota Commissioner of Agriculture and performed within the last three years indicates that the level of available phosphorus in the soil is insufficient to support healthy turf growth;**
- **(2) Newly established turf via seed or sod procedures and only during the first growing season; or**
- **(3) Fertilizer containing phosphorus is used on a golf course under the direction of a person licensed, certified or approved by an organization with an ongoing training program approved by the Minnesota Commissioner of Agriculture.**

SUMMARY OF COMMENTS Phosphorus Fertilizer Ordinance

- **Sec. 10.52. Restrictions on sale of phosphorus fertilizer.**
- No person, firm, corporation, franchise or commercial establishment shall sell or display for sale within the City any fertilizer containing any amount of phosphorus or other compound containing phosphorus, such as phosphate, unless:
- (1) Phosphorus-free fertilizer is also available for sale;
- (2) Phosphorus-free fertilizer and fertilizer with phosphorus are separately displayed with each display being clearly marked as to whether or not the fertilizer contains phosphorus;
- (3) Displays of phosphorus-free fertilizer are of equal size and prominence; and
- (4) A sign or brochure is on prominent display next to any fertilizer display containing the City of Bloomington's regulations concerning the use of fertilizer with phosphorus.

Other Agency Comments

NEXT STEPS

- Meet with other agencies
- Develop draft management plan
- Provide draft to City Council
- Provide draft to public for comments/information meeting
- Public hearing
- Approve final plan
- Submit plan to DNR for approval
- Implement plan

QUESTIONS?

APPENDIX B

Lower Penn Lake Draft Management Plan
July 31, 2007

City of Bloomington
Public Works Department
Engineering Division

Introduction

Based on public input, agency direction, and review of the recent history at Lower Penn Lake, it is necessary to develop a management plan for the lake identifying specific actions or strategies for the long-term management of the lake. This plan will attempt to balance the desires of the public with the City's Park Master Plan, Comprehensive Surface Water Management Plan, Storm Water Pollution Prevention Program, Nine Mile Creek Watershed District Water Management Plan, DNR Rules, and State Statute. Staff has taken comments from the public and had initial discussions with representatives of the DNR and Watershed District and has incorporated that input into this draft. The final plan would ultimately be submitted to the DNR for approval.

On Tuesday, April 17, 2007, Engineering staff hosted a public information meeting to discuss the management of Lower Penn Lake. The purpose of the meeting was to provide the public with some background and a brief history of construction activities/management practices pertaining to Lower Penn Lake. Requests for comments were sent prior to the meeting to approximately 130 area properties within 500 feet of the lake's shoreline. In addition, notices were advertised in the Sun Current and posted on the City's web site. A summary of the presentation (Attachment A) is attached. Comments from residents (Attachment B) were addressed at the public information meeting and have been considered in development of this draft plan.

Background

The following is a brief chronological history of construction and management activities on Lower Penn Lake.

- **1958 –** Prior to 1958, Lower Penn Lake was a landlocked depressional wetland area reported to have been cultivated at times.

- **1958 –** Trunk storm sewer system from I-494 to Upper Penn Lake was constructed including connection between Upper and Lower Penn Lakes and an outlet for Lower Penn Lake.
- **1971 –** Trunk storm sewer system from 35W to Lower Penn Lake was constructed.
- **1974 –** A report by Braun Intertec investigated the potential for dredging and lake bottom sealing.
- **1974 –** A DNR survey of the lake reported a maximum depth of 3 ½ feet.
- **1974 –** Long dry periods lowered the lake elevation and exposed large mud flat areas.
- **1976 –** Lower Penn Lake improvement project was constructed as a cooperative project involving the City, DNR, and other agencies. The project included:
    - ➢ Excavation at north end to provide deeper water;
    - ➢ Construction of a well and aeration system – DNR permit authorizing augmentation to support fishery;
    - ➢ Public access to lake with parking;
    - ➢ Public picnic area;
    - ➢ Fish stocking by the DNR (sunfish, bass, northern pike);
    - ➢ Construction of a fishing pier; and
    - ➢ Construction of sediment ponds at storm water inlets.
- **1976 –** The normal water level of Lower Penn Lake was established at 808.0.
- **1977 –** Some homes along the south end of the lake flooded due to the August 30-31 rain event.
- **1981 –** Pump motor on well replaced.
- **1982 –** Well screen cleaned.
- **1984 –** DNR groundwater augmentation permit amended from 60.5 MGY to 200 MGY.
- **1987 –** Some homes adjacent to Lower Penn Lake flooded due to July 20-23 rain events.
- **1988 –** Storm sewer improvement construction to address July 1987 flooding included:
    - ➢ New outlet constructed re-establishing the lake's normal level at 807.0;
    - ➢ Construction of a storm sewer connection between Adelmann Pond and Upper Penn Lake to equalize normal water levels providing better flood protection.
- **1988 –** City-wide floodproofing project constructed at some homes on Lower Penn Lake providing protection from the 100-year rain event.
- **1989 –** DNR groundwater augmentation permit issued from the DNR to maintain water level at 807.0.
- **1990 –** The DNR suspended the groundwater augmentation permit (April).
- **1990 –** The groundwater augmentation permit was reinstated at the City's request to maintain game fish population (September).
- **1991 –** The DNR authorized winter aeration to prevent winter kill of fish.
- **1994 –** State Statute 103G.271 Subd. 5a revoked all existing groundwater augmentation permits in excess of 10,000,000 gallons per year for the primary purpose of maintaining surface water levels.

- **2005 –** DNR evaluations of Lower Penn Lake concluded that augmenting the lake with groundwater is not effective for fisheries management under the current plan. Existing permit to remain in effect for up to three years to allow time for re-evaluation.

A public open house is currently scheduled for August 8, 2007 to present this draft, gather additional comments and answer any questions. Depending on further direction from the City Council and outcomes from the open house, a hearing may be scheduled late summer of 2007.

Characteristics of Shallow Lakes

Characteristics of a healthy shallow lake:

- Water depth is often less than ten feet, although deeper depths are possible.
- Low fish numbers allowing aquatic plants to dominate resulting in clearer water.
- Significant buffer areas surrounding the lake to help filter out nutrients and sediment entering the lake.
- Temporary periods of low water stimulating plant growth.
- Minimized connectivity to impervious areas and storm water runoff.
- Shallow depths allow ample sunlight penetration for aquatic plant growth.

Lower Penn Lake is considered a shallow lake (mean depth of approximately four feet with a maximum depth of seven to ten feet on the north end). Lower Penn Lake also has considerable connection to the storm sewer system resulting in significant inputs of urban storm water runoff along with a fairly consistent normal water level due to the fixed outlet. The lake also currently has a fish population of predominately carp, stunted crappies, and bluegills. Large fish populations in shallow lakes tend to degrade shallow lake water quality as the fish, with no significant natural predators, feast on the macroinvertebrates that in turn would normally consume algae. The high levels of nutrients, especially phosphorus, further contribute to algal blooms and degradation of water quality.

With the exception of the native vegetative buffer that was established on park property adjacent to the boat landing and the existing buffer area along the north end of the lake, the shore area along Lower Penn is almost entirely manicured lawn. Native vegetative buffers not only provide wildlife habitat, but can filter pollutants and uptake excess nutrients from surface runoff.

Lower Penn Lake was analyzed in 2001 by the Nine Mile Creek Watershed District as part of a Use Attainability Analysis. Limited water quality data collected for Lower Penn Lake showed it is considered to be hypereutrophic. Hypereutrophic lakes are very productive lakes with high levels of total phosphorus and cholorphyll-*a* (which is the photosynthetic pigment in algae or an indicator of the amount of algae present) and very low transparency levels. The water quality of these lakes can fluctuate daily and seasonally and experience anoxia (depletion of oxygen), fish kills, or even toxic conditions (blue-green algae blooms can sometimes become toxic and can cause rash or illness in animals and potentially people).

Lower Penn Lake Classifications and Goals

Wetland Protection and Management Plan

The City's 1997 Wetland Protection and Management Plan inventoried Lower Penn Lake as a Circular 39 Type 5 wetland defined as shallow open water typically bordered by emergent vegetation providing floodwater detention, wildlife and fish habitat, and recreation uses. The use classification specified in the WPMP for Lower Penn Lake is for indirect recreational use including boating and fishing. The water quality was inventoried as being highly impacted with only slight sensitivity to storm water impacts. The highest inventoried functional value is that of providing flood protection and storm water storage. Finally the management designation is to apply best management practices (BMPs). BMPs have been and will continue to be utilized in an effort to maintain inventoried functions and values and can include items such as public education, invasive or exotic vegetative species control, buffer establishment, or other structural storm water components.

Nine Mile Creek Watershed District

The Nine Mile Creek Watershed District management strategy for Lower Penn Lake has been to assess the lake resource meaning to investigate and remedy degrading trends, causes of nonpoint source pollution and implement BMPs.

Other goals for Lower Penn Lake include a water quantity goal, water quality goal, aquatic communities goal, recreational use goal, and wildlife goal.

- Water Quantity – to provide sufficient storage of surface runoff during a regional flood for the critical 100-year frequency event.
- Water Quality – to achieve a Level IV classification supporting runoff management, however not intended to have significant recreational use values.
- Aquatic Communities – to achieve water quality that fully supports the DNR's lake's fishery use classification.
- Recreation Goal – not intended to support significant recreational use values.
- Wildlife Goal – to protect existing, beneficial wildlife uses.

Department of Natural Resources

The DNR use classification for Lower Penn Lake is as a Recreational Development Lake. Recreational Development Lakes usually have between 60 and 225 acres of water per mile of shoreline, between 3 and 25 dwellings per mile of shoreline, and are more than 15 feet deep.

The DNR encourages native vegetative buffers around lakes to filter runoff and provide wildlife habitat.

DNR Fisheries has concluded that the lake, in its current condition, is not capable of maintaining a quality fishery.

Pollution Control Agency

The MPCA is in the process of assessing all waters of the state to evaluate whether or not those waters are meeting their designated uses. Some waters along with their designated uses are specifically listed in Minnesota Rule Chapter 7050 while non-listed waters that are not wetlands are automatically classified as 2B, 3B, 4A, 4B, 5, and 6 waters where all of the water quality standards (and designated uses) for each class apply. The most restrictive of the standards for each class apply when parameters between classes differ. In the case of Lower Penn Lake, which has not been assessed, Class 2B is the most restrictive class. The quality of Class 2B waters shall be such to generally support fish and associated aquatic life and habitat as well as being suitable for aquatic recreation. If Lower Penn Lake was evaluated by the State as a wetland, it would likely be classified as a Class 2D wetland where it would be expected to generally support the propagation and maintenance of a healthy community of aquatic and terrestrial species indigenous to wetlands and their habitats.

It is intended that designated beneficial uses for non-listed waters such as Lower Penn Lake would be subject to a rigorous analysis such as a Use Attainability Analysis to determine actual attainable uses based on scientific physical, chemical, and biological data.

Alternatives for Future Management

Based on comments received from the public, existing data for Lower Penn Lake, and discussions with other local and state agencies, alternatives for the future management of the lake have been identified:

1. Manage as a Fishery Resource

Goal: To improve quality of the fishery as a recreational resource.

Maintaining a viable quality fishery on Lakes like Lower Penn can be difficult due to their size and the quantity of urban runoff impacting them. Factors impacting the fishery resource on Lower Penn are the lake's depth, urban storm water runoff impacts, existing water quality, and rough fish passage. A number of improvements would be required to increase the chances of maintaining a quality fishery there. A combination of dredging the lake to create deeper water to prevent winter kill along with some form of aeration to provide additional oxygen in the winter months would likely be needed. Additionally, construction of fish barriers to prevent passage of rough fish, elimination of existing rough fish population, and the stocking of a desirable fish population would be required. Lastly, additional storm water treatment, watershed best management practices such as buffer area establishment, and possibly in-lake water quality improvements would be recommended to address the current nutrient loading in the lake.

Estimated cost: $2,000,000

2. Manage as a Wildlife Resource

Goal: To maintain or improve the presence of a diverse wildlife population.

Managing Lower Penn Lake for wildlife would include certain activities aimed at maintaining or improving the overall ecosystem of the lake focusing on vegetation management to increase the diversity of wildlife habitat. Controlling invasive vegetative species, introducing high quality native plants, and maintaining buffer areas would be significant components.

The water level could be maintained at current or lower levels to promote additional areas of habitat for waterfowl, songbirds, etc. A fairly diverse wildlife population has already been reported by area residents so improvement to the diversity of the habitat there could result in an even greater wildlife presence.

Estimated cost: $300,000

3. Manage as a Shallow Lake

Goal: To improve water quality and clarity.

Managing Lower Penn Lake for improved water quality would be similar to the wildlife management alternative above. Efforts may consist of removal of the existing fish population and implementation of storm sewer and watershed best management practices including shore area buffer establishment. The water level would not be manipulated. Other improvements would focus on addressing storm water inputs to improve the quality of runoff entering the lake or in-lake management practices addressing nutrients.

Estimated cost: $1,000,000

4. Manage for Water Quantity and Flood Protection

Goal: To provide storage of surface water runoff for the 100-year rainfall event and help ensure protection of surrounding structures for the 100-year rainfall event.

Storm sewer infrastructure exists, and the floodproofing of some homes was completed in the late 1980s. Continued operation and maintenance of the storm sewer system would focus primarily on water quantity. The level of the lake would remain unchanged and winter aeration would cease.

Estimated cost: $20,000 (for removal and abandonment of well – no other improvements are anticipated strictly for water quantity management).

5. Collect Further Data

Goal: To accurately determine the most feasible alternative given the characteristics of the lake and watershed.

Many of the estimates for the alternatives above are significant. Given that the lake has not been able to sustain a fishery despite substantial improvements in the past, additional data and information on the lake, lake bottom, water quality, and watershed characteristics are critical for identification of the most feasible direction and likelihood of success.

Estimated cost: $100,000 (for survey work, soil borings, groundwater monitoring, and water quality monitoring).

Note: Estimated costs are based on the anticipated implementation of conceptual improvements to meet the stated goal for each alternative not actual specific items.

Recommendation

Lower Penn Lake has been identified as being hypereutrophic in the 2001 Nine Mile Creek Watershed District Use Attainability Analysis. The lake is not currently listed on the State's 303(d) list of impaired waters, however it likely could appear on a future list triggering a Total Maximum Daily Load Implementation Plan. Implementation of a successful management plan could keep Lower Penn Lake from being listed as impaired.

Based on the majority of comments from the public wishing to maintain the lake and given the cost magnitude and uncertainty of the success of a sustainable fishery, it is recommended that staff be directed to work with the Nine Mile Creek Watershed District to gather more detailed diagnostic information on the lake. Additional information would include watershed and lake water quality monitoring information, a lake bottom survey, and soil boring information to help to better identify attainable uses and predict the success of any of the alternatives. It is possible that the some of the costs associated with the collection and analysis of data may qualify for funding from the Watershed District.

It is anticipated that a minimum of three years would be needed to gather enough information to accurately determine the feasibility of the above alternatives. It is also recommended that the groundwater well not be operated during this time to provide an opportunity to more accurately monitor the lake's response to the watershed and climate. Status updates on the progress of the work can be posted on the City's website and forwarded to the City Council on a regular basis.

References

Nine Mile Creek Watershed District/Bloomington Use Attainability Analysis (UAA), Prepared for Nine Mile Creek Watershed District and the City of Bloomington, September 2001

Shoreland Management Guide, Minnesota Department of Natural Resources. 2007. The Minnesota Department of Natural Resources Web Site (online). Accessed 2007-7-20 at http://www.dnr.state.mn.us/sitetools/copyright.html

Lake Water Quality Summary Information, MPCA, September 2004 Minnesota Pollution Control Agency Web Site (online) http://www.pca.state.mn.us/water/clmp/ikwqReadFull.cfm?lakeid=27-0004

What Makes for a Healthy Shallow Lake, Ducks Unlimited, 2006

Nature of Shallow Lakes, Minnesota Department of Natural Resources, 2005

Minnesota Rules, Chapter 7050

APPENDIX C

103G.271 APPROPRIATION AND USE OF WATERS.

Subdivision 1. **Permit required.** (a) Except as provided in paragraph (b), the state, a person, partnership, or association, private or public corporation, county, municipality, or other political subdivision of the state may not appropriate or use waters of the state without a water use permit from the commissioner.

(b) This section does not apply to use for a water supply by less than 25 persons for domestic purposes.

(c) The commissioner may issue a state general permit for appropriation of water to a governmental subdivision or to the general public for classes of activities that have minimal impact upon waters of the state. The general permit may authorize more than one project and the appropriation or use of more than one source of water. Water use permit processing fees and reports required under subdivision 6 and section 103G.281, subdivision 3, are required for each project or water source that is included under a general permit, except that no fee is required for uses totaling less than 15,000,000 gallons annually.

Subd. 2. **Permits must be consistent with state and local plans.** A water use permit may not be issued under this section unless it is consistent with state, regional, and local water and related land resources management plans if the regional and local plans are consistent with statewide plans.

Subd. 3. **Permit restriction during summer months.** The commissioner must not modify or restrict the amount of appropriation from a groundwater source authorized in a water use permit issued to irrigate agricultural land under section 103G.295, subdivision 2, between May 1 and October 1, unless the commissioner determines the authorized amount of appropriation endangers a domestic water supply.

Subd. 4. **Minimum use exemption and local approval of low use permits.** (a) Except for local permits under section 103B.211, subdivision 4, a water use permit is not required for the appropriation and use of less than a minimum amount prescribed by the commissioner by rule.

(b) Water use permits for more than the minimum amount but less than an intermediate amount prescribed by rule must be processed and approved at the municipal, county, or regional level based on rules adopted by the commissioner.

(c) The rules must include provisions for reporting to the commissioner the amounts of water appropriated under local permits.

Subd. 4a. **Mt. Simon-Hinckley aquifer.** (a) The commissioner may not issue new water use permits that will appropriate water from the Mt. Simon-Hinckley aquifer in a metropolitan county, as defined in section 473.121, subdivision 4, unless the appropriation is for potable water use, there are no feasible or practical alternatives to this source, and a water conservation plan is

incorporated with the permit.
(b) The commissioner shall terminate all permits authorizing appropriation and use of water from the Mt. Simon-Hinckley aquifer for once-through systems in a metropolitan county, as defined in section 473.121, subdivision 4, by December 31, 1992.

Subd. 5. **Prohibition on once-through water use permits.** (a) Except as provided in paragraph (c), the commissioner may not, after December 31, 1990, issue a water use permit to increase the volume of appropriation from a groundwater source for a once-through cooling system using in excess of 5,000,000 gallons annually.
(b) Except as provided in paragraph (c), once-through system water use permits using in excess of 5,000,000 gallons annually, must be terminated by the commissioner by the end of their design life but not later than December 31, 2010, unless the discharge is into a public water basin within a nature preserve approved by the commissioner and established prior to January 1, 2001. Existing once-through systems must not be expanded and are required to convert to water efficient alternatives within the design life of existing equipment.
(c) Notwithstanding paragraphs (a) and (b), the commissioner, with the approval of the commissioners of health and the Pollution Control Agency, may issue once-through system water use permits on an annual basis for aquifer storage and recovery systems that return all once-through system water to the source aquifer. Water use permit processing fees in subdivision 6, paragraph (a), apply to all water withdrawals under this paragraph, including any reuse of water returned to the source aquifer.

Subd. 5a. **Maintenance of surface water levels.** Except as provided in subdivision 5, paragraph (b), the commissioner shall, by January 31, 1994, revoke all existing permits, and may not issue new permits, for the appropriation or use of groundwater in excess of 10,000,000 gallons per year for the primary purpose of maintaining or increasing surface water levels in the seven-county metropolitan area and in other areas of concern as determined by the commissioner. This subdivision does not apply until January 1, 1998, to a municipality that, by January 1, 1994, submits a plan acceptable to the commissioner for maintaining or increasing surface water levels using sources other than groundwater.

Subd. 6. **Water use permit processing fee.** (a) Except as described in paragraphs (b) to (f), a water use permit processing fee must be prescribed by the commissioner in accordance with the schedule of fees in this subdivision for each water use permit in force at any time during the year. The schedule is as follows, with the stated fee in each clause applied to the total amount appropriated:
(1) $101 for amounts not exceeding 50,000,000 gallons per year;
(2) $3 per 1,000,000 gallons for amounts greater than 50,000,000 gallons but less than 100,000,000 gallons per year;
(3) $3.50 per 1,000,000 gallons for amounts greater than 100,000,000 gallons but less than 150,000,000 gallons per year;

(4) $4 per 1,000,000 gallons for amounts greater than 150,000,000 gallons but less than 200,000,000 gallons per year;
(5) $4.50 per 1,000,000 gallons for amounts greater than 200,000,000 gallons but less than 250,000,000 gallons per year;
(6) $5 per 1,000,000 gallons for amounts greater than 250,000,000 gallons but less than 300,000,000 gallons per year;
(7) $5.50 per 1,000,000 gallons for amounts greater than 300,000,000 gallons but less than 350,000,000 gallons per year;
(8) $6 per 1,000,000 gallons for amounts greater than 350,000,000 gallons but less than 400,000,000 gallons per year;
(9) $6.50 per 1,000,000 gallons for amounts greater than 400,000,000 gallons but less than 450,000,000 gallons per year;
(10) $7 per 1,000,000 gallons for amounts greater than 450,000,000 gallons but less than 500,000,000 gallons per year; and
(11) $7.50 per 1,000,000 gallons for amounts greater than 500,000,000 gallons per year.
(b) For once-through cooling systems, a water use processing fee must be prescribed by the commissioner in accordance with the following schedule of fees for each water use permit in force at any time during the year:
(1) for nonprofit corporations and school districts, $150 per 1,000,000 gallons; and
(2) for all other users, $300 per 1,000,000 gallons.
(c) The fee is payable based on the amount of water appropriated during the year and, except as provided in paragraph (f), the minimum fee is $100.
(d) For water use processing fees other than once-through cooling systems:
(1) the fee for a city of the first class may not exceed $250,000 per year;
(2) the fee for other entities for any permitted use may not exceed:
(i) $50,000 per year for an entity holding three or fewer permits;
(ii) $75,000 per year for an entity holding four or five permits;
(iii) $250,000 per year for an entity holding more than five permits;
(3) the fee for agricultural irrigation may not exceed $750 per year;
(4) the fee for a municipality that furnishes electric service and cogenerates steam for home heating may not exceed $10,000 for its permit for water use related to the cogeneration of electricity and steam; and
(5) no fee is required for a project involving the appropriation of surface water to prevent flood damage or to remove flood waters during a period of flooding, as determined by the commissioner.
(e) Failure to pay the fee is sufficient cause for revoking a permit. A penalty of two percent per month calculated from the original due date must be imposed on the unpaid balance of fees remaining 30 days after the sending of a second notice of fees due. A fee may not be imposed on

an agency, as defined in section 16B.01, subdivision 2, or federal governmental agency holding a water appropriation permit.

(f) The minimum water use processing fee for a permit issued for irrigation of agricultural land is $20 for years in which:

(1) there is no appropriation of water under the permit; or

(2) the permit is suspended for more than seven consecutive days between May 1 and October 1.

(g) A surcharge of $20 per million gallons in addition to the fee prescribed in paragraph (a) shall be applied to the volume of water used in each of the months of June, July, and August that exceeds the volume of water used in January for municipal water use, irrigation of golf courses, and landscape irrigation. The surcharge for municipalities with more than one permit shall be determined based on the total appropriations from all permits that supply a common distribution system.

Subd. 6a. **Payment of fees for past unpermitted appropriations.** An entity that appropriates water without a required permit under subdivision 1 must pay the applicable water use permit processing fee specified in subdivision 6 for the period during which the unpermitted appropriation occurred. The fees for unpermitted appropriations are required for the previous seven calendar years after being notified of the need for a permit. This fee is in addition to any other fee or penalty assessed.

Subd. 7. **Transfer of permit.** A water use permit may be transferred to a successive owner of real property if the permittee conveys the real property where the source of water is located. The new owner must notify the commissioner immediately after the conveyance and request transfer of the permit.

History: *1990 c 391 art 7 s 27; 1990 c 594 art 1 s 49; 1990 c 597 s 63-65; 1991 c 214 s 6; 1991 c 234 s 1; 1991 c 354 art 10 s 5; 1992 c 366 s 1; 1992 c 601 s 1; 1993 c 186 s 3-5; 1994 c 557 s 15; 1995 c 218 s 10; 1997 c 104 s 1; 1998 c 401 s 38; 1999 c 231 s 128; 2001 c 160 s 1-3; 2003 c 128 art 1 s 116,117; 2005 c 89 s 1; 1Sp2005 c 1 art 2 s 121; 2006 c 281 art 1 s 21*

APPENDIX D

Penn Lake
Use Attainability Analysis

December 2003

BARR

4700 West 77th Street
Minneapolis, MN 55435
Phone: (952) 832-2600
Fax: (952) 832-2601

Executive Summary

Overview

This report details the results of a Use Attainability Analysis (UAA) of Penn Lake (also called Lower Penn Lake), located south of 86th Street and East of Penn Avenue in Bloomington, MN. The UAA is a scientific assessment of a water body's chemical, physical, and biological condition. This study includes both a water quality assessment and an evaluation of protective and/or remedial measures for Penn Lake and its watershed. The conclusions and recommendations are based on historical water quality data, the results of an intensive lake water quality monitoring in 2001, and computer simulations of land use impacts on water quality in Penn Lake using watershed and lake models calibrated to the 2001 data set. In addition, best management practices (BMPs) were evaluated to compare their relative effect on total phosphorus concentrations and Secchi disc transparencies (i.e., water clarity). Management options were then assessed to determine attainment or non-attainment of the lake's beneficial uses.

Nine Mile Creek Watershed District Water Quality Goals

The approved *Nine Mile Creek Watershed District Water Management Plan* (Barr, 1996) preliminarily assessed ultimate water quality of Penn Lake and articulated five specific goals for the lake. These goals address recreation, water quality, aquatic communities, water quantity, and wildlife. Where possible, Nine Mile Creek Watershed District (NMCWD) goals were quantified using a standardized lake rating system termed Carlson's Trophic State Index (TSI). This index considers the lake's total phosphorus, chlorophyll *a*, and Secchi disc transparencies to assign a water quality index number reflecting the lake's general fertility level. The rating system results in index values between 0 and 100, with the index value increasing with increased lake fertility.

Total phosphorus, chlorophyll *a*, and Secchi disc transparency are key water quality parameters upon which TSI statistics are computed, for the following reasons:

- Phosphorus generally controls the growth of algae in lake systems. Of all the substances needed for biological growth, phosphorus is typically the limiting nutrient.
- Chlorophyll *a* is the main photosynthetic pigment in algae. Therefore, the amount of chlorophyll *a* in the water indicates the abundance of algae present in the lake.
- Secchi disc transparency is a measure of water clarity and is inversely related to the abundance of algae. Water clarity typically determines recreational-use impairment.

All three of the parameters can be used to determine a TSI. However, water transparency is typically used to develop the TSI_{SD} (trophic state index based on Secchi disc transparency) because people's perceptions of water clarity are often directly related to recreational-use impairment. The TSI rating system results in the placement of a lake with medium fertility in the mesotrophic trophic status category. Water quality trophic status categories include oligotrophic (i.e., excellent water quality), mesotrophic (i.e., good water quality), eutrophic (i.e., poor water quality), and hypereutrophic (i.e., very poor water quality). Water quality characteristics of lakes in the various trophic status categories are listed below with their respective TSI ranges:

1. **Oligotrophic**—[$20 \leq TSI \leq 38$] clear, low productivity lakes, with total phosphorus concentrations less than or equal to 10 μg/L, chlorophyll *a* concentrations less than or equal to 2 μg/L, and Secchi disc transparencies greater than or equal to 4.6 meters (15 feet).
2. **Mesotrophic**—[$38 \leq TSI \leq 50$] intermediate productivity lakes, with 10 to 25 μg/L total phosphorus, 2 to 8 μg/L chlorophyll *a* concentrations, and Secchi disc measurements of 2 to 4.6 meters (6 to 15 feet).
3. **Eutrophic**—[$50 \leq TSI \leq 62$] high productivity lakes, with 25 to 57 μg/L total phosphorus, 8 to 26 μg/L chlorophyll *a* concentrations, and Secchi disc measurements of 0.8 to 2 meters (2.7 to 6 feet).
4. **Hypereutrophic**—[$62 \leq TSI$] extremely productive lakes, with total phosphorus concentrations greater than 57 μg/L, chlorophyll *a* concentrations greater than 26 μg/L, and Secchi disc measurements less than 0.8 meters (less than 2.7 feet).

The NMCWD goals for Penn Lake include the following:

1. Water Quantity Goal

The water quantity goal for Penn Lake is to provide sufficient water storage during a regional flood. This goal has been achieved.

2. Water Quality Goal

The water quality goal for Penn Lake is specified by the NMCWD and presented in the 1996 *NMCWD Water Management Plan*. The plan specifies a Level IV classification level. This level is generally intended for runoff management and has no significant recreational use values. The lake's TSI_{SD} is expected to be greater than 70. This goal has been achieved.

3. Aquatic Communities Goal

The aquatic communities goal for Penn Lake is to achieve a water quality that fully supports the lake's fisheries-use classification determined by the Minnesota Department of Natural Resources (MDNR) as outlined in *An Ecological Classification of Minnesota Lakes with Associated Fish*

Communities (Schupp, 1992) and achieve a balanced ecosystem. Specifically, the goal for Penn Lake is to achieve a water quality that will maintain a MDNR ecological Class 40 rating, with a balanced fishery. The MDNR has estimated the water quality requirements of the fishery community associated with each ecological class rating. The estimation involved calculating the average TSI_{SD} for lakes within each ecological class, based upon data collected during MDNR fisheries surveys. The calculated average TSI_{SD} for each ecological class was selected as its recommended water transparency to support its fishery community. The recommended water transparency, however, is not a requirement. A lake may support its fishery community and maintain its ecological class rating without achieving the recommended water clarity for its ecological class. Hence, the goal for Penn Lake is to maintain an ecological Class 40 rating, with a recommended TSI_{SD} 55. Although the lake's TSI_{SD} is greater than 55, the lake has maintained an ecological Class 40 rating. Hence, this goal has been achieved. Nonetheless, an evaluation of water quality improvement alternatives was completed to determine whether the lake's TSI_{SD} could be reduced to achieve the recommended TSI_{SD} 55.

4. Recreational-Use Goal

The recreational-use goal for Penn Lake is to achieve a water quality that will maintain a MDNR ecological Class 40 rating, with a balanced fishery. As discussed for the aquatic communities goal, the goal for Penn Lake is to maintain an ecological Class 40 rating, with a recommended TSI_{SD} 55. Although the lake's TSI_{SD} is greater than 55, the lake has maintained an ecological Class 40 rating. Hence, this goal has been achieved. Nonetheless, an evaluation of water quality improvement alternatives was completed to determine whether the lake's TSI_{SD} could be reduced to achieve the recommended TSI_{SD} 55.

5 Wildlife Goal

The wildlife goal for Penn Lake is to protect existing, beneficial wildlife uses. The wildlife goal has been achieved, but the current wildlife use of the lake is adding additional nutrients to the lake and impeding the aesthetic enjoyment of the lake. There is a substantial use of Penn Lake by waterfowl, particularly geese.

Water Quality Problem Assessment

The discharge of excess phosphorus to Penn Lake has resulted in degraded water quality. The problem is primarily due to phosphorus added to the lake by four conveyance systems. The conveyance systems are comprised of a network of storm sewers, which convey runoff waters to

Penn Lake. The runoff waters are pre-treated by detention basins prior to entering Penn Lake. Despite the pre-treatment, the total phosphorus load from the conveyance systems exceeds the lake's carrying capacity. As a result, poor water quality is observed in Penn Lake.

Analysis of phosphorus loading to Penn Lake indicates the following details. Under varying climatic conditions, the annual phosphorus load added to Penn Lake from four conveyance systems is estimated to range from 496 to 1,022 pounds per year under existing land use conditions. This amount represents from 96 to 97 percent of the lake's annual watershed phosphorus load and from 72 to 82 percent of the lake's total phosphorus load. Under proposed future land use conditions, phosphorus loading from the lake's conveyance systems was estimated to increase by 27 to 40 pounds per year (i.e., a 4 to 5 percent increase).

Contributions by the lake's direct watershed are small and are not problematic. Under existing land use conditions and varying climatic conditions, the amount of phosphorus added to the lake from the lake's direct watershed is estimated to range from 16 to 38 pounds. Hence, the lake's direct watershed contributes from 3 to 4 percent of the lake's annual watershed phosphorus load and from 2 to 3 percent of the lake's total phosphorus load. Under proposed future land use conditions, phosphorus loading from the lake's direct watershed is estimated to increase by 2 to 5 pounds (i.e., a 13 to 17 percent increase).

Other estimated sources of phosphorus loading to Lower Penn Lake include atmospheric deposition (16 pounds), augmentation well (12 pounds), geese (44 pounds), and internal loading from sediment phosphorus release (108 pounds). These sources represent from 15 percent to 36 percent of the lake's annual total phosphorus load.

The lake's estimated total phosphorus load under varying climatic conditions is shown in Figure EX-1 (existing land use) and Figure EX-2 (proposed future land use).

Phosphorus loading details under calibration year (2001) precipitation conditions and existing land use conditions are shown in Figure EX-3. In 2001, an estimated 83 percent of the lake's annual phosphorus load was from its watershed, 10 percent from internal loading, 4 percent from geese, 2 percent from atmospheric deposition, and 1 percent from the augmentation well.

Total Phosphorus Loads to Penn Lake Under Varying Climatic Conditions: Existing Land Use

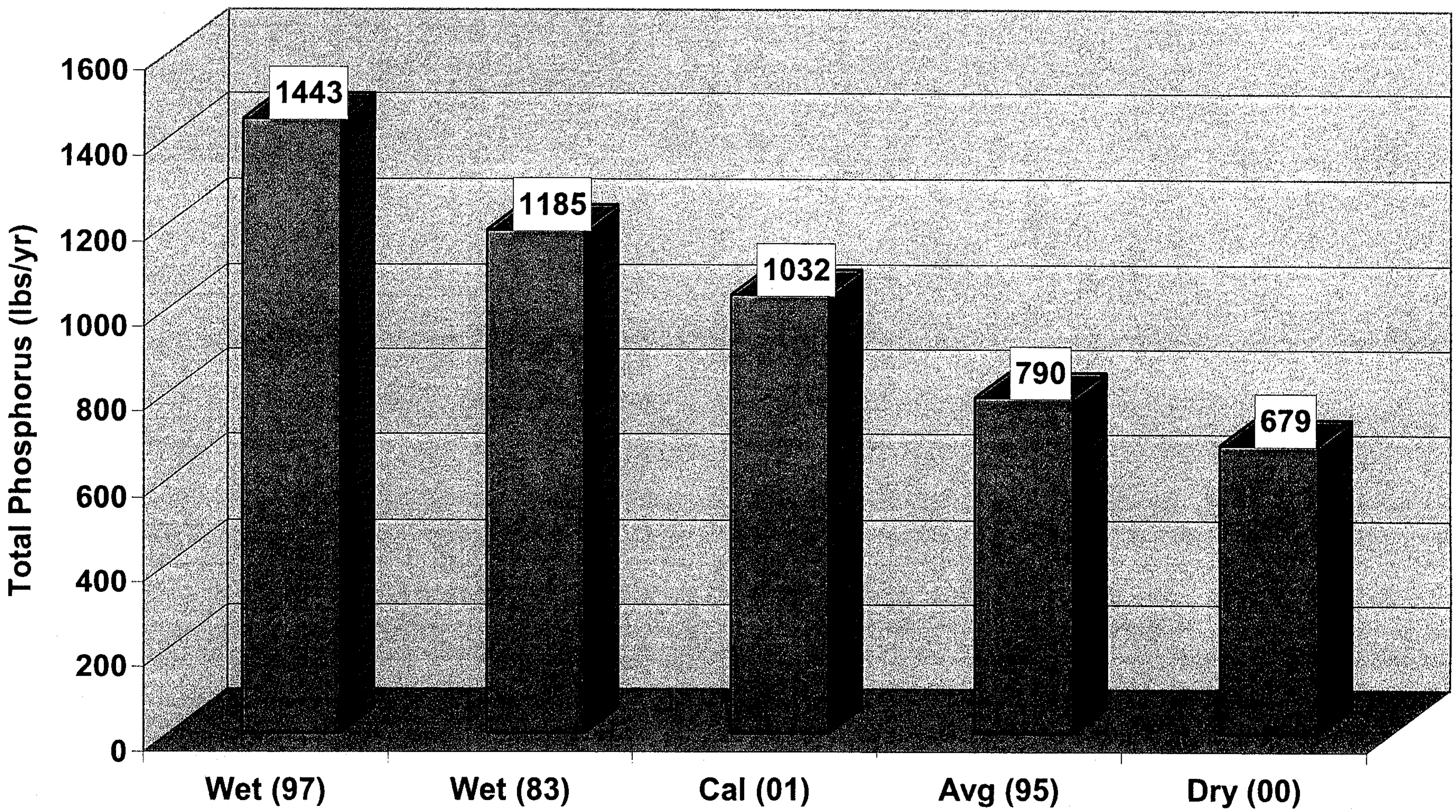


Figure EX-1

Total Phosphorus Loads to Penn Lake Under Varying Climatic Conditions: Future Land Use

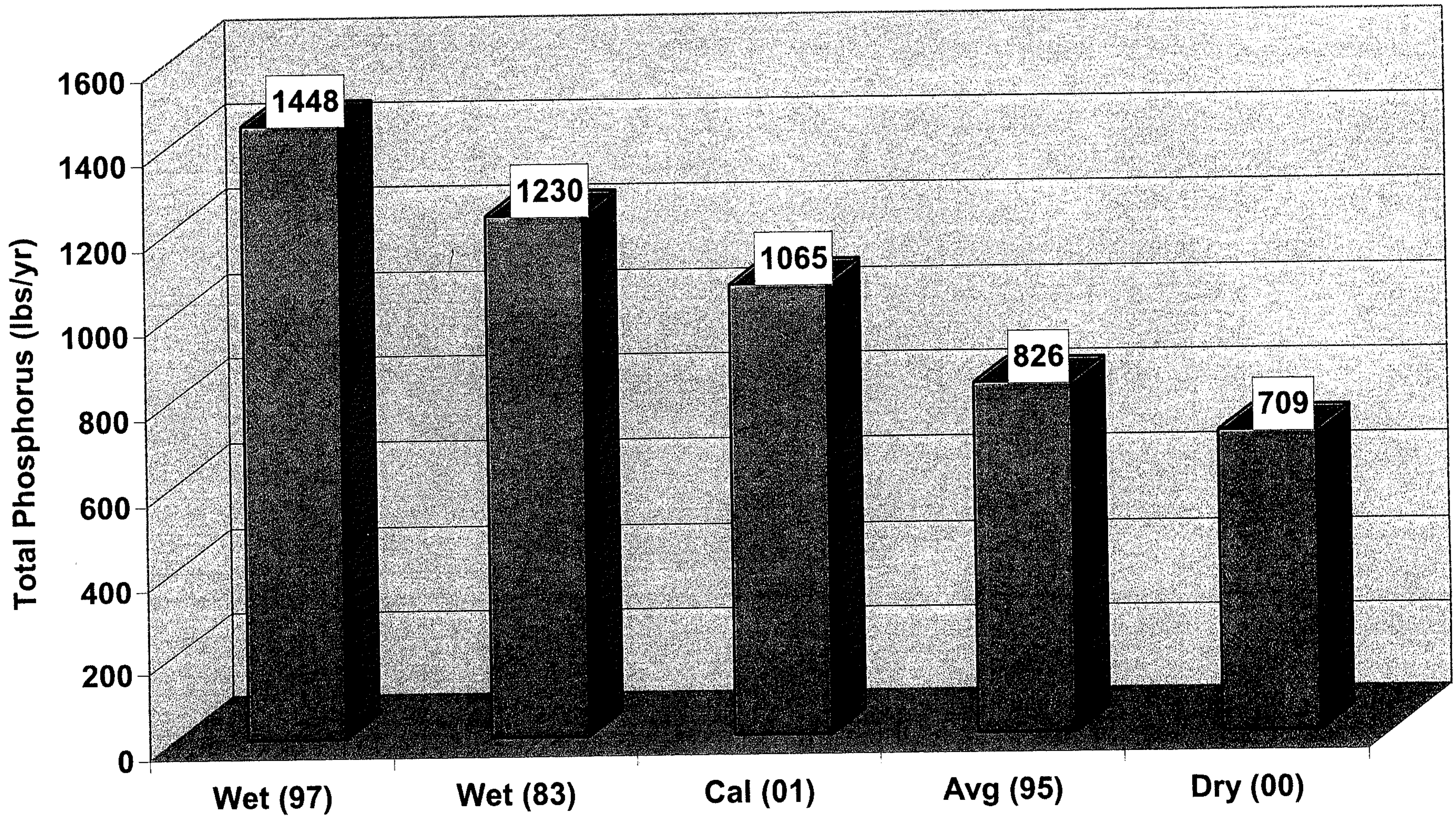


Figure EX-2

Penn Lake Phosphorus Budget: Sources--Calibration Precipitation Year (2001)--Existing Watershed Land Uses

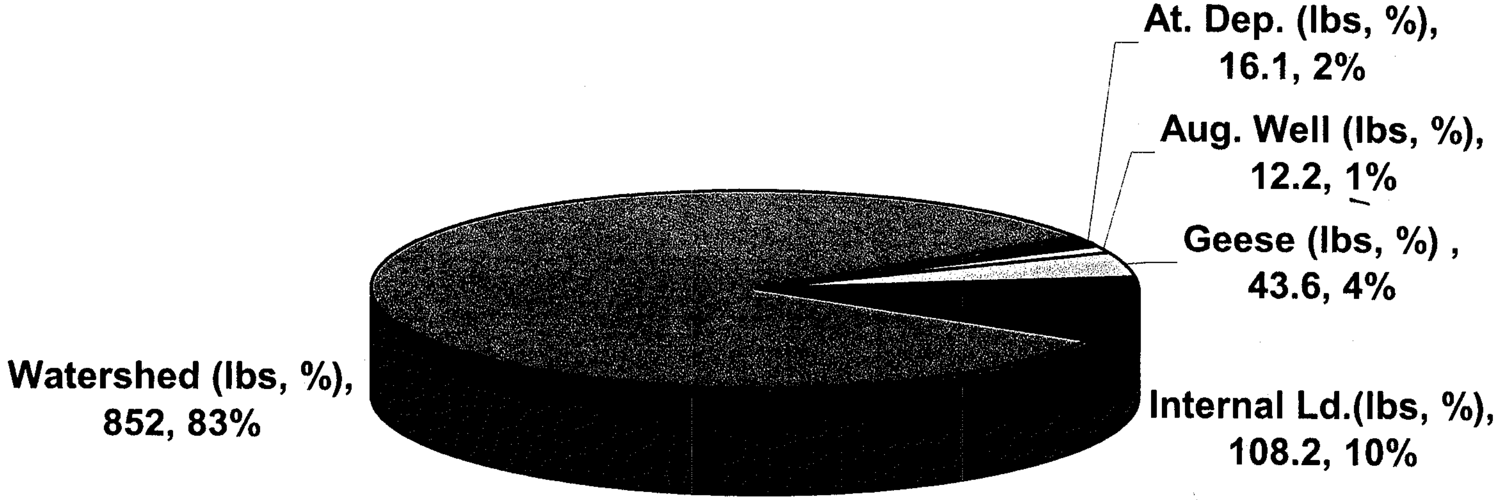


Figure EX-3

The lake's high annual phosphorus load results in high in-lake phosphorus concentrations (estimated from 129 μg/L to 216 μg/L) and poor water transparency (estimated from 0.2 m to 0.4 m) under varying climatic conditions. The lake's average summer trophic state index Secchi disc value (TSI_{SD}) is estimated to range from 74 to 81 under varying climatic conditions. The lake is in the hypereutrophic (very poor water quality) category under all climatic conditions.

Penn Lake's primary use is fishing. Water quality requirements of the lake's fishery were evaluated and compared with the lake's water quality under varying climatic conditions. The MDNR has classified Penn Lake as a Class 40 lake and indicated that the average water quality of a Class 40 lake is a TSI_{SD} of approximately 55 or lower (i.e., a summer average Secchi disc transparency of about 5 feet or greater). Based upon the assumption that the average lake water quality of lakes within each fisheries class is indicative of the water quality required for the fisheries within the lakes, MDNR has recommended a TSI_{SD} of approximately 55 or lower for Penn Lake. The lake's water quality does not meet this recommendation.

Fish survey results indicate that Penn Lake's fish community has adapted to its habitat, including the lake's poor water transparency. Although improved water quality, including improved water transparency, is expected to improve the lake's habitat and fishery, unchanged water quality is expected to result in a minimally changed fishery. MDNR has indicated the lake needs no further management (MDNR, 1998).

Aquatic Plant Assessment

Aquatic plant surveys indicated the lake's poor water transparency prevented the growth of submerged and floating leaf vegetation in Penn Lake. Emergent vegetation was observed along portions of the lake's shoreline. During August 2001, purple loosestrife, a nuisance plant, was found in one location in the southeast corner of the lake. Although the plant was not problematic in 2001, it could become problematic in the future if not managed.

APPENDIX E

WHAT MAKES FOR A HEALTHY SHALLOW LAKE?

- ***WATER CLARITY***
  - Clear water allows sunlight to reach the bottom of the lake, allowing an adverse community of aquatic plants to grow.
- ***LOW FISH NUMBERS***
  - In a healthy shallow lake, fish are absent or present in low numbers. Invertebrates and aquatic plants dominate the lake and clearer water is sustained.
- ***HEALTHY WATERSHED***
  - Buffer areas surrounding the lake help maintain water clarity by reducing the amount of nutrients and sediment entering the lake.
- ***"RESETTING THE BIOLOGICAL CLOCK"***
  - Temporary periods of low water play a vital role in maintaining a healthy shallow lake. In effect, periods of low water reset the "biological clock," similar to what fire does to a prairie.

Ducks Unlimited, 2006

THE NATURE OF SHALLOW LAKES

DEPTH

Shallow Lakes are often less than 10 feet deep, although some might be as deep as 15 feet.

EXTENDED LITTORAL ZONE

The portion of the lake that is less than 15 feet deep where sufficient light for plant growth reaches the lake bottom.

VEGETATION

Aquatic plant growth is abundant due the shallowness of the water and provides food and habitat for zooplankton and wildlife. Aquatic plants also lock up sediments keeping the water more clear.

FLUCTUATING WATER LEVELS

Shallow lakes often benefit from periods of low water that stimulates plant growth.

FISH

Low levels of dissolved oxygen and winterkills tend to limit fish numbers.

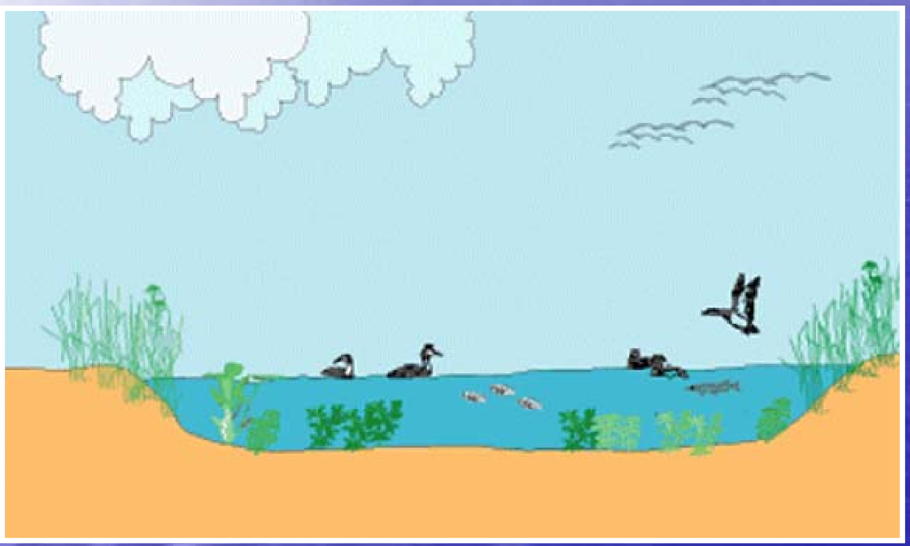
LAND USE IMPACTS

Run-off from impervious surfaces such as roads, parking lots and roofs, and soil particles that flow into a shallow lake will eventually cause the lake to become seriously degraded.

Minnesota DNR, 2005

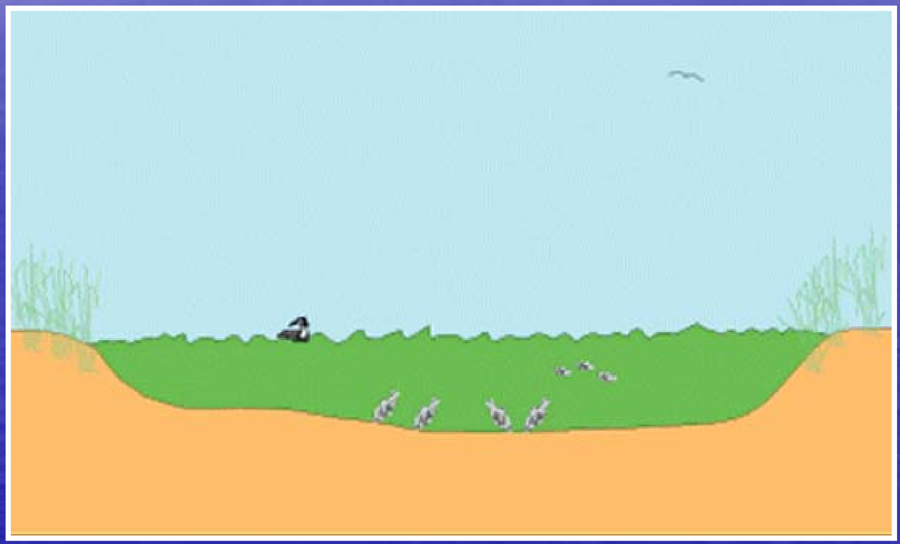
Two Stable States of Shallow Lakes

Stable Clear Water State



A shallow lake in a vegetation dominated, clear water state

Stable Turbid Water State



A shallow lake in a turbid water state where submerged vegetation is largely absent and fish and waves stir up the sediments

Scheffer, Marten; July 6, 2001

Reduced Water Clarity

Reduced Vegetation

Wind Action Creates Waves

Sediment is Suspended

Reduced Water Clarity

Plants Can't Grow

Reduced Oxygen

Low Oxygen Fish Species Become Dominant

Sediment is Suspended

A SHALLOW LAKE IN A TURBID STATE IS REALLY STABLE

Julie Klocker,
Middle Fork River Watershed District
April, 2007

Stable Turbid Water State

- No Macrophytes (aquatic plants)
- Nutrient rich sediments
  - Total phosphorus levels > 30µg/L cause nuisance algal blooms
  - Total Phosphorus levels > 90µg/L are algal dominated
- Sediments re-suspend through
  - Wave action
  - Rough fish
- When in bloom algae
  - Reduce available oxygen
  - Limit light penetration and macrophytes cannot photosynthesize and therefore cannot produce oxygen

Stable Clear Water State

- Abundance of macrophytes (aquatic plants)
  - Wind effect is minimized
  - Oxygen is present
  - Play key role in structuring food webs
  - Help maintain water transparency
  - Optimal plant coverage for fish habitat and water quality is 40 – 80%
  - 40% coverage of lake bottom with marcophytes may be the threshold between the clear water state and turbid water state
- Abundance of ‘grazers’ (zooplankton) to control algae
- Water levels fluctuate to allow vegetation re-growth and some winterkill
- Low fish numbers
  - Carp in numbers greater than 100 lbs/ac can eliminate aquatic plants altogether
  - A high density of bluegills deplete plankton in the water column and move to sediments
  - Ensure enough piscivorous (carnivorous) fish to keep planktivore fish population in check

APPENDIX F

2.0 Inventory and Classification of Wetlands

2.10 Wetland Inventory

The wetland inventory was completed using a slightly modified version of the Minnesota Routine Assessment Methodology for Evaluating Wetland Functions (MNRAM) as approved in the Wetland Conservation Act Rules, Chapter 8420. MNRAM was developed by the Minnesota Interagency Wetland Group comprised of BWSR, MDNR, Mn/DOT, MPCA, USCOE, USDA and USF&WS to be used as a field evaluation tool to assess wetland functions on a qualitative basis. MNRAM was being developed during the period of time that the inventory was being conducted. Bloomington was using an adaptation of the Wisconsin Rapid Assessment Method. Staff from Bloomington attended the interagency group meetings and adapted the Bloomington methodology to meet MNRAM requirements.

The functions for which values were assessed using MNRAM are listed in Table 2.10, found on the following page. The Groundwater Interaction and Commercial Uses functions were not evaluated during the 1995 wetland inventory. Groundwater Interaction was not evaluated due to the complexity and cost of such an undertaking. Commercial Uses were not evaluated because none of Bloomington's wetlands are currently being used for commercial purposes. Sample MNRAM inventory data forms and appendixes can be found in Appendix C.

Interns were used to conduct the field evaluations using MNRAM. Four interns, two graduates and two undergraduates, from the University of Minnesota's College of Natural Resources, were hired. Each intern had experience or course work in the areas of wetland soils, vegetation, and/or hydrology.

From June to September, 1995, interns completed field visits and assessment forms for approximately 300 wetlands located above the Minnesota River bluff line in Bloomington. Interns received MNRAM training from City staff with the assistance of MDNR representatives (listed below). The qualifications of the interns and the MNRAM training can be found in Appendix C.

The inventory information is compiled in a computer database. Individual wetland inventory data summary sheets can be found in Appendix A.

Representatives from the MDNR

John Parker	*Area Wildlife Manager*
Joan Galli	*Non-game Wildlife Specialist*
Larry Westerburg	*Forester*
Molly Schodeen	*Area Hydrologist*
Ceil Strauss	*Area Hydrologist*

Table 2.10

Minnesota Routine Assessment Method Functions

Floral Diversity/ Integrity	Floral diversity/integrity is evaluated based on the number of plant communities and the variety of species within each community.
Wildlife Habitat	Wildlife habitat is evaluated based upon the quality of the habitat provided by a wetland related primarily to the level of disturbance or degradation compared to an undisturbed or least disturbed reference wetland of the same type
Fishery Habitat	Fishery habitat is evaluated based on the wetland's connection with deep water habitat.
Flood/Storm Water	Flood/storm water detention is evaluated based upon a wetland's ability to detain floodwater, the level of potential flood damage it prevents due to the attenuation of floodwater, the degree to which the wetland's tributary watershed is developed (i.e., the need for stormwater detention), and the infiltration characteristics of the soils in the tributary drainage area.
Water Quality Protection	Water quality protection is evaluated according to a wetland's ability to treat stormwater runoff. The value of this function increases with the importance of the downstream receiving water.
Shoreline Protection	Shoreline protection is evaluated based on the wetland's proximity to lakes, streams or open water basins and whether the wetland is positioned to absorb erosive forces (i.e. wave action, land uses, unstable soils).
Aesthetics/Recreation/ Education	Aesthetics, recreation, and education are evaluated based on the wetland's visibility, accessibility, evidence of recreational uses, evidence of human influences (e.g. noise and air pollution) and any known educational purposes.
Groundwater Interaction*	Groundwater interaction is evaluated based on the wetland's connection to ground water recharge and discharge and surface water flow-through.
Commercial Uses*	Commercial uses are evaluated based on the wetland's ability to provide a commercial product or agricultural commodity without hydrologic or vegetative modification.

*Functions not assessed in Bloomington wetland inventory.

2.20 Classification System

City staff selected a water body/wetland classification system for Bloomington after reviewing the classification systems from four other cities, two watershed districts, and two watershed management organizations. Each wetland was classified using the five classification systems shown in the table below.

Table 2.20

Wetland Classification Table

Minnesota 7050 Rule Classification	Bloomington Primary Use Classification	Sensitivity to Storm Water	Wetland Quality	Management Classification
Class 2B	Direct Contact	Highly Sensitive	Excellent	Preserve
Class 2C	Indirect Contact	Moderately Sensitive	Moderate	Apply Best Management Practices
Class 4B	Scenic Habitat	Slightly Sensitive	Highly Impacted	Utilize
Class 5	Detention	Least Sensitive		
Class 6	Nutrient/Sediment (Quality)			

2.21 Minnesota Rules - Chapter 7050 Water Quality Classifications

The Minnesota Rules, Chapter 7050, parts 7050.0130 through 7050.0220 apply to all waters of the state, both surface and underground. This portion of the Rules includes general provisions applicable to the maintenance of water quality and aquatic habitats; definitions of water use classes; standards for discharges of sewage, industrial, and other wastes; and standards of quality and purity for specific water use classes. The Rules also designate seven classes of Waters of the State.

The Nine Mile Creek and Riley-Purgurtory-Bluff Creek Watershed Districts have adopted, and will implement, the water quality standards of the Chapter 7050 Rules. These two watershed districts cover 55 percent of the City of Bloomington (see Figure 4).

Classes of the Waters of the State

1	Domestic consumption
2	Fisheries and recreation
3	Industrial consumption
4	Agriculture and wildlife
5	Aesthetic enjoyment and navigation
6	Other uses
7	Limited resource value waters

Refer to excerpts from the Minnesota Rules, Chapter 7050, located in Appendix D, for the full definition of the classifications that apply to the wetlands in this plan.

2.22 Bloomington Primary Use Classification

Each of the City's wetlands was reviewed to determine if one of its functions (as defined in MNRAM) had a much higher value than the others, or if one of its functions was more important than the others to the City because of the way the wetland was being managed. A classification scheme was developed based on the results of this review. This primary use classification system consists of two categories with multiple sub-categories and is presented below. It is intended to be used as a quick reference for individuals who are considering an activity that might affect a wetland.

Bloomington Primary Use Classifications

Recreation
- Direct contact (swimming)
- Indirect contact (boating, fishing)
- Scenic/habitat (education/interpretive study/preservation of wildlife)

Treatment
- Detention (storm water storage)
- Nutrient/sediment (removal of nutrient/pollutant loading, sediment)

2.23 Wetland Sensitivity to Storm Water

The wetland sensitivity to storm water was evaluated using the Guidance for Evaluating Urban Storm Water and Snowmelt Runoff Impacts to Wetlands (May 1995 draft) by the State of Minnesota Storm Water Advisory Group. Sensitivity is discussed and evaluated in Section IV of that document: Wetland Susceptibility (see Appendix D).

Wetland type is determined by hydrology, vegetation and soils. Table 2.23, which follows this section, is a figure taken from the guidance document found in Appendix D. It lists wetland types according to their susceptibility to degradation by storm water input. It is important to note that there can be exceptions to the general categories listed. There is a broad range of tolerance among wetlands to urban storm water input.

As noted in the guidance document, "Diverse, sensitive native plant communities can be readily degraded by storm water impacts resulting in monotypes of sediment- and nutrient-tolerant species such as reed canary grass and/or cattails. Greater frequency and duration of inundation can destroy native plant communities as can depriving them of their water supply. Each wetland should be carefully evaluated to determine potential impacts from a proposed urban storm water project."

Wetland sensitivity is broken into 4 categories **highly, moderately, slightly** and **least sensitive/susceptible**. Wetlands were evaluated using the criteria in Table 2.23. For the expanded definitions of the 4 categories, see Appendix D.

It was necessary to estimate the amount of bounce and period of inundation occurring in each wetland for the rainfall events referenced in the guidance document. The flood level for a 1 percent chance rainfall of 24 hour duration has been computed for the majority of water bodies in Bloomington. This has not been done for more frequent rainfall events. The City is in the process of updating its storm water model. More frequent rainfalls will be considered in this round of modeling. If the results of the modeling show an impact to a wetland that affects its intended management function(s), City staff will determine what changes are needed to address the situation.

Table 2.23

SUSCEPTIBILITY (SENSITIVITY) OF WETLANDS TO DEGRADATION BY STORM WATER IMPACTS*

Highly Susceptible Wetland Types[1]:	**Moderately Susceptible Wetland Types[2]:**	**Slightly Susceptible Wetland Types[3]:**	**Least Susceptible Wetland Types[4]:**
Sedge Meadows	Shrub-carrs[a.]	Floodplain Forests[a.]	- Gravel Pits
Open Bogs	Alder Thickets[b.]	Fresh (Wet) Meadows[b.]	- Cultivated Hydric Soils
Coniferous Bogs	Fresh (Wet) Meadows[c.,e.]	Shallow Marshes[c.]	- Dredged Material/Fill Material Disposal Sites
Low Prairies	Deep Marshes[d.,e.]	Deep Marshes[c.]	
Coniferous Swamps			
Lowland Hardwood Swamps			
Seasonally Flooded Basins			
1. Special consideration must be given to avoid altering these wetland types, Inundation must be avoided. Water chemistry changes due to alteration by storm water impacts can also cause adverse impacts. **Note:** All scientific and natural areas and pristine wetlands should be considered in this category regardless of wetland type.	**2. a,b,c)** Can tolerate inundation from 6 inches to 12 inches for short periods of time. May be completely dry in drought or late summer conditions. **d)** Can tolerate +12" inundation, but adversely impacted by sediment and/or nutrient loading and prolonged high water levels **e)** Some exceptions	**3. a)** Can tolerate annual inundation of 1 to 6 feet or more, possibly more than once/year. **b)** Fresh meadows which are dominated by reed canary grass. **c)** Shallow marshes dominated by reed canary grass, cattail, giant reed or purple loosestrife.	**4.** These wetlands are usually so degraded that input of urban storm water may not have adverse impacts.

NOTES: There will always be exceptions to the general categories listed above. Use best professional judgment. Pristine wetlands are those that show little disturbance from human activity.

*This is an excerpt from the Guidance for Evaluating Urban Storm Water and Snowmelt Runoff Impacts to Wetlands, Section IV, Figure IV-1.

2.24 Wetland Quality

Wetland quality was also evaluated using the Guidance for Evaluating Urban Storm Water and Snowmelt Runoff Impacts to Wetlands (May 1995 draft) by the State of Minnesota Storm Water Advisory Group. Wetland quality is discussed and evaluated in Section I of that document: Comprehensive Storm Water Management (see Appendix D).

Wetland quality and condition can be assessed one of two ways. An intensive, quantitative analysis may be used. This method would be appropriate to assess wetlands identified as high priority. A rapid or practical qualitative analysis based on best professional judgment would be appropriate for the evaluation of each wetland or complex in a watershed.

MNRAM, considered to be a rapid/practical strategy, was applied to all the wetlands above the Minnesota River bluff line. The MNRAM field data was compiled and used to determine wetland quality.

As noted in the guidance document "Wetland quality can be assessed as **excellent, moderate, or highly impacted** depending on the extent to which human activities have affected the wetland. Wetlands were evaluated using the following criteria.

> **Excellent Quality Wetlands**: These wetlands remain in a least impacted condition and, as such, typically possess very diverse vegetative assemblages. Strata are well developed and composed of native species. Non-native species, if present, are infrequent and do not comprise significant relative cover percentiles. Wetlands which support rare, threatened, or endangered species are likely to be included as excellent quality wetlands.
>
> **Moderate Quality Wetlands:** Areas that have been subject to varying degrees of human disturbances, but still provide important ecological wetland functions and values, are considered to be of moderate quality. An example would be a partially drained wetland complex composed of 60 percent cover of reed canary grass, and 40 percent cover of native species such as sedges. These wetlands often provide important wildlife habitat and water quality benefits.
>
> **Highly Impacted Wetlands:** Areas that have been severely degraded such that they have little vegetation or the vegetation is dominated by non-native species or by monotypic stands of species such as cattails. Hydrologic and/or biological processes have been greatly altered and inputs of urban storm water will have minimal impacts. Example wetlands include abandoned gravel pits, nutrient loaded wetlands, storm water detention basins and dredged areas within wetlands that result in extreme hydrologic modifications.

2.25 Bloomington Management Classification

The management classification was developed to assist in the process of determining recommendations for actions to be taken for future management of the wetlands. The primary use classification of a wetland, its sensitivity to storm water runoff and the current wetland quality were considered in assigning a wetland to a management classification. The classification categories and an explanation of each follow.

Utilize: This category of wetlands includes those that are currently, or planned to be[(1)], used in a manner that will likely result in a reduction in the value of certain functions in order to increase the value of other functions of that wetland or another located downstream in the watershed. These wetlands are managed to insure that they perform their primary function. Manmade ponds and highly degraded wetlands would fall into this category. Other examples would be wetlands being used for storm water detention that experience a large bounce in water surface elevation or an extended period of inundation following a runoff event, and wetlands that provide significant treatment of storm water prior to conveying it to a higher quality wetland.

Apply Best Management Practices: Wetlands in this category have typically been impacted to some degree by development in their tributary watershed. However, the current functions and values are considered acceptable. Best management practices (BMP's) will be used in an effort to maintain these functions and values. Some examples of BMP's that will be utilized are: public education to increase the residents' knowledge and awareness of how fertilizers, pesticides and lawn maintenance can affect wetlands, implementation of programs to control invasive or exotic vegetation, providing sufficient vegetative buffer areas around wetlands, reviewing turf maintenance practices on city land and minimizing the amount of connected impervious surface in new development or redevelopment.

Preserve: Wetlands that are either of high quality, rare, or not connected to storm sewer and having a relatively undisturbed tributary drainage area would typically be placed in this category. In addition to BMP's, other measures would be taken to protect these wetlands. These would include requiring any future development to maintain predevelopment wetland hydrology and an adequate vegetative buffer. In cases where the wetlands are connected to the storm sewer system, infrastructure changes such as sedimentation basins, forebays, and trap manholes would be recommended.

[(1)] Any changes that would affect a MDNR Protected Waters wetland would have to be approved via MDNR permit.

17-01 Penn Lake, Lower

Newton Ave & 87th St

Circular39	NWI
type 5	LIUBH
Restoration	**Acreage**
5	32.60

Diversity	Wildlife	Fishery	Flood/Storm	Water Quality	Shoreline	Aesthetics
low	med	med	high	med	N/A	med

DNR Protected Waters #	4P
Floral Diversity Break Down	95%low - open water
Flood/Stormwater Break Down	2 low, 2med, 7 high- soils not mapped
Mowed Upland Buffer	75% mowed
7050 Designation	2C
General Comment	*Chemically treated annually with copper sulfate; 3% of wetland area is altered by mowed; secondary Bloomington classification is detention; submergent community was not evaluated
Bloomington Classification	Indirect Contact
Wetland Sensitivity	Slight
Wetland Quality	Highly Impacted
Management Designation	BMP's

* TREATMENTS ARE NOT CURRENTLY PERFORMED.

08-01 Penn Lake, Upper

Newton & 86th

Circular39	NWI
type 4	PEMF PUBG PEMF
Restoration	**Acreage**
4	9.70

Diversity	Wildlife	Fishery	Flood/Storm	Water Quality	Shoreline	Aesthetics
low	med	med	high	excep	N/A	med

DNR Protected Waters #	4P
Floral Diversity Break Down	70%low, 10% altered
Flood/Stormwater Break Down	2 low, 2 med,7 high, 1 n/a
Mowed Upland Buffer	95% mowed
7050 Designation	5
General Comment	Contains islands; * chemically treated with coper sulfate annually; soils are not mapped; directly connected to Lower Penn Lake; 10% of wetland area is mowed weekly; contains purple loosestrife - amount unknown
Bloomington Classification	Detention
Wetland Sensitivity	Slight
Wetland Quality	Highly Impacted
Management Designation	Utilize

* TREATMENTS NOT CURRENTLY PERFORMED.

APPENDIX G

Scott Anderson 2-13-2009
City of Bloomington
Engineering division
1700 West 98th Street
Bloomington, MN 55431

Dear Scott,

At the meeting of February 3rd you asked what the Lower Penn Lake association expects to accomplish for Penn Lake as a result of the time and study that we all have invested On February 12th the Lower Penn Lake steering committee met. We discussed the new information we were given which included the 2003 Use Attainability Analysis presented by Barr Engineering and the results of the well pumping test and how this new information might affect our lake improvement requirements.

Here are the five main objectives of the association.

- Enhance the current fishery.
- Improve the Lake's water quality.
- Continue current flood control measures.
- Establish a best practices water quality monitoring system.
- Eliminate solid waste introduction into Upper and Lower Penn Lake.

We understand that the above objectives can be accomplished in many different ways. We also know that many methods have been identified and now it is time to choose those options in the form of a plan. We will cooperate in every possible way to have this plan in place by June1st of this year. We have put together an outline of the plan that we will forward to you as soon as we incorporate the additional material discussed by the steering committee, so we believe that June 1 is a very reachable goal.

It is encouraging to see the effort that the many interested groups have demonstrated to improve the quality of this urban asset. We as an association have been pleased with the additional interest from residents around Upper Penn Lake in our Association. They are now active participants.

Thank you for you and your staff's efforts in accomplishing these goals.

Sincerely,
Lower Penn Lake Association Steering Committee

Ingrid Lund	Pamela Ludvigsen	Lisa McIntire
Jim Lund	Roger Willette	Allan Rezak
Mary Thiesan	Dave Thorsen	Douglas Jones
Tom Carmody	James Schlemmer	
Ida Darsow	Robert Schwirtz	
Donn Darsow	John Cecere	

cc Kevin Bigalke

APPENDIX H

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Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO

Technical Memorandum

To: Nine Mile Creek Watershed District and City of Bloomington
From: Rita Weaver, Miguel Wong, Tina Pint
Subject: Water Balance for Lower Penn Lake – First Phase
Date: February 20, 2008
Project: 23/27-634
c: Bob Obermeyer

Introduction

The Minnesota Department of Natural Resources has informed the City of Bloomington (the City) and Nine Mile Creek Watershed District (the Watershed District) that the water appropriation permit (permit number 75-6273) that is used to pump water from a well (referred to here as the Penn Lake Well; unique well number 224648) into the Lower Penn Lake will be cancelled in February 2008. The City and the Watershed District have expressed concern regarding future water levels in Lower Penn Lake if there is no discharge of pumped groundwater into the lake.

Barr prepared a work plan (Internal Memorandum dated December 11, 2007) outlining the methodology (a) to evaluate the effect of the pumping operation on the current Lower Penn Lake water levels, and (b) to make preliminary predictions of future lake levels without the appropriated groundwater discharge. It was anticipated in the work plan that depending on the results of the first phase of the study, additional work will likely be needed. This memorandum presents the results of the first phase of the study, which include:

1. Update information on Lower Penn Lake water levels.
2. Update information on, and confirm timing of appropriated groundwater discharge to Lower Penn Lake.
3. Develop a rating curve for Lower Penn Lake.
4. Review of the existing hydrologic model developed in P8 for the upper watershed of Lower Penn Lake.
5. Complete a water balance of Lower Penn Lake for the period 1988-2006, including appropriated groundwater discharge, to quantify natural groundwater gains or losses from this lake.

6. Complete a water balance of Lower Penn Lake for the period 1988-2006, not including appropriated groundwater discharge, to quantify the effect of not accounting for the pumping operation on Lower Penn Lake water levels.

7. Outline recommended program of field investigations to conduct as part of the second phase of the study.

Review of Input Data

Water Level Data

The Minnesota Department of Natural Resources' (DNR) website provides information about measured water levels in Lower Penn Lake from April 23, 1964 through January 29, 2002. Additional information on water levels in Lower Penn Lake was obtained from the City for the period April 1, 2002 through January 2, 2008. The frequency of measurement is monthly on the average. Review of the time series of water levels in Lower Penn Lake presented in Figure 1 shows that:

1. There is a negative trend between 1964 and 1987, with an average water level drop of approximately 1.2 feet over a period of 23 years.

2. There is a positive trend between 1991 and 2003, with an average water level increase of approximately 0.5 feet over a period of 12.5 years.

3. There is a drop in the average water level beginning in 2004. Compared to the period 1991-2003, the drop is approximately 1 foot.

The initial hypothesis was that the long-term negative and positive trends in water levels were associated with the beginning of the pumping discharge into the lake, or with a significant increase in the pumping appropriation rates into the lake some time between 1987 and 1991. The pumping data presented below does not strongly support this hypothesis.

On the other hand, the drop in the average water level beginning in 2004 (i.e., the year after which pumping was restricted to the winter season) suggests that the groundwater appropriation has an effect on the water levels in Lower Penn Lake. However, such effect does not seem to cause a long-term negative trend in water levels.

Therefore, it could be argued that not accounting for the pumping operation would not have a significant effect on the lake water levels.

Pumping Data

The City provided information about gaged volumes of groundwater appropriation discharge into the Lower Penn Lake from 1976 to 2006. When available beginning in 1988, the frequency of measurement is monthly; otherwise, yearly values were provided (e.g., years 1998 and 1999.) Review of the pumping data in Figures 2 and 3 reveals that:

1. The average groundwater appropriation was approximately 100 million gallons per year between 1976 and 2003 (see Figure 3). In general for this period, groundwater appropriation during winter was greater than during summer, but the ratio of winter to summer monthly appropriation pumping rates was less than two. Put more simply, groundwater appropriation was not restricted to winter time (see Figure 2).

2. The average groundwater appropriation dropped to approximately 40 million gallons per year between 2004 and 2006 (see Figure 3). For this period, groundwater appropriation was restricted to winter time (see Figure 2). According to the 2005 DNR - Annual Report of Water Use, the Penn Lake Well is only operated for winter aeration purposes under aeration permit number F0563015.

As indicated above, the drop in the average water level beginning in 2004 suggests that the groundwater appropriation has an effect on the water levels in Lower Penn Lake, but such effect does not seem to cause a long-term negative trend in water levels.

Comparison of precipitation values (April through October) against annual pumping rates depicts a poor correlation between these two variables during the period 1988-1997. Some degree of negative correlation is apparent during the period 2000-2006, with relatively low pumping rates matching relatively high precipitation values. This finding could be an indication of precipitation (and runoff from the upper watershed) input to Lower Penn Lake having a greater effect than groundwater appropriation on the maintenance of the lake water levels.

Rating Curve

The City provided a copy of the as-built drawing for the outlet structure of Lower Penn Lake, which indicates that the invert elevation of the 42-inch pipe is at 807 feet above sea level. A rating curve for Lower Penn Lake was developed by using the information in this as-built drawing, and by comparing predicted inflows (with the P8 Hydrologic Model; see discussion below) against calculated outflows based on measured water levels.

One interesting finding to highlight with respect to the rating curve is provided in Figure 1. This figure shows that during 2004-2006 (i.e., the period when pumping was restricted to the winter season), Lower Penn Lake water levels were at or below elevation 807 feet above mean sea level approximately 75 percent of the time. During 1976-2003 (i.e., the period when pumping was not restricted to the winter season), Lower Penn Lake water levels were at or below elevation 807 feet above mean sea level approximately 50 percent of the time. In other words, there was a significant reduction in the amount of time during which surface water outflow from the lake occurred as a result of an overall drop in lake water levels. Such drop is hypothesized to be the result of restricting the groundwater appropriation to the winter season. The drop of 1 foot in the average water level beginning in 2004 translates into a lake surface area reduction of 32-33 acres to 30-31 acres.

P8 Hydrologic Model

The existing hydrologic model developed in P8 for the upper watershed of Lower Penn Lake was reviewed. Comparison of 1988-2006 measured annual precipitation against 1988-2006 simulated inflows (with the P8 hydrologic model) to Lower Penn Lake resulted in an annual average runoff coefficient of 0.42. This value is somewhat lower than expected for an urbanized area like the study watershed, yet an annual average runoff coefficient of 0.42 is within the expected range.

Water Balances

Including Groundwater Appropriation

A daily water balance for Lower Penn Lake was completed for 1988-2006, which corresponds to the coincident period of record of water level and pumping data; years 1998 and 1999 were not included because data on groundwater appropriation discharges was available on an annual basis only. The daily water balance was restricted to the months of April through October, i.e., the open water period. Winter months were not included in the water balance because of:

1. the uncertainty about potential freezing of the outlet pipe and zero outflows from Lower Penn Lake, and

2. the uncertainty about water level fluctuations caused by ice growth and decay, rather than as a result of increased or reduced inflows and outflows.

The water balance was formulated as follows:

$$V_t + \Delta t\left(Q_{in} + Q_{pump} + GW + P \times A - E \times A - Q_{out}\right) = V_{t+\Delta t} \qquad (1)$$

The water balance included the following components:

1. The time series of volumes of water stored V_t (at time step t) and $V_{t+\Delta t}$ (at time step $t+\Delta t$) were obtained from the storage-elevation curve of Lower Penn Lake and water level data.

2. The time series of surface water inflows from the upper watershed of Lower Penn Lake Q_{in} was obtained from running a continuous simulation using the P8 hydrologic model.

3. The time series of groundwater appropriation discharges into Lower Penn Lake Q_{pump} was obtained from the pumping data.

4. The time series of direct precipitation onto the lake P was obtained from recorded values in the Watershed District's precipitation gage at Bloomington.

5. The time series of evaporation rates from the lake E was obtained from the Meyer Model developed as part of the Penn Lake Use Attainability Analysis (Barr, 2003).

6. The time series of surface water outflows from Lower Penn Lake Q_{out} was obtained using the lake's rating curve and water level data. More specifically for the latter, the average of the water levels associated with V_t and $V_{t+\Delta t}$ is used to estimate Q_{out}.

The main output of the water balance formulated in equation (1) above is the quantification of the gain of natural groundwater into the lake (positive *GW*) or the loss of water from the lake to natural groundwater (negative *GW*). The results of the water balance for the open water period of 1988-2006 indicate that, on the average, there is a net loss of water from the lake to groundwater. The average net groundwater loss is approximately 6 percent of the total combined inflow from the upper watershed of Lower Penn Lake, direct precipitation onto the lake, and the groundwater appropriation discharge.

Using the water balance approach presented here it is not possible to quantify groundwater inflows and outflows to the lake, but only the net groundwater gain or loss. On an annual basis, during 10 out of the 17 years evaluated, there is a net groundwater loss. It is more important to note in Figure 4 that on years of relatively high groundwater appropriation discharge there was loss of water from the lake to natural groundwater, whereas on years of relatively low groundwater appropriation discharge there was gain of natural groundwater into the lake. Lowering or increasing the average water level of the lake might be controlling the gain or loss of water from/to natural groundwater. If so, cancellation of the pumping operation would not necessarily result in Lower Penn Lake converting to a wetland.

Not Including Groundwater Appropriation

Another daily water balance for Lower Penn Lake was completed for the open water period of 1988-2006 (again, years 1998 and 1999 were not included for the reasons given above). This water balance made use of the same information presented in the previous section, except for:

1. The groundwater appropriation discharge Q_{pump} in equation (1) above was set equal to zero, to simulate the conditions after cancellation of the pumping operation.

2. The time series of groundwater gain/loss GW to use in equation (1) above corresponded to the one obtained in the previous section.

The output of this second water balance is that not accounting for the groundwater appropriation discharge would result in a significant drop of the water level 4 out of the 17 years of water balance. The water balance results presented in Figure 5 for years 2000 to 2006 appear to be less affected by the uncertainty in quantifying natural groundwater gains/losses from Lower Penn Lake, with a water level drop in a given year of the order of 1.0 to 1.5 feet for periods of a few weeks. Such water level drop would translate into a lake surface area reduction of 32 acres to 30 acres.

Although the groundwater appropriation discharge represented, on the average, less than 10 percent of the surface water inflow from the upper watershed of Lower Penn Lake, it is worthwhile mentioning that (a) the lake water level seems to be controlling the gain/loss of water from/to natural groundwater, with lower water levels apparently correlating with groundwater recharge rather than groundwater loss; and (b) lower water levels result in smaller outflows through the pipe outlet, but the lower range of water surface elevations does not translate into a significant reduction in the lake surface area. Therefore, cancellation of the pumping operation would not necessarily result in Lower Penn Lake developing wetland characteristics.

The program of field investigations presented in the next section of this memo is intended to address the main uncertainties of the present analysis, in particular those related to the potential connection between groundwater appropriation discharges and natural groundwater gains or losses from Lower Penn Lake.

Recommended Program of Field Investigations

The greatest uncertainty in the lake water balance is the rate and direction of flow between the lake and the groundwater system. Initial review of the date presented in previous sections suggests that groundwater seepage may be correlated to lake levels and/or the volume pumped from the Penn Lake Well. In order to help decrease the uncertainly associated with the groundwater flux to and from the lake, the following field investigation is proposed.

Up to six monitoring wells will be installed around Lower Penn Lake. Water levels in these wells will be monitored at the same frequency as lake levels. A slug test[1] will be performed using each well in order to determine a representative average hydraulic conductivity for the surficial deposits surrounding the lake. If possible, water levels in the wells will be monitored prior to, during, and following pumping from the Penn Lake Well. This data will be analyzed to predict groundwater exchange rates with the lake. These predicted rates will be compared to the rates solved for as part of

[1] A slug test is an aquifer test conducted by inserting PVC rod (i.e. a "slug") into a well, letting water levels in the well equilibrate and than rapidly removing the rod. Water levels in the well are monitored during the test and can be analyzed to provide a prediction of average hydraulic conductivity for the formation surrounding the well.

the water balance presented above. If needed, a simple groundwater-surface water interaction model can be constructed to further predict groundwater seepage rates. Finally, the lake water balance will be reevaluated using the data collected as part of the field investigation.

Figure 1 Measured water levels in Lower Penn Lake

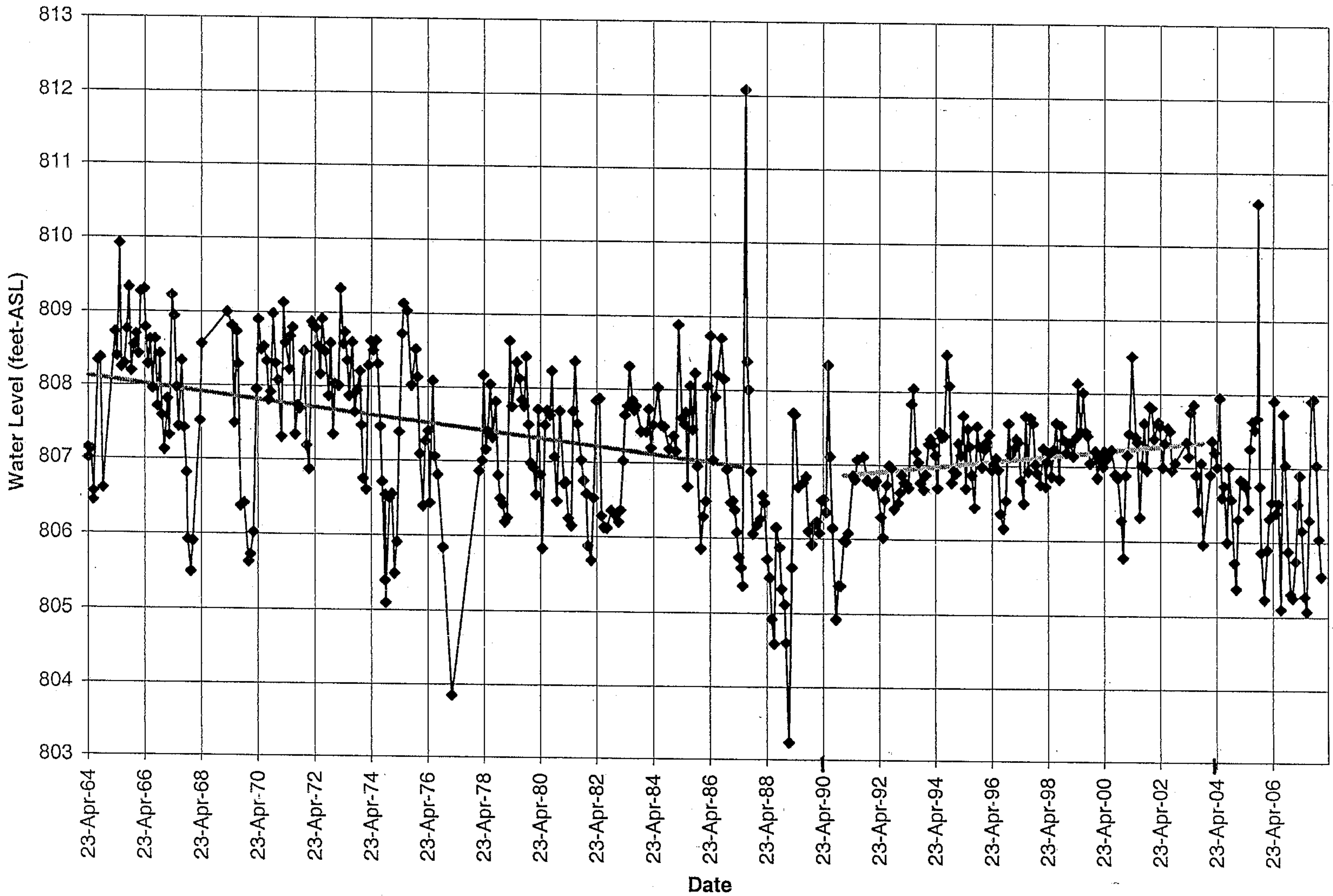


Figure 2 Measured monthly groundwater appropriation into Lower Penn Lake

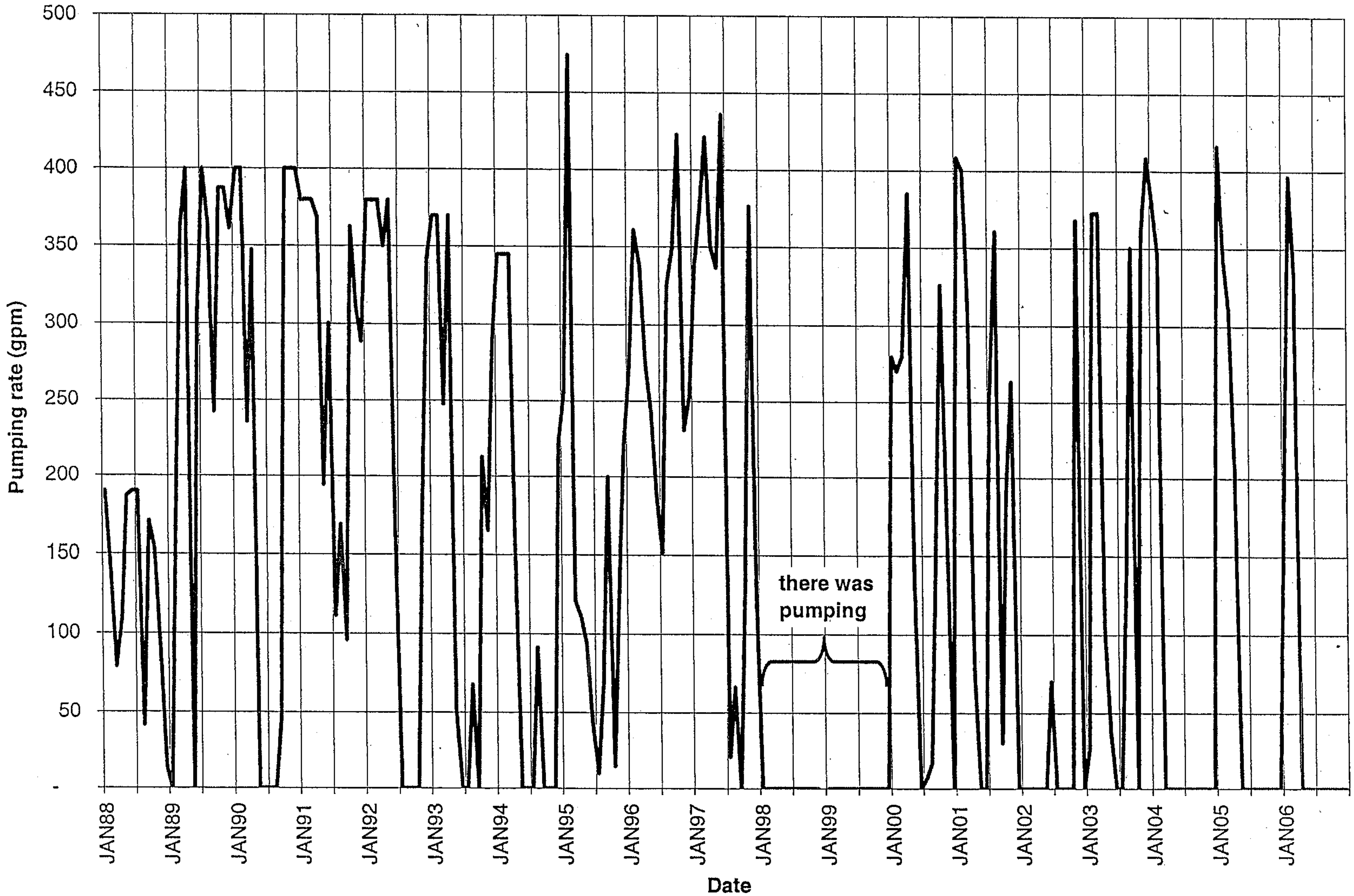


Figure 3 Measured annual groundwater appropriation into Lower Penn Lake

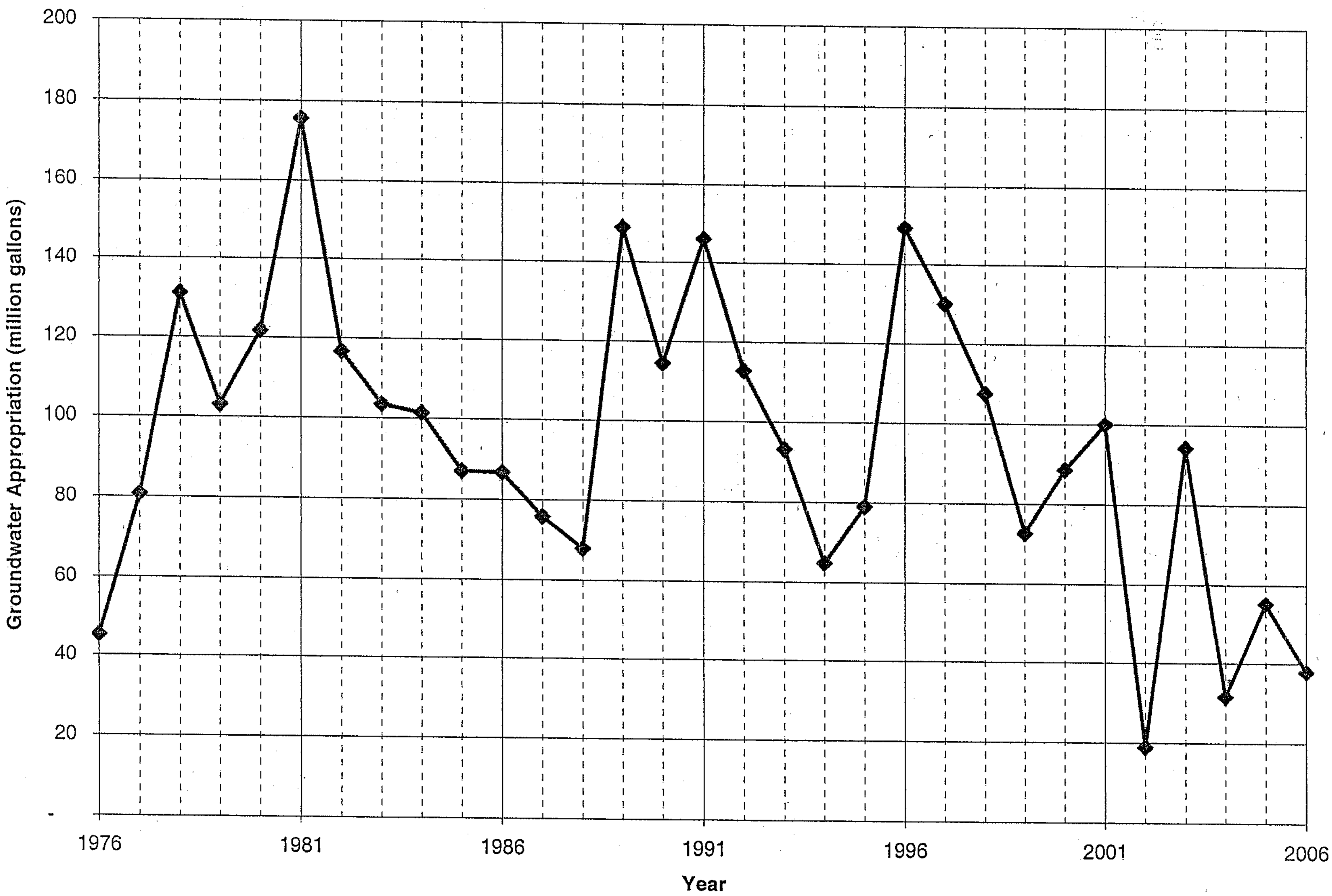


Figure 4 Calculated annual groundwater flux from Lower Penn Lake versus annual pumping appropriation into Lower Penn Lake

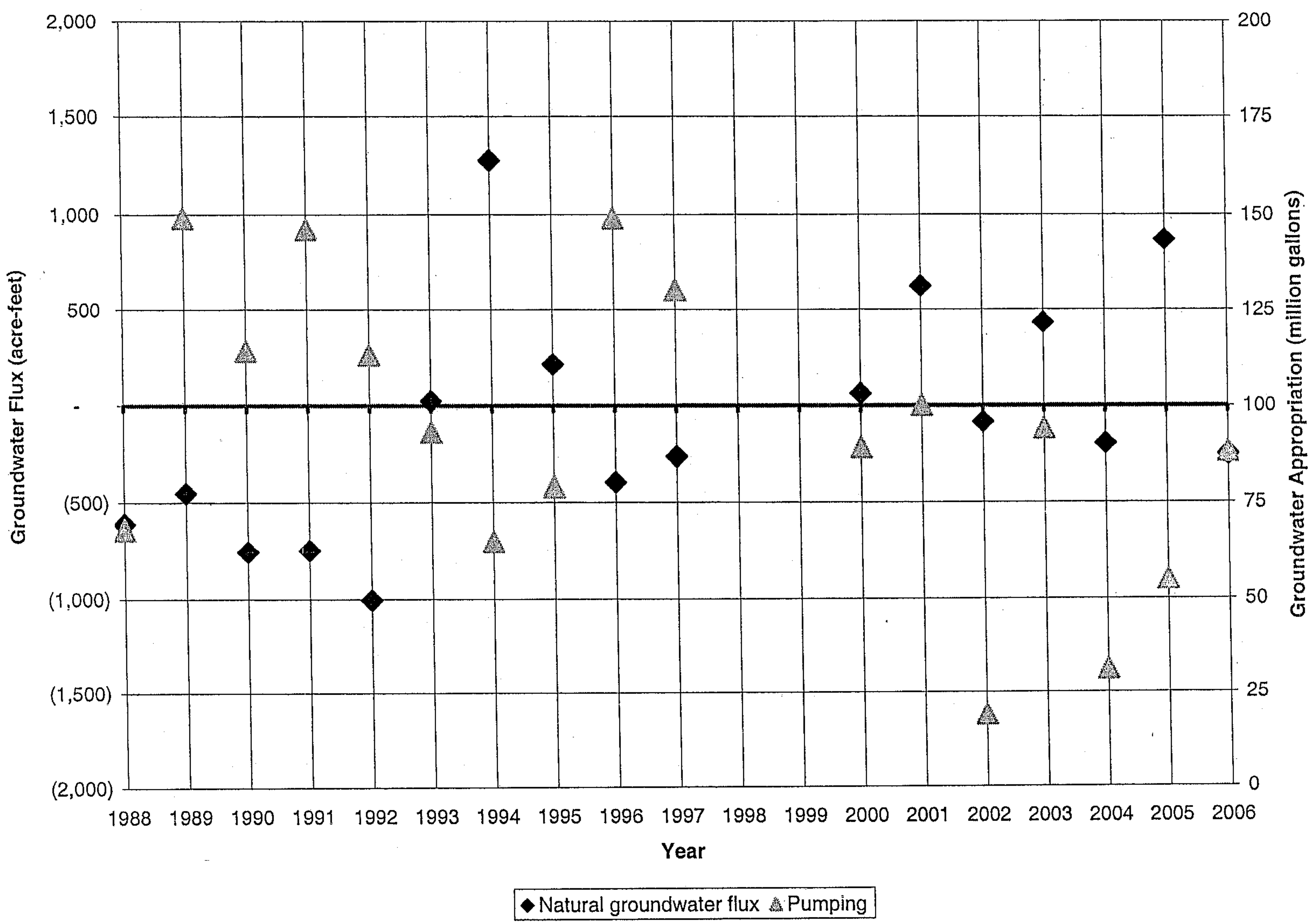
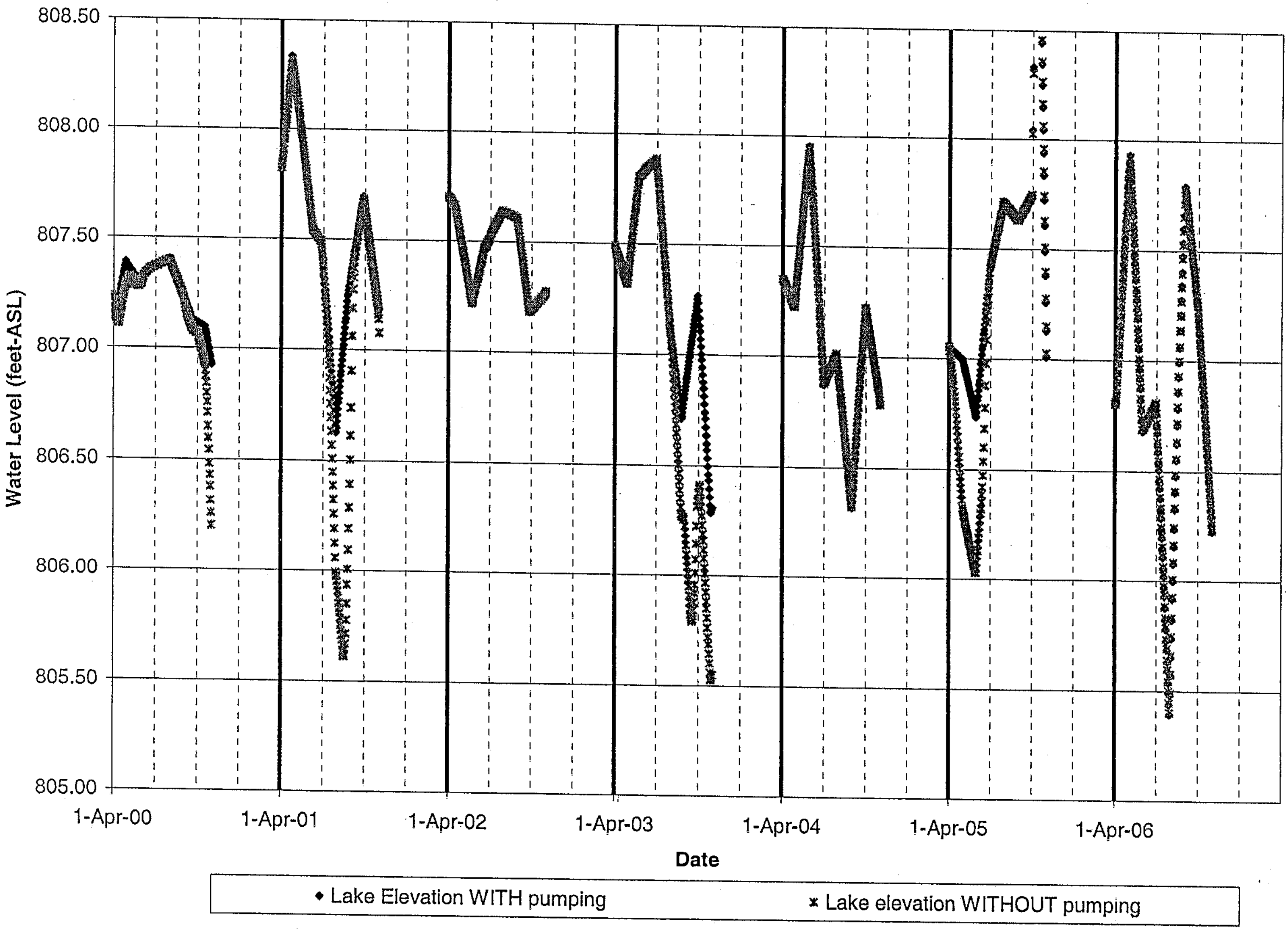


Figure 5 Calculated daily water balance in Lower Penn Lake during years 2000 to 2006 (open water period from April through October)



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Technical Memorandum

To: Nine Mile Creek Watershed District and City of Bloomington
From: Evan Christianson
Subject: Pumping Test, Penn Lake, Bloomington, Minnesota
Date: November 26th, 2008
Project: 23/27-634 WQ03 180
c: Bob Obermeyer

Introduction

A pumping test was performed using the high capacity well on the north side of Penn Lake (Well Unique ID 224648; referred to here after as the pumping well, or augmentation well). This well was previously used for lake level augmentation and is currently used for aeration in the winter. During the test, water levels were measured in the 6 monitoring wells on the north end of the lake along with the lake level (Figure 1). The purpose of the test was to gain a better understanding of the hydrogeology near Penn Lake. The primary objective was to refine the hydrogeologic conceptual model pertaining to groundwater – lake interaction. It was presumed that the lake may be acting as a recharge source for the pumping well, and that pumping water into the lake may cause more induced recharge, or leakage, from the lake.

Methods

The pumping well was turned on 8/25/2008 at 9 a.m. and pumped at a constant rate of 318 gallons per minute for 48 hours, with the pump being shut off on 8/27/2008 at 9 a.m. A flow meter was installed on the pump discharge line to better quantify flow rates. Water levels were measured by hand frequently throughout the test. Pressure transducers and data loggers were installed in wells 2, 4, 5, and 6 along with the pumping well to measure and record water levels at more frequent intervals than could be done manually. Drawdown data was adjusted to account for regional trends in groundwater levels using a linear fit to groundwater levels collected for the two days prior to the pumping test Data from the pumping test was then analyzed qualitatively to better define the hydrogeologic conceptual model.

Results

Results from the pumping test show that the water level in wells 1, 3, 5, and 6 were affected by the pumping. The greatest impact was at Well 3, with a maximum drawdown of 0.23 feet (Table 1). Well 1 had the least distinguishable response with a maximum drawdown of 0.05 feet. Water levels in wells 2 and 4 showed no distinguishable response to the pumping.

Data from the pumping test lends little value for the traditional type of analysis, where transmissivity or hydraulic conductivity is calculated. The depth of the pumping well, in comparison to the depth of the monitoring wells, along with the complexities of the lake acting as a recharge boundary, makes the traditional quantitative analysis difficult. Rather, the data from this pumping test is valuable qualitatively and helped in refining the hydrogeologic conceptual model developed during the initial phase of this study.

Discussion

Based on data from the pumping test, and water levels collected weekly from the monitoring wells, the hydrogeologic conceptual model developed in the initial phase of this study has been refined. Weekly water levels show that the lake level is consistently above the groundwater level at all monitoring well nests (Figure 2). Also, a strong, downward, vertical hydraulic-gradient exists at well nest 1,2 and well nest 3,4. Little vertical hydraulic-gradient is present at well nest 5,6. The strong, downward, vertical hydraulic-gradients suggest that the lake is losing lake water to groundwater. This is in general agreement with the first phase of the study which showed that, on average, there is a net groundwater loss from the lake. During the initial phase of the study it was found that 10 out of the 17 years evaluated showed a net groundwater loss.

The hydrogeologic conceptual model developed during the initial phase of the study was that groundwater likely flowed into the lake on the north side and flowed out of the lake to the south, with generally more groundwater flowing out of the lake than flowing into the lake, accounting for the net groundwater loss. This conceptual model is similar to that shown in Figure 3a. Water levels collected from the monitoring wells and lake from June 3, 2008 to November 17, 2008 (Figure 2; Appendix A) show that the lake - groundwater interaction is more similar to Figure 3b where little to no groundwater flows into the lake during most periods and the lake is losing water to groundwater.

The response to pumping in the monitoring wells shows that a connection exists between the shallow groundwater and the pumping well. As the well is pumped, the hydraulic head in the groundwater is lowered, inducing a greater vertical hydraulic-gradient and inducing more leakage from the lake. The lake is potentially acting as a source of water for the well. While water is likely flowing from the lake to the well, much of the water flowing to the well may be coming from up gradient to the north.

The use of the augmentation well likely has little long term effect on the water levels of Penn Lake. Rather, results from the pumping test show that pumping from the well likely induces more leakage from the lake to groundwater. This increase in leakage potentially offsets much of the increase in flow to the lake that the well provides. While pumping from the augmentation well may help to mitigate short drops in the lake water level, long term water level trends are controlled by precipitation and associated runoff along with regional groundwater levels.

Table 1. Maximum Drawdown from Pumping

Well	Unique ID #	Maximum Drawdown from Pumping (ft)
1	725256	0.05
2	725255	No distinguishable response
3	725258	0.23
4	725257	No distinguishable response
5	725260	0.09
6	725259	0.23
Pumping Well	224648	> 65

N

Meters
100 0 100

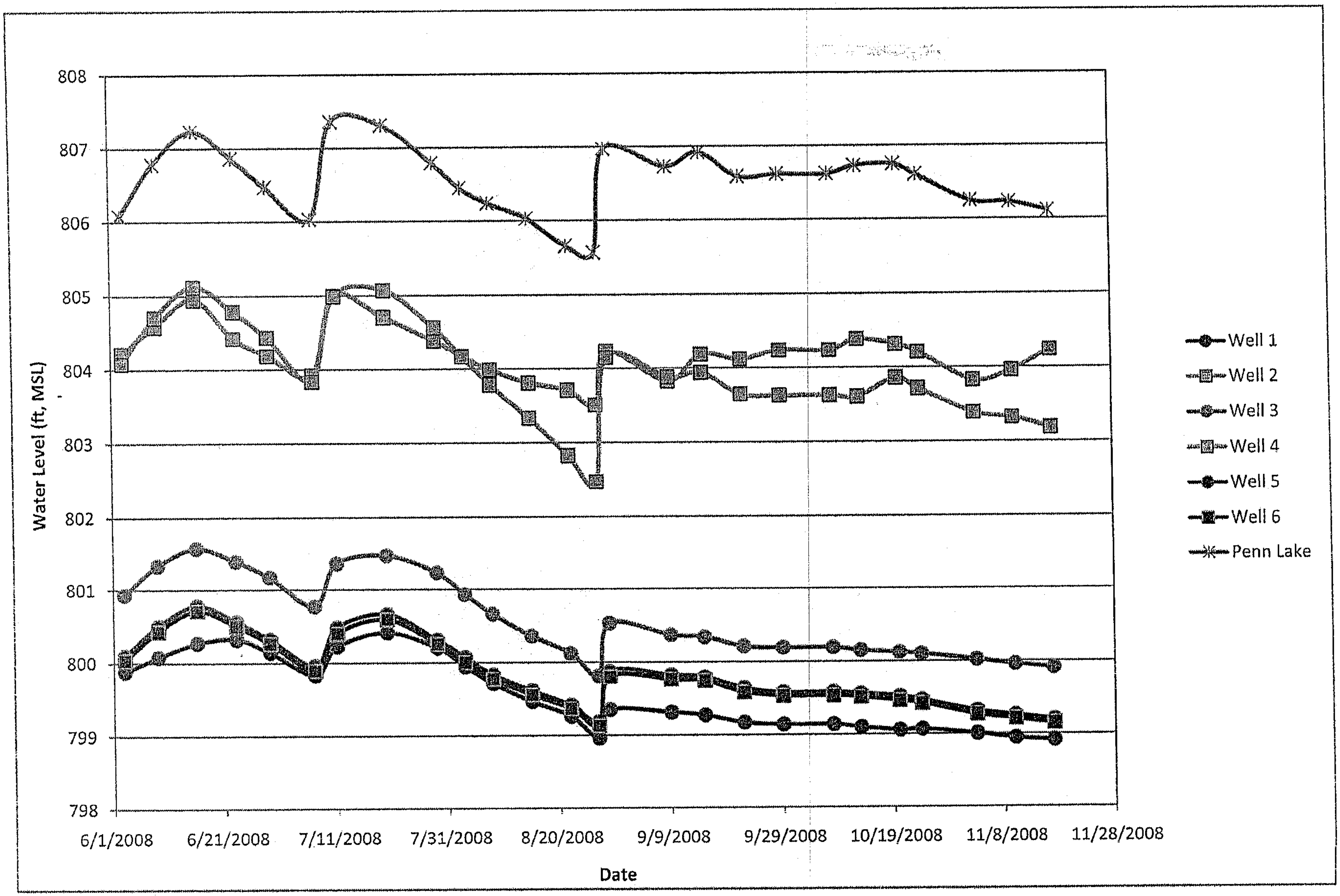
Feet
200 0 200

BARR

Figure 1

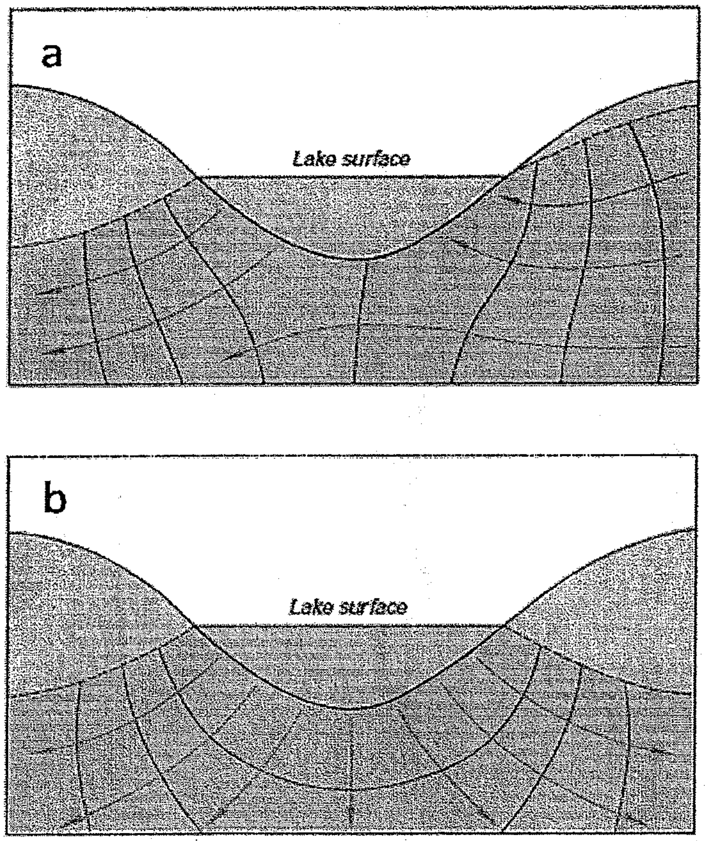
Well Locations
Penn Lake Groundwater Study

Figure 2
Weekly Water Level Measurements
Penn Lake
Bloomington, MN



P:\Mpls\23 MN\27\2327634\WorkFiles\Penn Lake WQ03-160\GroundwaterStudy - 180\Well Monitor Data\Water_Level_Summary_Table.xlsx

Figure 3
Hydrogeologic conceptual models



a.) Hydrogeologic conceptual model after first phase of study
b.) Hydrogeologic conceptual model after current phase of study
Modified from Winter et al. (2002)

Appendix A

Water Level Measurements for Monitoring Wells and Penn Lake

Table A-1

Water Elevations in Monitorings Wells and Penn Lake (ft, MSL)

Date	Well 1	Well 2	Well 3	Well 4	Well 5	Well 6	Penn Lake
6/3/2008	799.88	804.22	800.93	804.08	800.10	800.04	806.08
6/9/2008	800.08	804.59	801.33	804.71	800.50	800.43	806.78
6/16/2008	800.27	804.95	801.57	805.12	800.78	800.71	807.23
6/23/2008	800.32	804.43	801.39	804.79	800.56	800.50	806.86
6/29/2008	800.14	804.19	801.17	804.44	800.32	800.26	806.47
7/7/2008	799.83	803.92	800.77	803.84	799.96	799.89	806.03
7/11/2008	800.22	805.00	801.36	804.99	800.48	800.40	807.36
7/20/2008	800.41	804.71	801.47	805.07	800.66	800.59	807.31
7/29/2008	800.20	804.39	801.23	804.57	800.31	800.25	806.79
8/3/2008	799.94	804.18	800.93	804.17	800.07	800.00	806.45
8/8/2008	799.71	803.99	800.66	803.79	799.83	799.77	806.24
8/15/2008	799.46	803.81	800.36	803.33	799.61	799.55	806.03
8/22/2008	799.26	803.71	800.12	802.83	799.41	799.36	805.66
8/27/2008	798.96	803.51	799.81	802.47	799.19	799.13	805.57
8/29/2008	799.35	804.24	800.53	804.15	799.87	799.80	806.97
9/9/2008	799.31	803.83	800.37	803.88	799.82	799.76	806.73
9/15/2008	799.27	804.19	800.34	803.94	799.79	799.74	806.92
9/22/2008	799.17	804.12	800.21	803.65	799.64	799.58	806.59
9/29/2008	799.14	804.24	800.19	803.63	799.58	799.53	806.62
10/8/2008	799.14	804.24	800.19	803.63	799.58	799.53	806.62
10/13/2008	799.10	804.39	800.15	803.61	799.56	799.51	806.73
10/20/2008	799.06	804.32	800.12	803.86	799.52	799.46	806.75
10/24/2008	799.07	804.21	800.10	803.72	799.47	799.42	806.61
11/3/2008	799.01	803.83	800.02	803.39	799.32	799.27	806.25
11/10/2008	798.95	803.96	799.96	803.32	799.26	799.21	806.23
11/17/2008	798.92	804.24	799.91	803.18	799.20	799.15	806.11

Appendix B

Well Logs

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 725260

WELL LOCATION
County Name: Hennepin

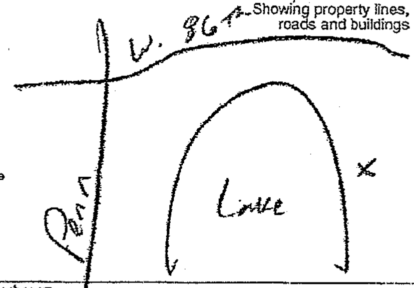
Township Name	Township No.	Range No.	Section No.	Fraction
				¼ ¼ ¼

GPS LOCATION: Latitude ____ degrees ____ minutes ____ seconds ____
Longitude ____ degrees ____ minutes ____ seconds ____

House Number, Street Name, City, and Zip Code of Well Location: 1925 W. 86th St Bloomington
or Fire Number:

Show exact location of well in section grid with "X" (N, S, E, W; ½ Mile; 1 Mile)

Sketch map of well location. Showing property lines, roads and buildings.



PROPERTY OWNER'S NAME/COMPANY NAME
City of Bloomington

Property owner's mailing address if different than well location address indicated above.
1800 W. Old Shakopee Road
Bloomington, MN
55431

WELL OWNER'S NAME/COMPANY NAME
Nine Mile Creek Watershed District

Well owner's mailing address if different than property owners address indicated above.
c/o Barr Engineering Company
4700 W. 77th St
Minneapolis, MN 55435

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Fine Sand	Tan	soft	0	11
Med Silty Sand	Gray	soft	11	30

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc.

WELL DEPTH (completed): 30 ft.
Date Work Completed: 5/29/08

DRILLING METHOD
☐ Cable Tool ☐ Driven ☐ Dug
☒ Auger ☐ Rotary ☐ Jetted
☐

DRILLING FLUID: None
WELL HYDROFRACTURED? ☐ Yes ☒ No
FROM ____ ft. TO ____ ft.

USE
☐ Domestic ☒ Monitoring ☐ Heating/Cooling
☐ Noncommunity PWS ☐ Environ. Bore Hole ☐ Industry/Commercial
☐ Community PWS ☐ Irrigation ☐ Remedial
☐ Dewatering ☐

CASING
☒ Steel ☐ Plastic
Drive Shoe? ☐ Yes ☒ No
☐ Threaded ☐ Welded ☐

HOLE DIAM.

CASING DIAMETER		WEIGHT	HOLE DIAM.
2"	in. to ~~30~~ 25 ft.	lbs./ft.	8 1/4 in. to 30 ft.
	in. to ft.	lbs./ft.	in. to ft.
	in. to ft.	lbs./ft.	in. to ft.

SCREEN Stainless Steel
Make: Johnson
Type: Stainless
Slot/Gauze: .010
Diam.: 2"
Length: 5'
Set between 25 ft. and 30 ft.
FITTINGS: Drive couplers

OPEN HOLE
FROM ____ ft. TO ____ ft.

STATIC WATER LEVEL
13.69 ft. ☒ below ☐ above land surface Date measured 6/2/08

PUMPING LEVEL (below land surface)
~~13.69~~ NA ft. after ____ hrs. pumping ____ g.p.m.

WELL HEAD COMPLETION
☐ Pitless adapter manufacturer ____ Model ____
☒ Casing Protection 6" x 7' protop ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION
Well grouted ☒ Yes ☐ No
Grout material ☐ Neat cement ☐ Bentonite ☐ Concrete ☒ High Solids Bentonite
from 0 to 21 ft. 2.5 ☐ yds. ☒ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags

NEAREST KNOWN SOURCE OF CONTAMINATION
Unk ____ feet ____ direction ____ type

Well disinfected upon completion ☐ Yes ☐ No

PUMP
☒ Not installed Date installed ____
Manufacturer's name ____
Model number ____ HP ____ Volts ____
Length of drop pipe ____ ft. Capacity ____ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐

ABANDONED WELLS
Does property have any not in use and not sealed well(s) ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ____

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Matrix Environmental — 1966
Licensee Business Name — *Lic. or Reg. No.*

Dan Thompson — 5/29/08
Authorized Representative Signature — *Date*

Dan Thompson
Name of Driller

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY

725260

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 725259

WELL LOCATION

County Name: Henneph

Township Name	Township No.	Range No.	Section No.	Fraction
				¼ ¼ ¼

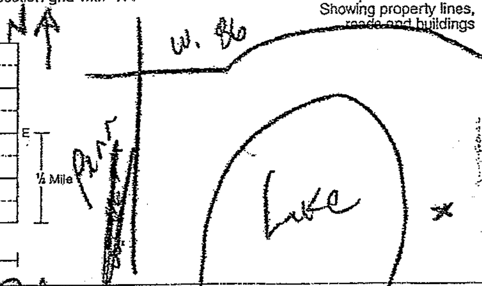
GPS LOCATION: Latitude ____ degrees ____ minutes ____ seconds ____
Longitude ____ degrees ____ minutes ____ seconds ____

House Number, Street Name, City, and Zip Code of Well Location: 1925 W. 86th St, Bloomington, MN

or Fire Number:

Show exact location of well in section grid with "X". (N, S, E, W, ½ Mile, 1 Mile) NA

Sketch map of well location. Showing property lines, roads and buildings



PROPERTY OWNER'S NAME/COMPANY NAME: City of Bloomington

Property owner's mailing address if different than well location address indicated above:
1800 W. Old Shakopee Road
Bloomington, MN 55431

WELL OWNER'S NAME/COMPANY NAME: Nine Mile Creek Watershed District c/o

Well owner's mailing address if different than property owners address indicated above:
Barr Engineering Company
4700 W. 77th St.
Minneapolis, MN 55435

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Fine sand	Tan	soft	0	11
Med sand & silt	Gray	soft	11	14.5

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc.

WELL DEPTH (completed): 14.5 ft.

Date Work Completed: ~~5/29/08~~ 5/30/08

DRILLING METHOD: ☐ Cable Tool ☒ Auger ☐ Driven ☐ Rotary ☐ Dug ☐ Jetted ☐

DRILLING FLUID: None

WELL HYDROFRACTURED? ☐ Yes ☒ No FROM ____ ft. TO ____ ft.

USE: ☐ Domestic ☐ Noncommunity PWS ☐ Community PWS ☒ Monitoring ☐ Environ. Bore Hole ☐ Irrigation ☐ Dewatering ☐ Heating/Cooling ☐ Industry/Commercial ☐ Remedial ☐

CASING: ☒ Steel ☒ Plastic ☐ Drive Shoe? ☐ Yes ☒ No ☐ Threaded ☐ Welded ☐

CASING DIAMETER		WEIGHT	HOLE DIAM.
2 in. to ~~11.5~~ ~~10~~ 9.5 ft.		lbs./ft.	8¼ in. to 14.5 ft.
in. to ft.		lbs./ft.	in. to ft.
in. to ft.		lbs./ft.	in. to ft.

SCREEN: ~~Stainless Steel~~ PVC
Make: ~~Johnson~~ Roart Longyear
Type: ~~Stainless Steel~~ PVC
Slot/Gauze: .010
Set between: ~~9.5~~ 9.5 ft. and 14.5 ft.

OPEN HOLE: FROM ____ ft. TO ____ ft. Diam. 2 Length 5'
FITTINGS: Drive couplers.

STATIC WATER LEVEL: 13.93 ft. ☒ below ☐ above land surface Date measured 6/2/08

PUMPING LEVEL (below land surface): NA ~~ft. after ____ hrs. pumping ____ g.p.m.~~

WELL HEAD COMPLETION:
☐ Pitless adapter manufacturer ____ Model ____
☒ Casing Protection 6" x 7' protop ☐ 12 in above grade
☐ At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION: Well grouted ☒ Yes ☐ No
Grout material ☐ Neat cement ☐ Bentonite ☐ Concrete ☒ High Solids Bentonite
from 0 to ~~10~~ 9 ft. 2.5 ☐ yds. ☒ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags

NEAREST KNOWN SOURCE OF CONTAMINATION: Unk ~~feet ____ direction ____ type~~

Well disinfected upon completion ☐ Yes ☒ No

PUMP: ☒ Not installed Date installed ____
Manufacturer's name ____
Model number ____ HP ____ Volts ____
Length of drop pipe ____ ft. Capacity ____ g.p.m
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐

ABANDONED WELLS
Does property have any not in use and not sealed well(s) ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN#

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Matrix Environmental — 1916
Licensee Business Name — *Lic. or Reg. No.*

Dan Thompson — 6/5/08
Authorized Representative Signature — *Date*

Dan Thompson
Name of Driller

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY

725259

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 725258

WELL LOCATION
County Name: Hennepin

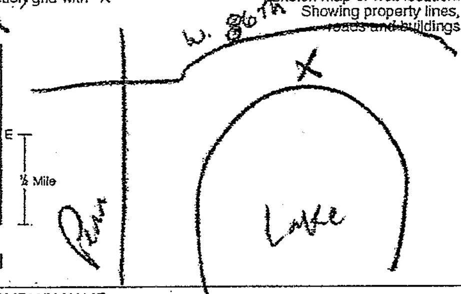
Township Name	Township No.	Range No.	Section No.	Fraction
				¼ ¼ ¼

GPS LOCATION: Latitude ____ degrees ____ minutes ____ seconds ____
Longitude ____ degrees ____ minutes ____ seconds ____

House Number, Street Name, City, and Zip Code of Well Location: 1925 W. 86th St, Bloomington, MN
or Fire Number:

Show exact location of well in section grid with "X" — Sketch map of well location. Showing property lines, roads and buildings

N / S / E / W — ½ Mile — 1 Mile



PROPERTY OWNER'S NAME/COMPANY NAME: City of Bloomington

Property owner's mailing address if different than well location address indicated above:
1800 W. Old Shakopee Road
Bloomington, MN
55431

WELL OWNER'S NAME/COMPANY NAME: Nine Mile Creek Watershed District c/o

Well owner's mailing address if different than property owners address indicated above:
Barr Engineering Company
4700 W. 77th St.
Minneapolis, MN 55435

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Silty Clay	Gray	Soft	1	11
Silt	Dark Brown	soft	11	12
Sandy Silt	Gray	soft	12	15
Silt & sandy silt	Tan	soft	15	16.5
Silty Sand	Gray	Soft	16.5	30

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc.

WELL DEPTH (completed): 30 ft.
Date Work Completed: 5/29/08

DRILLING METHOD: ☐ Cable Tool ☒ Auger ☐ ☐ Driven ☐ Rotary ☐ Dug ☐ Jetted

DRILLING FLUID: None
WELL HYDROFRACTURED? ☐ Yes ☒ No — FROM ____ ft. TO ____ ft.

USE: ☐ Domestic ☐ Noncommunity PWS ☐ Community PWS ☒ Monitoring ☐ Environ. Bore Hole ☐ Irrigation ☐ Dewatering ☐ Heating/Cooling ☐ Industry/Commercial ☐ Remedial ☐

CASING: ☒ Steel ☐ Plastic — Drive Shoe? ☐ Yes ☒ No — ☐ Threaded ☐ Welded ☐

CASING DIAMETER		WEIGHT	HOLE DIAM.
2 in. to 25 ft.		lbs./ft.	8.25 in. to 30 ft.
in. to ft.		lbs./ft.	in. to ft.
in. to ft.		lbs./ft.	in. to ft.

SCREEN: Stainless Steel
Make: Johnson
Type: Stainless — Diam. 2"
Slot/Gauze: .010 — Length 5'
Set between 25 ft. and 30 ft. FITTINGS

OPEN HOLE: FROM ____ ft. TO ____ ft.

STATIC WATER LEVEL: 11.35 ft. ☐ below ☐ above land surface — Date measured 5/30/08

PUMPING LEVEL (below land surface): NA ft. after ____ hrs. pumping ____ g.p.m.

WELL HEAD COMPLETION
☐ Pitless adapter manufacturer ____ Model ____
☒ Casing Protection 6" x 7' protop ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION
Well grouted ☒ Yes ☐ No
Grout material ☐ Neat cement ☐ Bentonite ☐ Concrete ☒ High Solids Bentonite
from 0 to 22 ft 2.5 ☐ yds. ☒ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags

NEAREST KNOWN SOURCE OF CONTAMINATION: NA ____ feet ____ direction ____ type
Well disinfected upon completion ☐ Yes ☐ No

PUMP
☒ Not installed Date installed ____
Manufacturer's name ____
Model number ____ HP ____ Volts ____
Length of drop pipe ____ ft. Capacity ____ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐

ABANDONED WELLS
Does property have any not in use and not sealed well(s) ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN#

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Matrix Environmental
Licensee Business Name — *Lic. or Reg. No.*

Dan Thompson — 5/29/08
Authorized Representative Signature — *Date*

Dan Thompson
Name of Driller

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY — 725258

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 725257

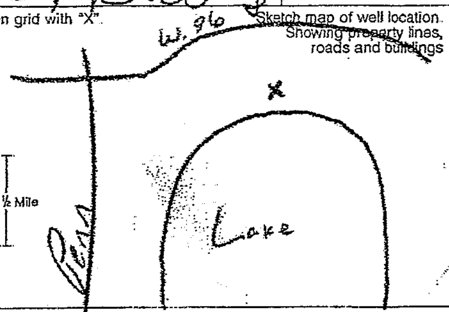
WELL LOCATION
County Name: Hennepin
Township Name: | Township No.: | Range No.: | Section No.: | Fraction: ¼ ¼ ¼

GPS LOCATION: Latitude ____ degrees ____ minutes ____ seconds ____
Longitude ____ degrees ____ minutes ____ seconds ____

House Number, Street Name, City, and Zip Code of Well Location or Fire Number: 1925 W. 86th St, Bloomington

Show exact location of well in section grid with "X". (N, S, E, W; ½ Mile; 1 Mile)

Sketch map of well location. Showing property lines, roads and buildings



PROPERTY OWNER'S NAME/COMPANY NAME: City of Bloomington

Property owner's mailing address if different than well location address indicated above:
1800 W. Old Shakopee Road
Bloomington, MN 55431

WELL OWNER'S NAME/COMPANY NAME: Nine Mile Creek Watershed District c/o

Well owner's mailing address if different than property owners address indicated above:
Barr Engineering Company
4700 W. 77th St.
Minneapolis, MN 55435

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Silty Clay	Gray	Soft	1	11
Silt	Dark Brown	Soft	11	12.5

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc.

WELL DEPTH (completed): 12.5 ft.
Date Work Completed: 5/30/08

DRILLING METHOD: ☐ Cable Tool ☒ Auger ☐ ☐ Driven ☐ Rotary ☐ Dug ☐ Jetted

DRILLING FLUID: None
WELL HYDROFRACTURED? ☐ Yes ☒ No FROM ____ ft. TO ____ ft.

USE: ☐ Domestic ☐ Noncommunity PWS ☐ Community PWS ☒ Monitoring ☐ Environ. Bore Hole ☐ Irrigation ☐ Dewatering ☐ Heating/Cooling ☐ Industry/Commercial ☐ Remedial ☐

CASING: ☐ Steel ☒ Plastic
Drive Shoe? ☐ Yes ☒ No ☐ Threaded ☐ Welded ☐
HOLE DIAM.

CASING DIAMETER: 2 in. to 7.5 ft. | WEIGHT ____ lbs./ft. | ____ in. to ____ ft.
____ in. to ____ ft. ____ lbs./ft. ____ in. to ____ ft.
____ in. to ____ ft. ____ lbs./ft. ____ in. to ____ ft.

SCREEN: Flush thread PVC
Make: Boart Longyear
Type: PVC
Slot/Gauze: .010
Set between 7.5 ft. and 12.5 ft.
OPEN HOLE FROM ____ ft. TO ____ ft.
Diam. 2"
Length 5'
FITTINGS: Flush thread

STATIC WATER LEVEL: 9.7 ft. ☒ below ☐ above land surface Date measured ____

PUMPING LEVEL (below land surface): NA ft. after ____ hrs. pumping ____ g.p.m.

WELL HEAD COMPLETION
☐ Pitless adapter manufacturer ____ Model ____
☒ Casing Protection 6" x 7' protop ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION
Well grouted ☒ Yes ☐ No
Grout material ☐ Neat cement ☐ Bentonite ☐ Concrete ☒ High Solids Bentonite
from 3.5 to 0 ft. .5 ☐ yds. ☒ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags

NEAREST KNOWN SOURCE OF CONTAMINATION: Unk feet ____ direction ____ type
Well disinfected upon completion ☐ Yes ☐ No

PUMP
☒ Not installed Date installed ____
Manufacturer's name ____
Model number ____ HP ____ Volts ____
Length of drop pipe ____ ft. Capacity ____ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐

ABANDONED WELLS
Does property have any not in use and not sealed well(s) ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ____

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Matrix Environmental
Licensee Business Name *Lic. or Reg. No.*

Dan Thompson 5/30/08
Authorized Representative Signature *Date*

Dan Thompson
Name of Driller

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY
725257

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 725256

WELL LOCATION

County Name: Hennepin

Township Name: ___ Township No.: ___ Range No.: ___ Section No.: ___ Fraction: ¼ ¼ ¼

WELL DEPTH (completed): 30 ft.

Date Work Completed: 5/28/08

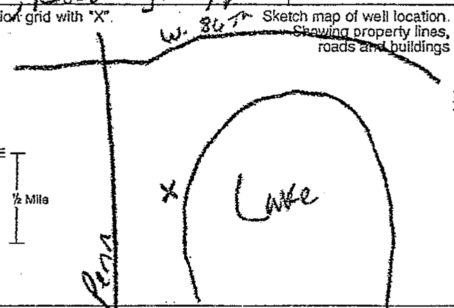
GPS LOCATION: Latitude ___ degrees ___ minutes ___ seconds ___ Longitude ___ degrees ___ minutes ___ seconds ___

House Number, Street Name, City, and Zip Code of Well Location: 1925 W. 86th St. Bloomington, MN

or Fire Number: ___

Show exact location of well in section grid with "X". NA

Sketch map of well location. Showing property lines, roads and buildings.



N / W / E / S — ½ Mile — 1 Mile

DRILLING METHOD: ☐ Cable Tool ☒ Auger ☐ ___ ☐ Driven ☐ Rotary ☐ Dug ☐ Jetted

DRILLING FLUID: None

WELL HYDROFRACTURED? ☐ Yes ☒ No FROM ___ ft. TO ___ ft.

USE: ☐ Domestic ☐ Noncommunity PWS ☐ Community PWS ☒ Monitoring ☐ Environ. Bore Hole ☐ Irrigation ☐ Dewatering ☐ Heating/Cooling ☐ Industry/Commercial ☐ Remedial ☐ ___

CASING: ☒ Steel ☐ Plastic ☐ ___ Drive Shoe? ☐ Yes ☒ No ☐ Threaded ☐ Welded

HOLE DIAM: 8.25 in. to 30 ft.

CASING DIAMETER: 2 in. to 25 ft. WEIGHT ___ lbs./ft.

PROPERTY OWNER'S NAME/COMPANY NAME: City of Bloomington

Property owner's mailing address if different than well location address indicated above:
1800 W. Old Shakopee Road
Bloomington, MN 55431

SCREEN: Stainless Steel
Make: Johnson
Type: Stainless
Slot/Gauze: .010
Set between 25 ft. and 30 ft.

OPEN HOLE: FROM — ft. TO — ft.
Diam. 2"
Length 5'
FITTINGS ___

STATIC WATER LEVEL: 7.6 ft. ☒ below ☐ above land surface Date measured 5/29/08

PUMPING LEVEL (below land surface): Unk ~~ft. after ___ hrs. pumping ___ g.p.m.~~

WELL OWNER'S NAME/COMPANY NAME: Nine Mile Creek Watershed c/o

Well owner's mailing address if different than property owners address indicated above:
Barr Engineering Company
4700 W. 77th St.
Minneapolis, MN 55435

WELL HEAD COMPLETION:
☐ Pitless adapter manufacturer ___ Model ___
☒ Casing Protection 6" X 7' pro top ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION:
Well grouted ☒ Yes ☐ No
Grout material ☐ Neat cement ☒ Bentonite ☐ Concrete ☒ High Solids Bentonite
from 0 to 23.5 ft. 2 ☐ yds. ☒ bags
from ___ to ___ ft. ___ ☐ yds. ☐ bags
from ___ to ___ ft. ___ ☐ yds. ☐ bags

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Gray Silty Clay	Gray	Soft	1	5
Peaty Clay	Black	soft	5	14
Clayey Silt	Tan	soft	14	16
Sand clay & silt	Gray	soft	16	24
Silty clay	Gray	soft	24	30

Use a second sheet, if needed

NEAREST KNOWN SOURCE OF CONTAMINATION: Unk ~~feet ___ direction ___ type~~

Well disinfected upon completion ☐ Yes ☒ No

PUMP: ☒ Not installed Date installed ___
Manufacturer's name ___
Model number ___ HP ___ Volts ___
Length of drop pipe ___ ft. Capacity ___ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐

ABANDONED WELLS: Does property have any not in use and not sealed well(s) ☐ Yes ☒ No

VARIANCE: Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ___

REMARKS, ELEVATION, SOURCE OF DATA, etc.:

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Matrix Environmental
Licensee Business Name *Lic. or Reg. No.*

Dan Thompson 5/28/08
Authorized Representative Signature *Date*

Dan Thompson
Name of Driller

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY

725256

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 725255

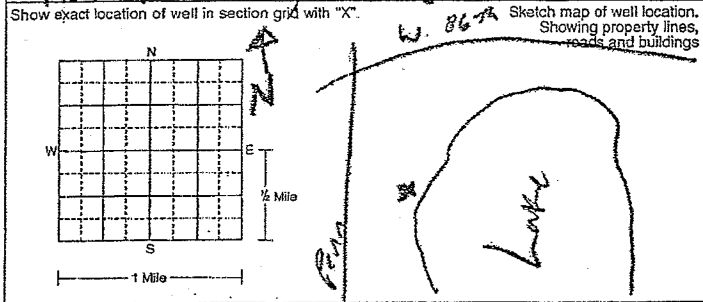
WELL LOCATION
County Name: Hennepin

Township Name	Township No.	Range No.	Section No.	Fraction
				¼ ¼ ¼

GPS LOCATION: Latitude ____ degrees ____ minutes ____ seconds ____
Longitude ____ degrees ____ minutes ____ seconds ____

House Number, Street Name, City, and Zip Code of Well Location: 1925 W. 86th St. Bloomington
or Fire Number:

Show exact location of well in section grid with "X". Sketch map of well location. Showing property lines, roads and buildings



PROPERTY OWNER'S NAME/COMPANY NAME: City of Bloomington

Property owner's mailing address if different than well location address indicated above:
1800 W. Old Shakopee Road
Bloomington, MN 55431

WELL OWNER'S NAME/COMPANY NAME: Nine Mile Creek Watershed District c/o

Well owner's mailing address if different than property owners address indicated above:
Barr Engineering Company
4700 W. 77th St
Minneapolis, MN 55435

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Gray Silty Clay	Gray	Soft	1	5
Peaty Clay	Black	Soft	5	10

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc.

WELL DEPTH (completed): 10 ft.
Date Work Completed: 5/29/08

DRILLING METHOD: ☐ Cable Tool ☒ Auger ☐ ☐ Driven ☐ Rotary ☐ Dug ☐ Jetted

DRILLING FLUID: None
WELL HYDROFRACTURED? ☐ Yes ☒ No
FROM ____ ft. TO ____ ft.

USE: ☐ Domestic ☐ Noncommunity PWS ☐ Community PWS ☒ Monitoring ☐ Environ. Bore Hole ☐ Irrigation ☐ Dewatering ☐ Heating/Cooling ☐ Industry/Commercial ☐ Remedial ☐

CASING: ☐ Steel ☒ Plastic
Drive Shoe? ☐ Yes ☒ No ☐ Threaded ☐ Welded ☐
HOLE DIAM.

CASING DIAMETER / WEIGHT:
2 in. to 5 ft. Sch 40 PVC lbs./ft. 8.25 in. to 10 ft.
____ in. to ____ ft. ____ lbs./ft. ____ in. to ____ ft.
____ in. to ____ ft. ____ lbs./ft. ____ in. to ____ ft.

SCREEN: Flush thread PVC
Make: Boart Longyear
Type: PVC — Diam. 2"
Slot/Gauze: .010 — Length: 5
Set between 5 ft. and 10 ft. FITTINGS: Flush threaded

OPEN HOLE: FROM ____ ft. TO ____ ft.

STATIC WATER LEVEL: 8 ft. ☒ below ☐ above land surface Date measured 6/2/08

PUMPING LEVEL (below land surface): NA ft. after ____ hrs. pumping ____ g.p.m.

WELL HEAD COMPLETION
☐ Pitless adapter manufacturer ____ Model ____
☒ Casing Protection 6" x 7' protop ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION
Well grouted ☒ Yes ☐ No
Grout material ☐ Neat cement ☐ Bentonite ☐ Concrete ☒ High Solids Bentonite
from 0 to 4 ft. .5 ☐ yds. ☒ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags

NEAREST KNOWN SOURCE OF CONTAMINATION: UNK feet ____ direction ____ type
Well disinfected upon completion ☐ Yes ☐ No

PUMP
☒ Not installed Date installed ____
Manufacturer's name ____
Model number ____ HP ____ Volts ____
Length of drop pipe ____ ft. Capacity ____ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐

ABANDONED WELLS
Does property have any not in use and not sealed well(s) ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN#

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Matrix Environmental — 1916
Licensee Business Name — *Lic. or Reg. No.*

Dan Thompson (signature) — 5/29/08
Authorized Representative Signature — *Date*

Dan Thompson
Name of Driller

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY
725255

HE-01205-08 (Rev. 5/02)

IC 140-0020

Minnesota Unique Well No.

224648

County Hennepin
Quad Bloomington
Quad ID 104D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/24/1991
Update Date 06/03/2004
Received Date

Well Name BLOOMINGTON PENN LAKE

Township	Range	Dir	Section	Subsections	Elevation	810 ft.
27	24	W	4	CCDCDB	Elevation Method	7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
157 ft.	157 ft.	09/30/1975

Drilling Method --

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Other (specify in remarks)

Casing Type Steel (black or low carbon) Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below 0 ft.

Casing Diameter	Weight	Hole Diameter
16 in. to 30 ft.	lbs./ft.	
12 in. to 137 ft.	lbs./ft.	

Open Hole from ft. to ft.

Screen YES Make Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
12		20	137 ft. and 157 ft.

Well Address

BLOOMINGTON MN

Geological Material	Color	Hardness	From	To
SAND			0	45
GRAVEL			45	55
SAND + GRAVEL			55	120
SAND + CLAY			120	128
SAND + GRAVEL			128	157

Static Water Level
11 ft. from Land surface Date Measured 09/30/1975

PUMPING LEVEL (below land surface)
31 ft. after hrs. pumping 550 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
M.G.S. NO.1076

Grouting Information Well Grouted? ☐ Yes ☐ No

Located Minnesota Geological Survey
Method Digitized - scale 1:24,000 or larger (Digitizing Table)

Unique Number Verification Information from owner
Date N/A

System *UTM - Nad83, Zone15, Meters* X: 475843 Y: 4966132

Nearest Known Source of Contamination
__feet __direction __type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number__ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Cuttings Yes
First Bedrock
Last Strat Sand
Aquifer Quat. Water Table Aquifer
Depth to Bedrock ft.

Well Contractor Certification

Keys Well Co.	62012	
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report

224648

Printed 10/12/2008
HE-01205-07

Change in Lake Stage for Various Pumping Scenarios
Lower Penn Lake
Bloomington, MN

Volume Added (gal) / Starting Lake Elev. (ft)	1,000,000	2,000,000	3,000,000	4,000,000	5,000,000	6,000,000	7,000,000	8,000,000	9,000,000	10,000,000
803.0	803.1	803.2	803.3	803.4	803.5	803.6	803.7	803.8	803.9	804.0
803.1	803.2	803.3	803.4	803.5	803.6	803.7	803.8	803.9	804.0	804.1
803.2	803.3	803.4	803.5	803.6	803.7	803.8	803.9	804.0	804.1	804.2
803.3	803.4	803.5	803.6	803.7	803.8	803.9	804.0	804.1	804.2	804.3
803.4	803.5	803.6	803.7	803.8	803.9	804.0	804.1	804.2	804.3	804.4
803.5	803.6	803.7	803.8	803.9	804.0	804.1	804.2	804.3	804.4	804.5
803.6	803.7	803.8	803.9	804.0	804.1	804.2	804.3	804.4	804.5	804.6
803.7	803.8	803.9	804.0	804.1	804.2	804.3	804.4	804.5	804.6	804.7
803.8	803.9	804.0	804.1	804.2	804.3	804.4	804.5	804.6	804.7	804.8
803.9	804.0	804.1	804.2	804.3	804.4	804.5	804.6	804.7	804.8	804.9
804.0	804.1	804.2	804.3	804.4	804.5	804.6	804.7	804.8	804.9	805.0
804.1	804.2	804.3	804.4	804.5	804.6	804.7	804.8	804.9	805.0	805.1
804.2	804.3	804.4	804.5	804.6	804.7	804.8	804.9	805.0	805.1	805.2
804.3	804.4	804.5	804.6	804.7	804.8	804.9	805.0	805.1	805.2	805.3
804.4	804.5	804.6	804.7	804.8	804.9	805.0	805.1	805.2	805.3	805.4
804.5	804.6	804.7	804.8	804.9	805.0	805.1	805.2	805.3	805.4	805.5
804.6	804.7	804.8	804.9	805.0	805.1	805.2	805.3	805.4	805.5	805.6
804.7	804.8	804.9	805.0	805.1	805.2	805.3	805.4	805.5	805.6	805.7
804.8	804.9	805.0	805.1	805.2	805.3	805.4	805.5	805.6	805.7	805.8
804.9	805.0	805.1	805.2	805.3	805.4	805.5	805.6	805.7	805.8	805.9
805.0	805.1	805.2	805.3	805.4	805.5	805.6	805.7	805.8	805.9	806.0
805.1	805.2	805.3	805.4	805.5	805.6	805.7	805.8	805.9	806.0	806.1
805.2	805.3	805.4	805.5	805.6	805.7	805.8	805.9	806.0	806.1	806.2
805.3	805.4	805.5	805.6	805.7	805.8	805.9	806.0	806.1	806.2	806.3
805.4	805.5	805.6	805.7	805.8	805.9	806.0	806.1	806.2	806.3	806.4
805.5	805.6	805.7	805.8	805.9	806.0	806.1	806.2	806.3	806.4	806.5
805.6	805.7	805.8	805.9	806.0	806.1	806.2	806.3	806.4	806.5	806.6
805.7	805.8	805.9	806.0	806.1	806.2	806.3	806.4	806.5	806.6	806.7
805.8	805.9	806.0	806.1	806.2	806.3	806.4	806.5	806.6	806.7	806.8
805.9	806.0	806.1	806.2	806.3	806.4	806.5	806.6	806.7	806.8	806.9
806.0	806.1	806.2	806.3	806.4	806.5	806.6	806.7	806.8	806.9	807.0
806.1	806.2	806.3	806.4	806.5	806.6	806.7	806.8	806.9	807.0	
806.2	806.3	806.4	806.5	806.6	806.7	806.8	806.9	807.0		
806.3	806.4	806.5	806.6	806.7	806.8	806.9	807.0			
806.4	806.5	806.6	806.7	806.8	806.9	807.0				
806.5	806.6	806.7	806.8	806.9	807.0					
806.6	806.7	806.8	806.9	807.0						
806.7	806.8	806.9	807.0							
806.8	806.9	807.0								
806.9	807.0									

Lake level above outlet elevation

Notes:

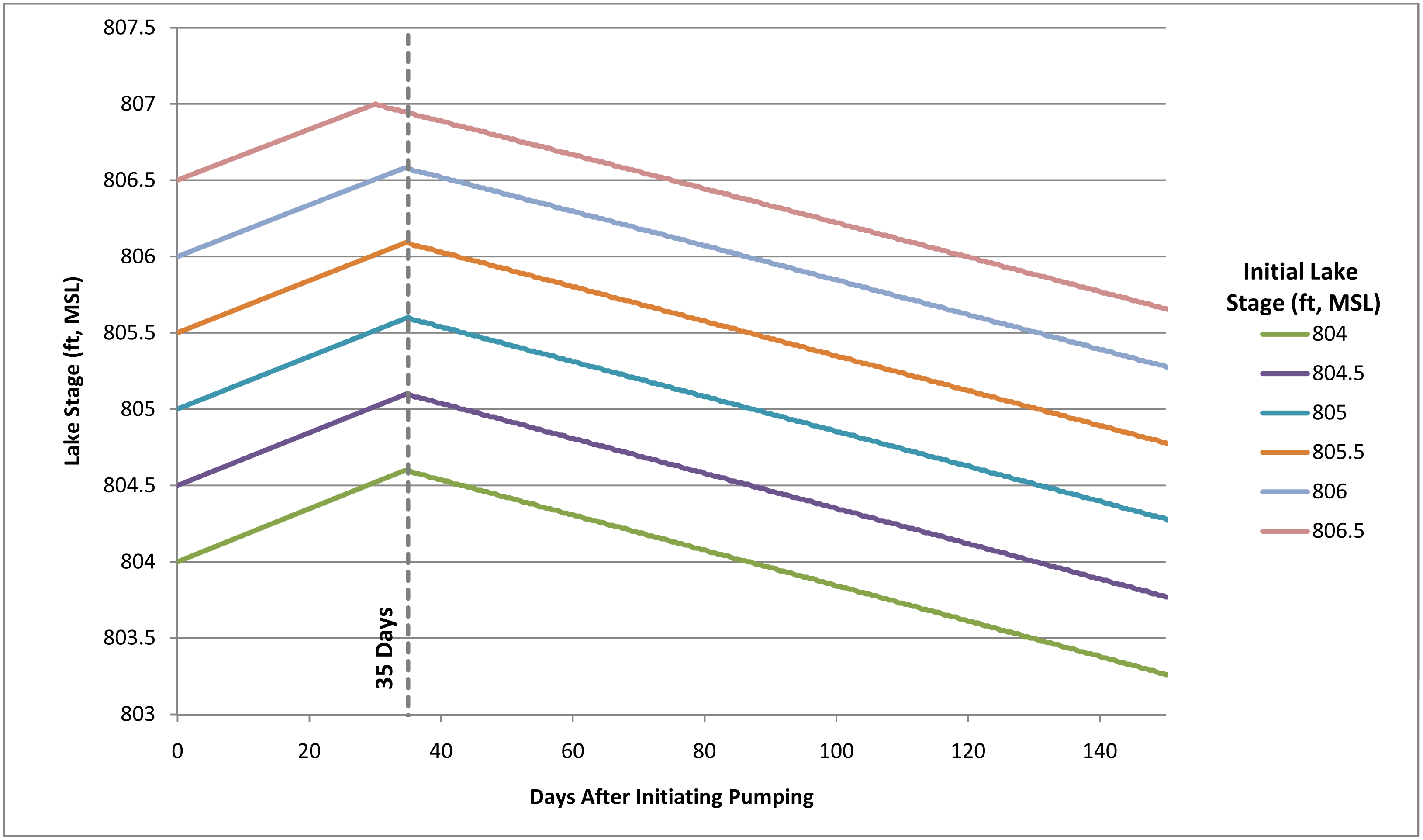
1.) Table assumes no other contributions or losses from the lake (i.e. precipitation, evaporation, runoff, groundwater flow).

2.) Minnesota Statute 103G.271, Subd. 5a limits pumping of groundwater for lake level augmentation to 10 Mgal per year.

3.) Based on the pumping test conducted in summer of 2008, the well on the north side of the lake pumps at an average rate of 318 gal/min. At this pumping rate, the 10 Mgal limit will be met after approximately 524 hours (21.8 days).

4.) Assuming an average groundwater flow out of the lake of 114,000 gallons per day (0.35 acre-ft per day), over the course of 21.8 days approximately 2.5 Mgal will be lost to groundwater, reducing the actual amount of change in lake level.

Increase in Lake Stage Due to Pumping and Subsequent Decline in Lake Stage Due Groundwater Seepage
Lower Penn Lake
Bloomington, MN



Notes:

1.) Chart assumes a constant groundwater flow out of the lake of 114,000 gallons per day (0.35 acre-ft per day)

2.) Minnesota Statute 103G.271, Subd. 5a limits pumping of groundwater for lake level augmentation to 10 Mgal per year

3.) Chart assumes a constant pumping rate of 198.4 gpm (10Mgal over 35 days)

4.) Pumping assumed to cease after 35 days or when lake stage reaches outlet elevation (807 ft)

5.) Chart assumes no other contributions or losses for the lake (i.e. precipitation, evaporation, runoff)

6.) When initial lake stage is 806.5, the lake elevation reaches the outlet stage after 30 days (8.57 Mgal pumped) and the pump is turned off.

APPENDIX I

Minnesota Department of Natural Resources
Central Region Waters - 1200 Warner Road, St. Paul, MN 55106-6793
Telephone: (651) 259-5845   Fax: (651) 772-7977

Minnesota
DEPARTMENT OF NATURAL RESOURCES

August 31, 2009

Scott Anderson, Engineering Division
City of Bloomington
1700 West 98th Street
Bloomington, Minnesota 55431-2501

Subject: Lower Penn Lake (27-4) Draft Management Plan, Second Draft, City of Bloomington, Hennepin County

Dear Mr. Anderson:

The Department of Natural Resources Division of Waters is in receipt of the Lower Penn Lake Draft Management Plan, Second Draft, dated August 3, 2009. We offer the following comments on the Plan.

The Plan accurately describes the history and current condition of Penn Lake. We support the currently programmed implementation strategies. We suggest that the public education component include information on the impact of climatic conditions on the water level of Penn Lake, such as how the drought of 2008-2009 has impacted the water levels of lakes and streams throughout the metropolitan area, not just Penn Lake. We are available to assist your staff in incorporating such information into the public education strategy.

Regarding potential implementation strategies, we recommend that the City prioritize these strategies. We recommend that the strategies that will reduce the introduction of external sources of phosphorus and sediment be addressed as a higher priority. Without a significant reduction in new phosphorus and sediment from entering Lower Penn Lake, strategies dealing only with existing in-lake phosphorus and sediment may be ineffective or the benefits short-lived. Therefore, we recommend that establishment of a water quality monitoring program (option G) be the highest priority so as to establish a good baseline of information that can be used to evaluate the effectiveness of the implemented strategies and help guide future lake management decisions.

We also recommend that improving the existing sediment ponds (option J), and development of a vegetative management plan (option L) be priorities. If the desired reduction in phosphorus is not achieved using those strategies, we recommend a more detailed evaluation – and possible implementation, if so indicated - of strategies to retro-fit water quality treatment devices to the existing storm sewer system (option K), and parking lot sweeping (options N). We do not recommend that an alum treatment (option H) or barley straw application (option I) be used until external sources of phosphorus have been reduced.

Regarding the strategies regarding rough fish removal and construction of a fish barrier, please consult with DNR Fisheries to discuss if these options are feasible and practical solutions that will improve the Penn Lake fishery.

We strongly agree with your conclusion that whole lake dredging and use of the ground water well are not feasible and not practical given current state permits, statutes, and rules. The Plan accurately states that any proposed dredging on Penn Lake would conflict with state rules, which prohibit excavation of Public Waters when there are feasible and practicable alternate solutions which do not require excavation. The Plan is accurate in its reference to *Minnesota Statute* 103G.271 Subd. 5. This statute prohibits the use of groundwater to augment surface waters in excess of 10 million gallons per year. Please be advised that there is absolutely no exception to this statute and no variances are possible under any circumstance. We advise the City that appropriating up to the authorized 10 million gallons of ground water per year is not a useful lake management strategy because it does not help in meeting any of the lake management goals. The water balance studies have demonstrated that ground water augmentation has little or no effect on surface water levels and the City has installed a lake aeration system that recirculates lake water, which provides sufficient dissolved oxygen for fish survival during the winter.

We feel that this plan balances the interests of the public, state laws and regulations, agency direction, scientific data, and limited budgets. The Plan represents a good strategy for meeting the goals and objectives for Lower Penn Lake, as described in the Plan. We thank you and your citizens for your efforts to protect, restore, and enhance the water resources of the State of Minnesota.

If you have any questions regarding these comments or need further input from the DNR, please contact me at 651-259-5754.

Sincerely,

John M. Gleason

John M. (Jack) Gleason
Area Hydrologist

c: Kevin Bigalke, Nine Mile Creek WSD
Bob Obermeyer, Barr Engineering
Dale E. Homuth, Regional Hydrologist
Daryl Ellison, Area Fisheries Supervisor
Mike North, Ecological Resources
Bryan Leuth, DNR Wildlife
Penn Lake (27-4) File

APPENDIX J

Name: LOWER PENN

Nearest Town: BLOMMINGTON
Primary County: Hennepin

Survey Date: 07/08/1996
Inventory Number: 27-0004-00

Public Access Information

Ownership	Type	Description
City	Concrete	A MUNICIPAL BOATRAMP & PARKING AREA IS LOCATED ON THE NORTHWEST CORNER OF THE LAKE.

Lake Characteristics

Lake Area (acres): 31.00
Littoral Area (acres): 31.00
Maximum Depth (ft): 7.00
Water Clarity (ft): 1.00

Dominant Bottom Substrate: muck, sand, boulders (>10")
Abundance of Aquatic Plants: sparse
Maximum Depth of Plant Growth (ft): 1.00

Fish Sampled up to the 1996 Survey Year

Species	Gear Used	Number of fish per net		Average Fish Weight (lbs)	Normal Range (lbs)
		Caught	Normal Range		
Black Bullhead	Trap net	1.4	2.5 - 70.2	0.21	0.1 - 0.5
Black Crappie	Trap net	32.8	1.3 - 27.7	ND	0.1 - 0.4
Bluegill	Trap net	6.4	2.8 - 43.3	0.07	0.1 - 0.3
Common Carp	Trap net	2.4	0.4 - 2.9	1.90	1.4 - 4.5
Hybrid Sunfish	Trap net	0.2	N/A - N/A	0.06	N/A - N/A
White Crappie	Trap net	13.2	0.3 - 8.2	0.18	0.1 - 0.5
Yellow Perch	Trap net	0.4	0.4 - 3.5	0.08	0.1 - 0.2

Normal Ranges represent typical catches for lakes with similar physical and chemical characteristics.

Length of Selected Species Sampled for All Gear for the 1996 Survey Year

Species	Number of fish caught in each category (inches)								
	0-5	6-8	9-11	12-14	15-19	20-24	25-29	30+	Total
Black Bullhead	1	6	0	0	0	0	0	0	7
Black Crappie	30	94	2	0	0	0	0	0	126
Bluegill	31	1	0	0	0	0	0	0	32
Hybrid Sunfish	1	0	0	0	0	0	0	0	1
White Crappie	12	49	5	0	0	0	0	0	66
Yellow Perch	2	0	0	0	0	0	0	0	2

Fish Consumption Guidelines

No fish consumption guidelines are available for this lake. For more information, see the "Fish Consumption Advice" pages at the Minnesota Department of Health.

Status of the Fishery (as of 07/08/1996)

Lower Penn Lake is annually stocked with adult black crappies and bluegills. Black crappies were the most abundant species sampled. The average length was 6.3 inches. Only 5% of the black crappies captured were over 8 inches in length. White crappies were also very abundant. Their average length was 6.8 inches.

The bluegill population is within normal levels when compared to similar lakes, but their average length is only 4.4 inches. Only one bluegill over 6.0 inches was sampled in the trapnets, but growth is above average.

The black bullhead and carp populations were much less abundant than in previous years. The average black bullhead was 7.2 inches while the average length carp was 15.8 inches.

For more information on this lake, contact:

Area Fisheries Supervisor
9925 Valley View Rd
Eden Prairie, MN 55344
Phone: (952) 826-6771
E-Mail: metrowest.fisheries@dnr.state.mn.us

For general DNR Information, contact:

DNR Information Center
500 Lafayette Road
St. Paul, MN 55155-4040
TDD: (651) 296-6157 or (888) MINNDNR
Internet: www.dnr.state.mn.us
E-Mail: info@dnr.state.mn.us

Lake maps can be obtained from:

Minnesota Bookstore
660 Olive Street
St. Paul, MN 55155
(651) 297-3000 or (800) 657-3757
To order, use C2697 for the map-id.

Turn in Poachers (TIP):

Toll-free: (800) 652-9093

LAKE MANAGEMENT PLAN

(Use reverse side and add additional sheets as needed)

Region	Area	D.O.W. Number	County	Lake Name (Lake Class)	Acreage
6	West Metro	27 - 4	Hennepin	Penn	31 (31)

Long Range Goal:

Manage in the Kid's Fishing Pond Program by maintaining a fishery that will support 150 angler hours per acre.

Operational Plan:

1) Monitor winter oxygen levels to ensure that a high density of panfish is maintained.
2) If the aeration system fails and winterkill appears likely based on winter oxygen, stock 10 adult bluegills, 10 adult black crappie and 10 adult largemouth bass as brood stock.

Mid Range Objective:

Maintain the present level of fishing pressure of about 150 hours per acre.

Potential Plan:

None

Primary Species Management	Secondary Species Management
Bluegill, black crappie	Largemouth bass

Area Supervisor's Signature	Date
[signature]	9/21/98
Regional Supervisor's Signature	**Date**
[signature]	12/11/98

FOR CENTRAL OFFICE USE ONLY

Entry Date	Year Resurvey

Stock Species - Size - Number per Acre

Pr./Sec.

Schedule	Year Beginning

Population Manipulation

☐ Yes ☐ No Year ____ ____

Development

☐ Yes ☐ No Year ____ ____

Creel or Use Survey

☐ Yes ☐ No Year ____ ____

Other

NARRATIVE:

(Historical perspectives - various surveys; past management; social considerations; present limiting factors; survey needs; land acquisition; habitat development and protection; commercial fishery; stocking plans; other management tools; and evaluation plans.)

VARIOUS SURVEYS:

Lake survey in 1974, 1980, 1986; population assessment in 1977, 1978, 1979, 1981, 1982 and 1991; lake reconnaissance in 1962; recreational census in 1980; electrofishing in 1977 and 1978; winter oxygen testing since 1976; creel survey in 1983.

PAST MANAGEMENT:

Prior to the installation of the aeration system, dredging and water augmentation in 1977, the lake wasn't managed for fishing. Since these changes were implemented, walleye, largemouth bass, black crappie, bluegill and northern pike have been stocked. Penn Lake has been managed as a kid's fishing pond since 1980 by stocking adult bluegill and black crappie.

cc Area Fisheries, Regional Fisheries, Central Office Fisheries

SOCIAL CONSIDERATIONS:

The City of Bloomington was active in the management of Penn Lake by providing a combination water level augmentation well/aeration device, outlet control structure, dredging and public boat launch site. The 1980 recreational use survey indicated that fishing (151 angler hours per acre) was the majority of use on the lake. Canoes/rowboats (9 man hours per acre), inflatable rafts (1 man hour per acre) and sailboats (0.7 man hours per acre) made up the other activities on the lake. The City of Bloomington placed surface use restrictions for all lakes and rivers of 8 mph speed limit from sunrise until sunset and 5 mph from sunset to sunrise, 6 horsepower limit and a minimum distance for boats of 150 feet from a swimming area.

PRESENT LIMITING FACTORS:

Penn Lake is part of the City of Bloomington's storm sewer system. The lake receives high phosphorus loading. The poor water quality increases the chance of winterkill. An aeration system reduces the frequency of winterkill. A leak in the basin seal causes a loss of water from the wetland. Well water is pumped into the lake to maintain water levels.

SURVEY NEEDS:

No surveys are needed since the aeration system reduces the chance of winterkill.

LAND ACQUISITIONS:

None needed.

HABITAT DEVELOPMENT AND PROTECTION:

The aeration system and water level augmentation should be continued to provide adequate fishery habitat.

COMMERCIAL FISHERY:

Carp relative abundance was high in 1991.

STOCKING PLANS:

The installation of the aeration system allows bluegill and black crappie to overwinter. If the aeration system fails and winterkill appears likely based on winter oxygen, stock 10 adult bluegills, 10 adult black crappie and 10 adult largemouth bass as brood stock.

EVALUATION PLANS:

No netting surveys are needed with this management strategy.

LAKE	DOWNO	YEAR	SPECIES	SIZE	NUMBER STOCKED
LONG	270160				
		1994	WAE	FRY	130000
		1995	WAE	FRY	131000
		1996	WAE	FRY	100000
		1997	WAE	FRY	131000
		1998	WAE	FRY	466000
		1999	WAE	YRL	667
		2001	WAE	FGL	4540
LORING	270655				
		2001	BLC	ADL	417
		2001	BLG	ADL	465
LOST HORSE	271121				
		2001	WAE	FRY	40000
LOTUS	100006				
		1986	WAE	FGL	11627
		1988	WAE	FGL	4371
		1991	WAE	FGL	2156
		1991	WAE	YRL	27
		1993	WAE	FGL	2763
		1995	WAE	YRL	902
		1997	WAE	FGL	2082
		1998	WAE	FGL	1004
		1999	WAE	YRL	305
		2001	WAE	FGL	7992
LOWER PENN	270004				
		1977	BLG	ADL – adult	7370 – Bluegill
		1977	LMB	FRY –	2400 – largemouth bass
		1977	WAE	FRY	21000 – walleye
		1978	BLG	ADL	4032
		1978	LMB	FRY	11728
		1978	NOP	ADL	1 – N. Pike
		1978	NOP	FGL – fingerling	2635
		1978	NOP	YRL – yearling	18
		1979	LMB	FRY	12300
		1979	NOP	YRL	180
		1980	BLC	ADL	607 – black crappie
		1980	BLG	ADL	44
		1980	NOP	ADL	161
		1980	NOP	YRL	175
		1981	BLC	ADL	490
		1981	BLG	ADL	110
		1982	BLC	ADL	742
		1982	BLG	ADL	168
		1982	NOP	ADL	200
		1983	BLC	ADL	884
		1983	BLG	ADL	38
		1983	NOP	YRL	575
		1984	BLC	ADL	778
		1985	BLC	ADL	248
		1985	NOP	YRL	70
		1986	BLC	ADL	295
		1986	BLG	ADL	809
		1987	BLC	ADL	300
		1988	BLC	ADL	300
		1989	BLC	ADL	579
		1989	BLG	ADL	477
		1990	BLC	ADL	150
		1991	BLC	ADL	828
		1992	BLC	ADL	834
		1992	LMB	FGL	3316
		1993	BLC	ADL	416
		1994	BLC	ADL	384
LOWER PRIOR	700026				
		1976	WAE	FGL	315
		1977	WAE	FGL	5759

LAKE	DOWNO	YEAR	SPECIES	SIZE	NUMBER STOCKED
PARLEY	100042				
		1991	WAE	FRY	130000
		1992	WAE	FRY	133940
		1993	WAE	FRY	130000
		1994	WAE	FRY	130000
		1995	WAE	FRY	230000
		1996	WAE	FRY	200000
		1997	WAE	FRY	230000
		1998	WAE	FRY	465000
		1999	WAE	FRY	460000
		2000	WAE	FRY	480000
		2001	WAE	FRY	207000
PENN	270004				
		1995	BLC	ADL	301
		1995	BLG	ADL	144
		1996	BLC	ADL	260
		1996	BLG	ADL	246
		1997	BLC	ADL	100
		1997	BLG	ADL	256
		1998	BLC	ADL	155
		1998	BLG	ADL	258
PETERSON	270936				
		1977	WAE	FRY	16100
		1978	WAE	FRY	30000
		1979	WAE	FRY	29000
		1980	WAE	FRY	30000
		1981	WAE	FRY	32000
		1983	WAE	FRY	55000
		1987	WAE	FRY	65000
PIERSONS	100053				
		1978	NOP	FGL	5038
		1984	TME	FGL	300
		1988	TME	FGL	367
		1990	TME	FGL	136
		1990	TME	YRL	15
		1994	TME	FGL	166
		1997	TME	FGL	270
		2001	TME	FGL	180
PLEASANT	700098				
		2001	WAE	FRY	1500000
POWDERHORN	270014				
		1976	BLG	ADL	5007
		1976	LMB	FGL	100
		1976	LMB	FRY	5000
		1977	BLG	ADL	3002
		1977	LMB	FRY	3000
		1977	NOP	FRY	6000
		1978	BLG	ADL	3171
		1979	NOP	FRY	3500
		1979	LMB	FRY	5000
		1980	BLC	ADL	482
		1980	BLG	ADL	48
		1981	BLC	ADL	465
		1981	BLG	ADL	54
		1982	BLC	ADL	402
		1982	BLG	ADL	504
		1983	BLC	ADL	479
		1983	BLG	ADL	19
		1984	BLB	ADL	212
		1984	BLC	ADL	328
		1985	BLC	ADL	510
		1986	BLG	ADL	497
		1986	NOP	YRL	26
		1987	BLC	ADL	318
		1987	BLG	ADL	270

BLC = black crappie

BLG = bluegill

APPENDIX K

Potential Projects from the Draft Lower Penn Lake Management Plan

		Preliminary Cost Estimate/Draft Projections													
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	not scheduled	
Potential City Funded Alternatives															
A	Public education														$0
B	Excavate accumulated sediment at storm sewer inlets	0	100,000	0	0	0	0	0	0	0	0	0	0		100,000
C	Waterfowl feeding ban sign/ordinance	0	0	0	0	0	0	0	0	0	0	0	0		
D	Winter aeration	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000		60,000
F	Fish Inventory		10,000										10,000		20,000
K	Sediment pond reconstruction	0	0	100,000	0	0	0	0	0	0	0	0	0		100,000
L	Storm sewer retro-fits				100,000 each site			100,000				100,000			300,000
N	Increase street sweeping frequency		30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000		330,000
Q	Whole lake dredging to create deeper water													1,500,000	
R	Remove/seal groundwater well			25,000											
	Subtotal	5,000	145,000	160,000	135,000	35,000	35,000	135,000	35,000	35,000	35,000	135,000	45,000	1,500,000	2,435,000
Potential Third-Party Funded Alternatives															
E	Water quality monitoring program	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000		180,000
G	Rough fish removal	0	0	0	15,000	0	0	0	0	0	0	0	0		15,000
H	Fish barrier construction	0	0	150,000	0	0	0	0	0	0	0	0	0		150,000
I	Alum treatment	0	0	0	50,000	0	0	0	50,000	0	0	0	50,000		150,000
J	Barley straw application	0	0	0	25,000	25,000	25,000	25,000	0	0	0	0	0		100,000
M	Vegetation management plan	0	0	0	50,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000		130,000
O	Park/parking lot cleanup	500	500	500	500	500	500	500	500	500	500	500	500		6,000
P	Maintain, replace or improve groundwater well for add'l augmentation													50,000	
	Subtotal	15,500	15,500	165,500	155,500	50,500	50,500	50,500	75,500	25,500	25,500	25,500	75,500	50,000	781,000
	TOTAL	20,500	160,500	325,500	290,500	85,500	85,500	185,500	110,500	60,500	60,500	160,500	120,500	1,550,000	3,216,000

Recommended as part of this plan. $360,000

Identified as potential projects needing additional feasibility, partners, and funding. $1,281,000

Not recommended. $1,550,000

Recommended outside of this plan. $25,000